Scheme of B. Tech – Electrical Engineering, w.e.f. Session 2018-19

2nd Year

SEMESTER - III

S. No.	Course Code	Course Title	Teaching Schedule (Hours per week)			Credits
			L	T	P	
1.	PCC-EE201-T	Electrical Circuits and Networks	3	1	0	4
2.	PCC-EE203-T	Electronic Devices and Circuits	3	0	0	3
3.	PCC-EE205-T	Electrical Machines-I	3	1	0	4
4.	PCC-EE207-T	Generation of Electric Power	3	1	0	4
5.	BSC201-T	Mathematics-III	3	0	0	3
6.	PCC-EE203-P	Electronic Devices and Circuits Laboratory	0	0	2	1
7.	PCC-EE205-P	Electrical Machines-I Laboratory	0	0	3	1.5
8.	PCC-EE209-P	Electrical Workshop	0	0	2	1
9.	MC103-T	Indian Constitution	3	0	0	0
					Total Credits	**21.5**

L-Lecture, T-Tutorial, P-Practical

Course Code	Definition/Category
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
MC	Mandatory Courses
PCC	Program Core Courses
PEC	Program Elective Courses
OEC	Open Elective Courses
PROJ	Project Work
INT	Practical Training

Note: Students will be allowed to use non-programmable scientific calculator only, however sharing of calculator will not be permitted.

Scheme of B. Tech – Electrical Engineering, w.e.f. Session 2018-19

2nd Year

SEMESTER - IV

S. No.	Course Code	Course Title	Teaching Schedule (Hours per Week)			Credits
			L	T	P	
1.	PCC-EE202-T	Power Electronics	3	0	0	3
2.	PCC-EE204-T	Electrical Machines-II	3	1	0	4
3.	PCC-EE206-T	Power Systems-I	3	1	0	4
4.	PCC-EE208-T	Fields and Waves	3	1	0	4
5.	PCC-EE210-T	Signals and Systems	3	0	0	3
6.	PCC-EE202-P	Power Electronics Laboratory	0	0	2	1
6.	PCC-EE204-P	Electrical Machines-II Laboratory	0	0	3	1.5
7	PCC-EE206-P	Power Systems-I Laboratory	0	0	2	1
8.	MC104-T	Essence of Indian Traditional Knowledge	3	0	0	0
					Total Credits	**21.5**

Important Notes:

1. The students will have to undergo Practical Training-I of 4-6 weeks duration during summer vacations at the end of 4th semester which will be evaluated in 5th semester.

2. Students will be allowed to use non-programmable scientific calculator only, however sharing of calculator will not be permitted.

Scheme of B. Tech – Electrical Engineering, w.e.f. Session 2018-19

3rd Year

SEMESTER - V

S. No.	Course Code	Course Title	Teaching Schedule (Hours per Week)			Credits
			L	T	P	
1.	PCC-EE301-T	Advanced Power Electronics and Drives	3	0	0	3
2.	PCC-EE303-T	Control Systems-I	3	1	0	4
3.	PCC-EE305-T	Microprocessors and Microcontrollers	3	0	0	3
4.	ESC-EE307-T	Electrical Engineering Materials	3	0	0	3
5.	PCC-EE301-P	Advanced Power Electronics and Drives Laboratory	0	0	2	1
6.	PCC-EE303-P	Control Systems-I Laboratory	0	0	2	1
7.	PCC-EE305-P	Microprocessors and Microcontrollers Laboratory	0	0	2	1
8.	Open Elective Course – I		3	0	0	3
9.	HSMC302-T	Fundamentals of Management for Engineers	2	0	0	2
10.	INT-EE309-P	Practical Training-I Presentation	0	0	2	1
					Total Credits	**22**

Important Notes:

1. Open Elective Course– I to be offered by departments other than Electrical Engineering.
2. 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.
3. Students will be allowed to use non-programmable scientific calculator only, however sharing of calculator will not be permitted.

Scheme of B. Tech – Electrical Engineering, w.e.f. Session 2018-19

3rd Year

SEMESTER - VI

S. No.	Course Code	Course Title	Teaching Schedule (Hours per Week)			Credits
			L	T	P	
1.	PCC-EE302-T	Power Systems-II	3	1	0	4
2.	PCC-EE304-T	Electrical Measurements and Instrumentation	3	1	0	4
3.	PCC-EE306-T	Control Systems-II	3	0	0	3
4.	PCC-EE302-P	Power Systems-II Laboratory	0	0	2	1
5.	PCC-EE304-P	Electrical Measurements and Instrumentation Laboratory	0	0	2	1
6.	PCC-EE306-P	Control Systems-II Laboratory	0	0	2	1
7.	Program Elective Course– I		3	0	0	3
8.	Open Elective Course– II		3	0	0	3
9.	HSMC301-T	Economics for Engineers	2	0	0	2
					Total Credits	**22**

Important Notes:

1. Open Elective Course– II to be offered by departments other than Electrical Engineering.
2. The students will have to undergo Practical Training-II of 4-6 weeks duration during summer vacations in an industry/research institute at the end of 6th semester which will be evaluated in 7th semester.
3. Students will be allowed to use non-programmable scientific calculator only, however sharing of calculator will not be permitted.

Scheme of B. Tech – Electrical Engineering, w.e.f. Session 2018-19

4th Year

SEMESTER – VII

S. No.	Course Code	Course Title	Teaching Schedule (Hours per Week)			Credits
			L	T	P	
1.	PCC-EE401-T	Power System Operation and Control	3	1	0	4
2.	Program Elective Course – II		3	0	0	3
3.	Program Elective Course – III		3	0	0	3
4.	Open Elective Course – III		3	0	0	3
5.	PROJ-EE419-P	Minor Project	0	0	8	4
6.	INT-EE421-P	Practical Training-II Presentation	0	0	2	1
					Total Credits	18

Important Notes:

1. Open Elective Course– II to be offered by departments other than Electrical Engineering.
2. The Minor Project should be initiated by the student in the beginning of 7th semester and will be evaluated at the end of the semester on the basis of its implementation, presentation delivered, viva-voce and report.
3. The viva-voce for Minor Project by external examiner and Chairperson of the Department (Internal Examiner) at the end of the semester.
4. Assessment of Practical Training-II will be based on presentation/seminar delivered, viva-voce, report and certificate for the practical training taken at the end of 6th semester.
5. Students will be allowed to use the scientific calculator only, however sharing of calculator will not be permitted.

Scheme of B. Tech – Electrical Engineering, w.e.f. Session 2018-19

4th Year

SEMESTER - VIII

S. No.	Course Code	Course Title	Teaching Schedule (Hours per Week)			Credits
			L	T	P	
1.	PCC-EE402-T	Computer Methods in Power Systems	3	1	0	4
2.	Program Elective Course – IV		3	0	0	3
3.	Program Elective Course – V		3	0	0	3
4.	PCC-EE402-P	Computer Methods in Power Systems Laboratory	0	0	2	1
5.	PROJ-EE420-P	Major Project	0	0	12	6
6.	MC-EE422-P	General Proficiency	0	0	0	0
					Total Credits	**17**

Important Notes:

1. The project should be initiated by the student in continuation of the 7th semester and will be evaluated at the end of the 8thsemester on the basis of its implementation (software/hardware), presentation delivered, viva-voce and report.

2. A viva-voce of the students for Major Project will be taken by external examiner and Chairperson of the Department (Internal Examiner) at the end of the semester.

3. General Proficiency is a non-credit Mandatory Course and the student has to get pass marks in order to qualify for the award of degree.

4. Students will be allowed to use non-programmable scientific calculator only, however sharing of calculator will not be permitted.

Scheme of B. Tech – Electrical Engineering, w.e.f. Session 2018-19

Lists of Program Electives

PEC-I:

1. PEC-EE308-T Renewable Energy Resources
2. PEC-EE310-T Network Synthesis and Filters
3. PEC-EE312-T Digital Signal Processing
4. PEC-EE314-T Modeling and Simulation
5. Any one MOOCS/SWAYAM/Equivalent course not studied earlier

PEC-II:

1. PEC-EE403-T Electrical Machine Design
2. PEC-EE405-T Advance Power Electronics
3. PEC-EE407-T Reliability Engineering
4. PEC-EE409-T Utilization of Electrical Energy
5. Any one MOOCS/SWAYAM/Equivalent course not studied earlier

PEC-III:

1. PEC-EE411-T Energy Management and Auditing
2. PEC-EE413-T Soft Computing
3. PEC-EE415-T SCADA System and Applications
4. PEC-EE417-T Internet of Things (IOT)
5. Any one MOOCS/SWAYAM/Equivalent course not studied earlier

PEC-IV:

1. PEC-EE404-T Flexible AC Transmission Systems (FACTS)
2. PEC-EE406-T Distributed Generation
3. PEC-EE408-T Power Quality
4. PEC-EE410-T Smart Grid Technologies
5. Any one MOOCS/SWAYAM/Equivalent course not studied earlier

PEC-V:

1. PEC-EE412-T EHV AC and DC Transmission
2. PEC-EE414-T Restructured Power System
3. PEC-EE416-T High Voltage Engineering
4. PEC-EE418-T Optimization Theory
5. Any one MOOCS/SWAYAM/Equivalent course not studied earlier

Note: The MOOCS/SWAYAM/Equivalent course proposed/shortlisted by the students will be reviewed and finalized by the departmental committee consisting of chairperson, class coordinator/in-charge and subject teacher concerned(To be appointed by Chairperson). The committee will ensure that the course content of this course should not overlap more than ten percent with subjects already covered in the scheme and syllabus.

ELECTRICAL CIRCUITS and NETWORKS

General Course Information:

Course Code: PCC-EE201-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.	Recall the fundamental of network theorems	**L1(Remembering)**
CO2.	Understand and derive the response of electrical circuits and characteristics and parameters of two port networks	**L2(Understanding)**
CO3.	Apply the knowledge of network analysis in technical problen solving	**L3(Applying)**
CO4.	Perform analysis and synthesis of two port networks applicabl in various engineering problems	**L4(Analyzing)**

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

Course Content

UNIT- I

Network topology and theorems: Classification of circuits, sources and signals, standard signals, source transformations, Network topology, graph matrices, formulation and solution of circuit equations based on graph theory using different analysis techniques- circuit, cut set and mixed. Concept of duality, Network theorems and their applications- Superposition, reciprocity, Thevenin, Norton, Maximum power transfer, Millman, Substitution, Compensation and Tellegan's theorem.

UNIT- II

Transient response: Introduction to non-linear circuits and their analysis, Analysis of circuits with dependent sources, Transient response under d.c. and a.c. excitation, Analysis of magnetically coupled circuits, Series and parallel resonance circuits, bandwidth and Q-factor, response with variation in parameters and frequency.

UNIT- III

Two-port networks and Parameters: Concept of one port, two-port networks, characteristics and parameters(impedance parameters, admittance parameters, transmission parameters and hybrid parameters), interrelationships of parameters, image & iterative impedance, concept of characteristic impedance, scattering parameters, insertion loss, interconnection of two-port networks, analysis of terminated two-port networks, extensions to multiport networks.

UNIT- IV

Network functions and Synthesis: Generalized network functions (Driving point and Transfer), concepts of poles and zeros, determination of free and forced response from poles and zeros, concept of minimum phase networks, analysis of ladder, lattice, T and bridged-T networks, Network synthesis- Synthesis problem formulation, properties of positive real functions, Hurwitz polynomials, properties of RC, LC and RL driving point functions, Foster and Cauer synthesis of LC and RC circuits.

REFERENCES:

1. M.E. Vanvalkenburg, "Network Analysis", PHI, 3rd Edition, 2014.
2. Franklin F. Kuo, "Network Analysis and Synthesis", 2nd Edition, Wiley India Ltd., 2006
3. S. P. Ghosh, A.K. Chakraborthy, "Network Analysis and Synthesis" McGraw Hill, 2010
4. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1988.
5. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", 9th Edition, McGraw Hill Education, 2018.

Course Articulation Matrix:

Course/Course Code: Electrical Circuits and Networks (PCC-EE201-T),													Semester: III		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	-	-	-	1	-	-	2	3	2	2
CO2	3	3	2	1	1	-	-	-	1	-	-	2	2	2	1
CO3	3	3	2	2	2	-	-	-	1	-	-	2	2	3	1
CO4	3	3	2	2	2	-	-	-	1	-	-	2	2	3	1

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

ELECTRONIC DEVICES AND CIRCUITS

General Course Information:

Course Code: **PCC-EE203-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.

Course outcomes:

Sr. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1.	Outline semiconductors, diodes, transistors, operational amplifiers an digital circuits	**L1 (Remembering**
CO2.	Explain about different power amplifier circuits, their design and use in electronics and communication circuits	**L2 (Understandin**
CO3.	Demonstrate and interpret the working of analog and digital electroni devices and circuits	**L3 (Applying)**
CO4.	Distinguish between various logic families and their characteristics	**L4 (Analyzing)**
CO5.	Design and implement analog, combinational and sequential logic circuits applicable in various engineering problems	**L6 (Creating)**

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

Course Contents

UNIT-I

Diode and Transistor biasing circuits: P-N junction diode, I-V characteristics of a diode, Zener diodes, clamping and clipping circuits, Transistor biasing circuits: Base bias, Emitter-feedback bias, collector-feedback bias, Voltage divider bias, emitter bias, CE, CC and CB analysis, h-parameters, JFET: Gate bias, Self bias, Voltage-divider bias and source bias, current source bias, CS, CD and CG amplifier, MOSFET: Depletion type, Enhancement type and their biasing, Power Amplifiers: Class A, B, C, D and S power amplifiers, Push-pull operation.

UNIT-II

OP-AMP: Differential amplifier and its DC, AC analysis, OP-AMP characteristics, Non-Inverting/Inverting Voltage and Current feedback, Linear and Non-Linear OP-AMP circuits, Regulated power supplies**.**

Oscillators- Barkhausen criteria of oscillations, Wein-bridge, RC oscillator, 555 timer: its monostable and astable operation.

UNIT-III

Logic gates and Boolean Algebra: Logic gates, Universal gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic

Logic Families: transistor as a switching element, Tri-state switch, Bipolar logic Families: RTL, DTL, TTL, ECL, IIL, MOS Logic families: NMOS, CMOS families and characteristics, various logic functions and their implementation.

UNIT-IV

Combinational Circuits: Introduction to combinational circuits, arithmetic and logical operation, design of Half adder & full adder, subtractor circuits, decoders, multiplexers, demultiplexers, comparators, Sequential Circuits: Flip-flops, bistable circuits: RS, JK, D, T, Master/Slave Flip-flop, race around condition, latches, synchronous and asynchronous counters up & down counters, shift Registers.

REFERENCES:

1. J. Millman, C. Halkias and C. D. Parikh, "Integrated Electronics", McGraw Hill, 2nd edition 2017
2. R. Boylested and L. Nashelsky, "Electronics Devices and Circuit Theory", Pearson New International, 11th edition, 2013
3. J. Millman, C. Halkias and S. Jit, "Electronics Devices and Circuits", TMH 4th edition, 2015.
4. A. Malvino and D. Bates, "Electronic Principles", TMH 8th edition, 2016
5. D. Leach, A. Malvino, G. Saha, "Digital Principles and Applications", TMH education, 7th edition, 2010
6. C. H. Roth, L. L. Kinney, "Fundamentals of Logic Design", Cenegae learning, 7th edition, 2013
7. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 4th edition 2016.

Course Articulation Matrix:

Course/Course Code: Electronic Devices and Circuits (PCC-EE203-T), Semester: III															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	1	-	-	-	2	1	-	2	2	3	2
CO2	3	3	2	1	1	-	-	-	1	-	-	2	2	2	1
CO3	3	3	2	2	2	-	-	-	1	-	-	2	2	3	1
CO4	3	3	2	2	2	-	-	-	1	2	-	2	2	3	1
CO5	2	2	3	2	1	1	-	-	2	1	1	2	2	2	1

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

ELECTRIC MACHINES-I

General Course Information:

Course Code: PCC-EE205-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.	Recall the basics of electric machines	**L1(Remembering)**
CO2.	Describe the performance of different types of electric machines.	**L2(Understanding)**
CO3.	Solve the problems related with electric machines.	**L3(Apply)**
CO4.	Compare the performance characteristics of electric machines.	**H1(Analysis)**
CO5.	Judge and use the machines on the basis of their utilization and performance.	**H2 (Evaluating)**

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

Course Content

UNIT-I

Electromechanical Energy Conversion and Single Phase Transformer: Energy in a magnetic systems, field energy and mechanical force, energy in singly and multiply excited magnetic systems. Transformer construction, theory and operation, E.M.F. equation, Ideal and practical trans former, exact and approximate equivalent circuits, no load and on load operation, phasor diagrams, power and energy efficiency, open and short circuit tests, back to back test, voltage regulation, effect of load on power factor, Per Unit transformer values, excitation phenomenon in transformers, Auto transformers (construction, working & applications),

UNIT-II

Three Phase and Other Transformers

Constructional features of three phase transformers, Cooling methodology, parallel operation of single phase and three phase transformers, three phase transformer connections, phasor groups, three phase to two phase and six phase conversion. Three winding transformers and its equivalent circuit, Tap changing of transformers, tertiary winding, Applications. Variable frequency transformer, voltage and current transformers, Grounding transformer, welding transformers, Pulse transformer and applications.

UNIT-III

DC Generators: Construction, working and types of dc generator, EMF equation, lap & wave winding, distributed & concentrated windings, armature reaction, commutation, interpoles and compensating windings, characteristics of dc generators, voltage build up, Parallel operation of DC generators, Applications.

UNIT-IV

D.C. Motors: Principles of working, Significance of back emf, Torque Equation, Types and Characteristics of DC Motors, Need of Starter, three point starter, four point starter, Speed Control (armature resistance, flux control, armature voltage, Thyrisor), Ward-Leonard system, Swinburne's test, Hopkinson's test, braking of dc motor (regenerative, Dynamic, Plugging), Losses and Efficiency, Effect of saturation and armature reaction on losses; Applications.

REFERENCES:

1. I.J. Nagarath and D.P. Kothari, "Electric Machines", T.M.H. Publishing Co Ltd., New Delhi, 4^{th} Edition 2010.
2. P.S. Bhimbra, 'Electrical Machinery', Khanna Publications.
3. J. B. Gupta., "Theory and Performance of Electrical Machines", Kataria and Sons, 14th edition 2009.
4. Fitzgerald Kingsley and Umans, "Electric Machinery" McGraw HillBooks co., New Delhi, 7th Edition, 2013.
5. A.S.Langsdorf, "Theory of AC Machinery", Tata McGraw Hill.
6. B. L. Thareja, "A Text Book of Electrical Technology", Volume II, S. Chand Publications.
7. Ashfaq Husain, "Electrical Machines", Dhanpat Rai Publications.

Course Articulation Matrix:

Course/Course Code: Electric Machine-I (PCC-EE205-T)										Semester: III					
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	-	-	-	-	-	-	2	3	1	1
CO2	3	2	2	2	2	1	-	-	-	-	-	1	2	2	1
CO3	3	3	2	1	1	-	-	-	1	-	-	1	3	3	1
CO4	3	2	2	2	1	-	-	-	1	-	1	2	2	3	1
CO5	3	2	2	1	-	1	-	2	-	2	3	2	2	2	2

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

GENERATION OF ELECTRIC POWER

General Course Information:

Course Code: PCC-EE207-T Course Credits: 4.0 Mode: Lecture (L) 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.	Describe and analyze different types of sources and mathematical expressions related to thermodynamics and various terms and factors involved with power plant operation.	**L1(Remembering)**
CO2.	Summarize the working and layout of steam power plants and discuss about its economic and safety impacts.	**L2(Understanding)**
CO3.	Illustrate the working principle and basic components of the nuclear power plant, diesel engine and the economic and safety principles involved with it.	**L3(Apply)**
CO4.	Examine the mathematical and working principles of different electrical equipment's involved in the generation of power.	**L4(Analysis)**
CO5.	Evaluate the different power generating systems	**L5(Evaluating)**
CO6.	Construct the model on the applications basis of power plant	**L6(Creating)**

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

Course Content

UNIT- I

Load and loading forecasting: Load curves, maximum demand, load factor, diversity factor, capacity factor, utilization factor, types of load, load forecasting.
Power plant economics: Choice of type of generation, size of generator and number of units, cost of electrical energy, depreciation of plant, effect of load factor on cost of electrical energy.

UNIT- II

Thermal power plants: Choice of site, main and auxiliary equipment fuel gas flow diagram, water stream flow diagram, working of power plants and their layout, characteristics of turbo generators.

Hydroelectric plants: Choice of site, classification of hydroelectric plants, main parts and working of plants and their layouts, characteristics of hydro electric generators.

UNIT- III

Nuclear power plants: Choice of site, classification of plants, main parts, layout and their working, associated problems.

Diesel power plants: Diesel plant equipment, diesel plant layout and its working, application of diesel plants.

UNIT- IV

Combined working of plants: Advantages of combined operation plant requirements for base load and peak load operation. Combined working of run off river plant and steam plant.

Tariffs and power factor improvement: Different types of tariffs and methods of power factor improvement.

REFERENCES:

1. P.K. Nag, “Power Plant Engineering”, Tata McGraw Hill.
2. F.T. Morse, “Power Plant Engineering”, Affiliated East-West Press Pvt. Ltd, New Delhi/Madras.
3. Kothari & Nagrath, “Power System Engineering”, McGraw Hill.
4. Granger and Stevenson, “Power System Analysis”, McGraw Hill.
5. Electric Power Generation operation and control, Wood and Wollenberg, Willey.
6. R.K. Rajput, Power System Engineering, Laxmi Publication.

Course Articulation Matrix:

Course/Course Code: Generation of Electric Power(PCC-EE207-T),														Semester: III
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3	2	2	1	1	-	-	-	2	2	2	2	1
CO2	3	2	3	2	2	2	1	-	-	-	2	3	3	2	1
CO3	3	3	3	2	2	2	1	-	-	-	2	3	3	3	1
CO4	3	2	3	3	2	2	1	-	-	-	2	1	2	2	1
CO5	2	2	3	2	2	2	1	-	-	-	2	2	2	2	1
CO6	3	3	3	2	2	2	1	-	-	-	2	3	2	2	1

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

MATHEMATICS-III

General Course Information	
Course Code: BSC201-T Course Credit: 3 Contact Hours: 3/week, (L-T-P:3-0-0) Mode: Lectures Examination Duration: 3 Hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 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 answers 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 remaining four units. All questions carry equal marks.

Course Outcomes: By the end of the course students will be able to:

CO1. **Define** concepts and terminology of Fourier series and Fourier transforms, Functions of complex variables, Power Series and, Probability distributions and hypothesis testing. (LOTS: Level 1: Remember)
CO2. **Solve** problems using Fourier transforms in domains like digital electronics and image processing. (LOTS: Level 3: Apply)
CO3. **Apply** mathematical principles to solve computational problems. (LOTS: Level 3: Apply)
CO4. **Compare** various probability distributions (HOTS: Level 4: Analyse).
CO5. **Select** suitable hypothesis testing methods for given problems and interpret the respective outcomes. (HOTS: Level 4: Evaluate)
CO6. **Integrate** the knowledge of Fourier series and Fourier transforms, Functions of complex variables, Power Series and, Probability distributions and hypothesis testing for solving real world problems. (HOTS: Level 6: Create)

UNIT- I

Fourier Series and Fourier Transforms: Euler's formulae, conditions for a Fourier expansion, change of interval, Fourier expansion of odd and even functions, Fourier expansion of square wave, rectangular wave, saw-toothed wave, half and full rectified wave, half range sine and cosine series.

UNIT-II

Fourier integrals, Fourier transforms, Shifting theorem (both on time and frequency axes), Fourier transforms of derivatives, Fourier transforms of integrals, Convolution theorem, Fourier transform of Dirac delta function.

UNIT-III

Functions of Complex Variable: Definition, Exponential function, Trigonometric and Hyperbolic functions, Logarithmic functions. Limit and Continuity of a function, Differentiability and Analyticity. Cauchy-Riemann equations, necessary and sufficient conditions for a function to be analytic, polar form of the Cauchy-Riemann equations. Harmonic functions.

UNIT-IV

Complex integral, Cauchy Gaursat theorem (without proof), Cauchy integral formula (without proof), Power series, radius and circle of convergence, Taylor's Maclaurin's and Laurent's series. Zeroes and singularities of complex functions, Residues. Evaluation of real integrals using residues (around unit and semi-circle only).

Text and Reference Books:

1. F. Kreyszig, *Advanced Engineering Mathematics*, 10th edition, Wiley, 2015.
2. B. S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 44th edition, 1965.
3. R. K. Jain, S.R.K. Iyenger. *Advance Engineering. Mathematics*, 4th edition, Narosa Publishing House, 2012.
4. Michael D. Greenberg, *Advanced Engineering Mathematics*, 2nd edition, Pearson Education, 2002.
5. Johnson and Miller *Probability and statistics for Engineers*, 8th edition, Pearson Education India, 2015.

CO-PO Articulation Matrix Mathematics-III (BSC201-T)

List of Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1. **Define** concepts and terminology of Fourier series and Fourier transforms, Functions of complex variables, Power Series and, Probability distributions and hypothesis testing. (LOTS: Level 1: Remember)	**1**	**--**	**-**		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**
CO2. **Solve** problems using Fourier transforms in domains like digital electronics and image processing. (LOTS: Level 3: Apply)	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**2**
CO3. **Apply** mathematical principles to solve computational problems. (LOTS: Level 3: Apply)	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**3**
CO4. **Compare** various probability distributions (HOTS: Level 4: Analyse).	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**3**
CO5. **Select** suitable hypothesis testing methods for given problems and interpret the respective outcomes. (HOTS: Level 4: Evaluate)	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**3**
CO6. **Integrate** the knowledge of Fourier series and Fourier transforms, Functions of complex variables, Power Series and, Probability distributions and hypothesis testing for solving real world problems. (HOTS: Level 6: Create)	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**

ELECTRONIC DEVICES AND CIRCUITS LABORATORY

General Course Information:

Course Code: **PCC-EE203-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 characteristics of semiconductors, diodes, transistors, operational amplifiers and digital circuits	**L1 (Remembering)**
CO2.	Perform and learn about different power amplifier circuits, their design and use in electronics and communication circuits	**L2 (Understanding)**
CO3.	Demonstrate and interpret the working of analog and digital electronic devices and circuits	**L3 (Apply)**
CO4.	Analyze various logic families and their characteristics, combinational and sequential logic circuits	**L4 (Analyzing)**
CO5.	Design and implement analog, combinational and sequential logic circuits applicable in various engineering problems	**L6 (Creating)**

LIST OF EXPERIMENTS:

1. To observe the performance of
   (a) Common emitter amplifier (b) Common base amplifier (c) common collector amplifiers
2. To study the characteristic of BJT (NPN, PNP), JFET (N-channel, P-channel), MOSFET (N-channel, P-channel).
3. To study the following mathematical operations using Op-amps:-
   (a) Addition (b) Subtraction (c) Multiplication (d) Division (e) Integration (f) Differentiation
4. To study the Op-amp as:
   (a) Astable multivibrator (b) Mono-stable multivibrator (c) Schmitt Trigger cicuit
5. To study OP-AMP as non-inverting voltage amplifier, low pass filter, high-pass filter and bandpass filter
6. To study the characteristics of Wein-bridge, RC oscillator .
7. To study NOT, AND, OR, NOR, XOR, XNOR gates.
8. To study and verify the truth table of R-S, D, J-K and T flip flop
9. To verify the operation of a 4 bit UP and DOWN serial/parallel counter
10. Study of a combinational circuit of half adder, full adder, subtractor, encoder, decoder, multiplexer and 4 bit digital comparator.
11. Study of shift register SISO, SIPO, PISO, PIPO using shift register.

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

ELECTRICAL MACHINES-I LABORATORY

General Course Information:

Course Code: PCC-EE205-P Course Credits: 1.5 Mode: Practical Type: Program Core Contact Hours: 3 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 machines like: transformer, DC machine and electromechanical energy conversion principle	**L1(Remembering)**
CO2.	Discuss about different characteristics and working design of electric machines.	**L2(Understanding)**
CO3.	Demonstrate and interpret the working of electric machines at different operational conditions.	**L3(Apply)**
CO4.	Examine and analyze various performance characteristics of electric machines.	**H1(Analysis)**
CO5.	Select the electrical machines with ratings on the basis of their utilization and performance.	**H2 (Evaluating)**
CO6.	Design machine models for various engineering problems	**L6 (Creating)**

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

List of Experiments

1. To find turns ratio & polarity of a 1-phase transformer.
2. To perform open & short circuit tests on a 1-phase transformer.
3. To perform Sumpner's Back to back test on 1-phase transformers.
4. Parallel operation of two 1-phase transformers.
5. To convert three phase to 2-phase By Scott-connection.
6. To perform load test on DC shunt generator.
7. To perform load test on DC series generator.
8. To obtain magnetization characteristics of separately excited DC Machine.
9. To obtain magnetization characteristics of self-excited DC Machine.
10. Speed control of DC shunt motor.
11. Swinburne's test of DC shunt motor.
12. Hopkinson's test of DC shunt M/Cs.
13. Fields test on two identical D.C. series machines
14. Ward Leonard method of speed control.

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.

ELECTRICAL WORKSHOP

General Course Information:

Course Code: **PCC-EE209-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 about various tools, electrical material and symbols.	**L1 (Remembering)**
CO2.	Discuss various types of wiring systems, wiring tools, lighting & wiring accessories, wiring estimation & costing, etc.	**L2 (Understanding)**
CO3.	Use the electrical tools in real life.	**L3 (Apply)**
CO4.	Examine and estimate the basic requirements for wirings.	**L4 (Analyzing)**
CO5.	Understand modern manufacturing operations, including their capabilities, limitations, and how to design a model economically	**L6(Creating)**

LIST OF EXPERIMENTS:

1. To study of different type of tools, Electrical Material, Symbols and Abbreviations.
2. To study different types of wiring & Practices of Staircase, Corridor & Godown wiring
3. To study & Perform Fluorescent, Tube light, CFL, LED & its series and parallel Connections.
4. To study & Perform Circuit of SMPS.
5. To study moving iron, moving coil, Electrodynamics and induction type meter.
6. To study various types of wires/ cables and practices of switches.
7. To study importance of earthing and measurement of earth resistance.
8. Trouble earth resistance shooting of equipment like fan, iron, mixer, grinder.
9. To study various types of Transformers and assembling practices of transformers.
10. Different fuses, SFU, MCB, ELCB, MCCB.
11. Design of solar system for small houses.
12. To study & calibrate single phase energy meter.
13. To study & Perform Circuit of home inverter.

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

POWER ELECTRONICS

General Course Information:

Course Code: PCC-EE202-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.	Recall the fundamental of electronics devices and circuit	**L1(Remembering)**
CO2.	Describe various power semiconductor devices, passive components and switching circuits.	**L2(Understanding)**
CO3.	Deploy 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 assess the performance.	**L4(Analysis)**
CO5.	Estimate the critical areas for improvement in an industries and derive typical alternative solution.	**L5(Evaluating)**
CO6.	Design a suitable power converters to control Electrical Motors and other industry grade apparatus	**L6(Creating)**

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

Course Content

UNIT- I

Modern Power Electronics Devices: Principle of operation of SCR, dynamic characteristic of SCR during turn ON and turn OFF, Two transistor analogy, Protection of SCR, Commutation circuits, SCR ratings, Triggering Methods, Series and Parallel operation of SCR.

Single-phase half-wave and full-wave thyristor rectifiers, Single-phase full-bridge thyristor rectifier with R-load and inductive load; Three-phase full-bridge thyristor rectifier with R-load and inductive load; Input current wave shape and power factor.

UNIT- II

Single-phase Converter: Half wave converter, 2-pulse midpoint converter, half controlled and fully controlled bridge converters, input current and output voltage waveforms, effect of load and source impedance, expressions for output voltage, effect of free-wheeling diode, triggering circuits, Dual converter.
Three-phase Converter: Half wave, full wave, half controlled and fully controlled bridge converters, effect of load and source impedance, expressions for output voltage, Dual Converter.

UNIT- III

Inverters: Classification, basic series and improved series inverter, parallel inverter, single phase and three phase voltage source inverter, 120 degree mode and 180 degree mode conduction schemes, modified McMurray half bridge and full bridge inverters, McMurray -Bedford half bridge and full bridge inverters, brief description of parallel and series inverters, current source inverter (CSI), transistor and MOSFET based inverters

UNIT- IV

AC Voltage Controllers & Regulators: Single phase and three phase ac voltage controllers with R, RL and RLE loads, Single phase two SCR's in anti-parallel with R and RL loads, Voltage control, Operation waveforms, Types of voltage regulator, equation of load current, output voltage equation, synchronous tap changer, three phase regulator.

Cyclo-converter: Principle of operation of cyclo-converter, non-circulating and circulating types of cyclo-converters. Waveforms, control technique**.**

REFERENCES:

1. M. Ramamoorthy, "Thyristor and their applications", East West Publication, 1991.
2. P.S. Bimbhra, "Power Electronics", Khanna Publishers, 2015.
3. MD Singh and KB Khanchandani, "Power Electronics", TMH Edition, 2007.
4. AK Gupta and LP Singh, "Power Electronics", Dhanpat Rai Publishing Co.
5. G.K. Dubey, S. R. Doradla, A. Joshi, and R. M. K. Sinha, "Thyristorised Power Controllers", New Age International Private Ltd.
6. Mohan N., Undeland T. M. and Robbins W. P., "Power Electronics Converters, Applications and Design", 3rd ED, Wiley India.

Course Articulation Matrix:

Course/Course Code: Power Electronics (PCC-EE202-T),														Semester: IV
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	2	1	-	-	-	2	2	3	3	1
CO2	3	2	3	3	2	2	1	-	-	-	2	2	3	2	1
CO3	2	3	3	2	2	2	1	-	-	-	2	2	3	2	1
CO4	3	2	2	2	3	3	1	-	-	-	3	2	2	1	1
CO5	2	2	2	3	2	2	1	-	-	-	1	1	3	2	1
CO6	3	3	3	2	2	2	1	-	-	-	2	2	3	2	1

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

ELECTRICAL MACHINES-II

General Course Information:

Course Code: PCC-EE204-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 20marks, class performance measured through percentage of lecture attended (4 marks), assignments and 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.

Outcomes

Sr. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1.	Recall the basics of electric machines	**L1(Remembering)**
CO2.	Illustrate the performance of different types of rotating electric machines.	**L2(Understanding)**
CO3.	Solve the problems related with rotating electric machines.	**L3(Apply)**
CO4.	Compare the performance characteristics of rotating electric machines.	**H1(Analysis)**
CO5.	Judge and use the rotating electric machines on the basis of their utilization and performance.	**H2 (Evaluating)**

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

Course Content

UNIT-I

Poly Phase Induction Motors: Construction details of three-phase induction motor, Rotating magnetic field, principle of operation, slip, Induction motor as generalized transformer-Equivalent circuit, expression for torque, full load torque, maximum torque, starting torque and output power, torque-slip and torque-speed characteristics, no load and blocked rotor test, circle diagram, introduction to deep bar cage and double cage induction motor, starting of induction motors, speed control of induction motor, cogging &crawling, Applications.

UNIT-II

Synchronous Generators: Alternators: Construction features and types, EMF equation of alternators, armature reaction in alternators, Alternator on load, Synchronous reactance, Synchronous Impedance, Voltage regulation, Determination of voltage regulation using EMF, MMF methods, ZPF, Ampere Turn methods and Potier Triangle, Synchronizing and parallel operation of alternators, Salient pole synchronous machine, two-reaction theory, slip test, Applications.

UNIT-III

Synchronous Motor: Principle of operation, Methods of starting, Torque and power equations, Synchronous motor on load, Synchronous motor on constant excitation variable load, Synchronous motor on constant load variable excitation, 'V' and inverted 'V' curves, Synchronous condenser, Hunting and its suppression, Behaviour of synchronous machine on short circuit, capability curves, Applications.

UNIT-IV

Single Phase Induction & Special Motors: Single Phase Induction Motor, Double revolving field theory, Stepper Motor, Brushless DC motor, Servomotors, Shaded Pole Motor, Reluctance Motor, Hysteresis Motor, Single Phase Series Motor, Repulsion Motor, Schrage Motor, Linear Induction Motor.

REFERENCES:

1. I.J. Nagarath and D.P. Kothari, "Electric Machines", T.M.H. Publishing Co Ltd., New Delhi, 4th Edition 2010.
2. P.S. Bhimbra, 'Electrical Machinery', Khanna Publications.
3. J. B. Gupta., "Theory and Performance of Electrical Machines", Kataria and Sons, 14th edition 2009.
4. Fitzgerald Kingsley and Umans, "Electric Machinery" McGraw HillBooks co., New Delhi, 7th Edition, 2013.
5. A.S. Langsdorf, "Theory of AC Machinery", Tata McGraw Hill.
6. B. L. Thareja, "A Text Book of Electrical Technology", Volume II, S. Chand Publications
7. P.S. Bhimbra, "Generalized Theory of Electrical Machines", Khanna Publications.
8. Ashfaq Husain, "Electrical Machines", Dhanpat Rai Publications.

Course Articulation Matrix:

Course/Course Code: Electric Machine-II (PCC-EE204-T)													Semester: IV		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO2	3	1	2	2	-	-	-	-	1	-	-	1	2	2	1
CO3	2	3	2	1	-	-	-	-	1	-	-	-	3	3	1
CO4	3	2	2	2	1	-	-	-	-	-	1	2	2	3	1
CO5	3	2	2	1	-	1	1	2	-	2	3	2	2	2	2

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

POWER SYSTEMS - I

General Course Information:

Course Code: **PCC-EE206-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.	Draw the single line diagram and model the power system components for power system analysis	**L1(Remembering)**
CO2.	Understand the major components of Transmission and Distribution Systems, its modeling and important parameters	**L2(Understanding)**
CO3.	Investigate the performance of transmission lines by calculating voltage regulation and efficiency	**L3(Applying)**
CO4.	Analyze the mechanical and electrical design aspects of transmission system	**L4(Analyzing)**
CO5.	Compare between different supply systems, Overhead transmission lines and underground cables and select the appropriate according to the need.	**L5(Evaluating)**

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

Course Content

UNIT- I

Basic Concepts: Importance of electric power, single line diagram of power system, Modeling of power system components, Per unit system, Symmetrical and unsymmetrical components, Representation of generators, lines and transformers in sequence networks, Growth of power systems in India, power supply networks: effect of voltage on conductor size, comparison of conductor volume in typical supply systems, elementary high voltage DC transmission DC transmission and its advantages and disadvantages.

UNIT- II

Transmission line parameters: Calculations of resistance, inductance, and capacitance for single phase, three phase single circuit and double circuit lines, skin and proximity effect.

Performance of lines: Classification of lines as short, medium and long, representation and detailed performance analysis of these lines including ABCD parameters, Surge Impedance loading, Ferranti's effect, Power flow through a transmission line and power circle diagrams

UNIT- III

Mechanical considerations: Various types of line conductors, line supports, poles and towers, sag calculations, effect of wind, ice and temperature, stringing chart, sag template, line vibrations.
Insulators: various types of insulator, voltage distribution, string efficiency, methods of increasing string efficiency.
Corona: Phenomenon of corona, disruptive critical voltage, visual critical voltage, corona loss, radio interference.

UNIT- IV

Underground cables: Classification and construction, insulation resistance, capacitance, capacitance determination, power factor in cables, capacitance grading, use of inter sheaths, losses, heat dissipation and temperature rise in cables, current rating, Faults in cables, comparison with overhead lines
Distribution Systems: components – feeders, distributers, service mains, connections schemes of distribution, Introduction to distributed generation

REFERENCES:

1. C. L. Wadhwa, "Electrical Power Sytems", New Age Internationals, 7th edition, 2016.
2. I. J. Nagrath and D. P. Kothari "Power System Engineering". McGraw-Hill, 3rd Ed., 2019.
3. A. Chakrabarty, P. V. Gupta, M. L. Soni and U. S. Bhatnagar , "A Course in Electrical Power" Dhanpat Rai Pub. Co.(P) Ltd., 2008.
4. J.B.Gupta , "Power Systems", S.K. Kataria and sons, 2013.
5. B.R.Gupta , "Power System Analysis and Design", S. Chand, 7th edition, 2014.
6. B.M.Weedy, "Electric power system", John Wiley and sons.
7. S. N. Singh, "Electric Power Generation, Transmission and Distribution", PHI, 2nd edition, 2008.
8. L. M. Fualkenberry, W. Coffer, "Electrical Power Distribution and Transmission", Pearson Education, 1996.
9. S. K. Gupta, " Power System Engineering", Umesh Publications, 2009.

Course Articulation Matrix:

Course/Course Code: Power Systems- I (PCC-EE206-T),													Semester: IV		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	-	2	1	-	1	-	1	1	2	2	1
CO2	3	2	2	1	-	2	1	-	1	-	1	1	2	1	1
CO3	3	2	2	2	-	2	1	-	1	-	1	1	3	2	1
CO4	3	3	2	2	-	2	1	-	1	-	1	1	3	2	1
CO5	3	3	2	2	-	2	1	-	1	-	2	1	3	2	2

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

FIELDS AND WAVES

General Course Information:

Course Code: PCC-EE208-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.	Recall the basics of coordinates(2 D & 3D)	**L1(Remembering)**
CO2.	Describe the electromagnetic waves and theory.	**L2(Understanding)**
CO3.	Solve the problems related with electromagnetic waves and theory.	**L3(Apply)**
CO4.	Compare the performance of electromagnetic waves on the basis of different theories.	**H1(Analysis)**
CO5.	Judge the characteristics of electromagnetic waves and utilize them as per their requirements.	**H2 (Evaluating)**

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

Course Content

UNIT-I

Introduction of Coordinates: Cartesian coordinates, cylindrical coordinates, spherical coordinates, Vector calculus: Differential length, area and volume, line surface and volume integrals and their significance, Del operator, gradient of a scalar, divergence of a vector and divergence theorem, curl of a vector and Stoke's theorem

UNIT-II

Electrostatics: Electrostatic fields, Field intensity, Electric flux density, Coulomb's Law, Electric field and potential due to point, line, plane and charge distribution, Gausses's Law and application, Electric field in material space: Properties of materials, conductors, dielectric constants, Effect of dielectric medium, continuity equation, boundary condition. Poission's and Laplace's equations, Equipotential Surfaces, Uniqueness Theorem, capacitance, method of images.

UNIT-III

Magnetostatics: Magneto-static fields, Magnetic flux density, Magnetic field Intensity, Biot-Savart's Law, Ampere's circuit law ,Faraday Law of Induction, application of ampere's law, - Maxwell's equation, Maxwell's equation for static fields, for harmonically varying fields, for free space, magnetic vector potential. Lorentz Force, magnetization in materials, magnetic boundary conditions, Self and mutual inductances, Relation between E and H.

UNIT-IV

Electromagnetic Waves: Polarization, Reflection of plane wave for perfect conductor, perfect dielectric at normal incidence as well as oblique incidence, Electromagnetic wave propagation, Depth of

Penetration, Brewester's Angle Poynting Theorem and interpretation of Poynting vector. **Transmission lines:** Transmission line parameters, Transmission line equations, input impedance, Characteristic Impedance, Reflection Coefficient, Standing wave ratio, Smith chart and its application.

REFERENCES:

1. M. N. O. Sadiku, "Elements of Electromagnetic", 4th Ed, Oxford University Press.
2. K.D. Prasad, "Electromagnetic Fields and Waves", Satya Prakashan, New Delhi.
3. Balmein and Jordan, "Electromagnetic Waves and Radiating System", PHI Publication.
4. W. H. Hayt and J. A. Buck, "Electromagnetic field theory", 7th edition TMH Publications.
5. R. Gowri, "Electromagnetic Field and Waves", Katson Publications.
6. J.D.F. Krauss, "Electromagnetics", McGraw Hill Publications.

Course Articulation Matrix:

Course/Course Code: Fields and Waves (PCC-EE208-T)								Semester: IV							
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	-	-	-	-	-	-	-	1	3	1	1
CO2	3	1	1	1	-	-	-	-	1	-	-	1	2	2	-
CO3	2	3	2	1	-	-	-	-	1	-	-	-	3	3	1
CO4	3	2	1	2	1	-	-	-	-	-	1	2	2	3	1
CO5	3	1	2	1	-	1	1	2	-	2	3	2	2	1	1

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

SIGNALS AND SYSTEMS

General Course Information:

Course Code: **PCC-EE210-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.

Course outcomes:

Sr. No.	**Course Outcomes** **At the end of the semester, students will be able to:**	**RBT* Level**
CO 1	Describe various signals and their behaviour involved in processing**.**	**L1 (Remembering)**
CO 2	Classify different systems used for signal processing and operation and Conceptualize the effects of sampling a CT signal	**L2 (Understanding)**
CO 3	Demonstrate the Conversion of signals in analog domain to digital domain using various transforms	**L3 (Applying)**
CO 4	Analyze CT and DT systems using Laplace transforms and Z-Transforms.	**L4(Analyzing)**
CO 5	Modeling different systems with detailed analysis of LTI systems according to different types of applications	**L6 (Creating)**

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

Course Content

UNIT-I

Introduction to Signals: Signal Definition, Classification of Signals, Basic/Singularity Continuous and Discrete-Time Signals, Basic operations: Time Shifting, Time Reversal, Time Scaling on signals, Signal representation in terms of singular functions, Correlation of Signals and its Properties, Representation of a Continuous-Time Signal by its Samples: The Sampling Theorem, Reconstruction, Aliasing.

UNIT-II

Types of Systems: System, classification of Systems: Linear & Nonlinear Systems; Static & Dynamic Systems, Causal & Non-causal System, Invertible & Noninvertible, Stable & Unstable System, Time variant & Time Invariant Systems with examples.

Linear Time-Invariant Systems: Definition and Properties, Impulse Response, Convolution Sum/Integral and its Properties, Representation of LTI systems using Differential and Difference equations.

UNIT- III

Fourier Series & Fourier Transform: Introduction to Frequency domain Representation, Fourier Series Representation of Periodic Signals, Convergence of Fourier Series, Properties of Fourier Series, Fourier Transform for periodic and aperiodic signals, Convergence of Fourier Transform, Properties of Fourier Transform, Applications of Fourier Transform.

Discrete-Time Fourier Transform: Fourier Transform representation for Discrete –Time Aperiodic & Periodic Signals, Properties of Discrete-Time Fourier Transform, Basic Fourier Transform Pairs.

UNIT-IV

Laplace Transform: Introduction to Laplace transform, Region of convergence(ROC), relation with Fourier transform, Properties, Inverse of Laplace transform, Application to LTI systems, their interconnections and block diagram

Z-Transform: Introduction to Z-Transform, Region of convergence (ROC), Z-Transform Properties, Inverse Z-Transform, Analysis of LTI Systems using Z-Transform, Application of Z- transform, Introduction to Hilbert Transform.

REFERENCES:

1. A. V. Oppenheim, A. S. Willsky, and S. H. Nawab "Signals & Systems", Prentice –Hall India.
2. T. K. Rawat, "Signal & Systems", Oxford University Press.
3. S. Salivahanan, A. Vallavraj, C. Gnanapriya, "Digital Signal Processing", Tata McGraw Hill.
4. A. Papoulis, "Circuits and Systems: A Modern Approach", Oxford Univ. Press.
5. B. Kumar, "Signals and Systems", New Age International Publishers.
6. H. P. Hsu, "Signals and Systems", Schaum's Outlines, TMH
7. Fred J. Taylor, "Principles of Signals and System"s, TMH
8. S. Haykins and B.V. Veen, "Signals and Systems", Wiley

Course Articulation Matrix:

Course/Course Code: Signals and Systems (PCC-EE210-T), Semester: IV															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	-	-	-	2	1	-	2	2	2	2
CO2	3	3	3	2	1	-	-	-	1	-	-	2	2	2	2
CO3	3	3	3	2	2	-	-	-	1	-	-	2	3	3	2
CO4	3	3	2	1	1	-	-	-	1	1	-	2	3	2	2
CO5	3	3	2	1	1	-	-	-	1	2	-	2	3	3	2

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

POWER ELECTRONICS LABORATORY

General Course Information:

Course Code: **PCC-EE202-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 about various power converters and electric drives control methods.	**L1 (Remembering)**
CO2.	Identify relevant information to supplement to the Power Electronics devices.	**L2 (Understanding)**
CO3.	Apply a set up testing strategies and select proper instruments to evaluate performance characteristics of Power devices and power electronics circuits	**L3 (Apply)**
CO4.	Examine the basic requirements for electric drive based design.	**L4 (Analyzing)**
CO5.	apply techniques to different power electronic devices and evaluate possible causes of discrepancy in practical experimental observations in comparison to theory	**L5(Evaluating)**
CO6.	Design a model for controlling the system in an industries.	**L6 (Creating)**

LIST OF EXPERIMENTS:

1. To study the performance of single-phase half-wave and full-wave uncontrolled rectifiers.
2. To study the operation of single-phase full- wave phase control of a D.C. load using (i) a fully-controlled full-wave rectifier. (ii) A half-controlled full-wave rectifier.
3. To study speed control of a D.C. motor using single-phase half and fully controlled bridge converters.
4. To study speed control of a D.C. motor using three-phase half and fully controlled bridge converters.
5. To study and test buck, boost and buck- boost regulators.
6. To study Control speed of a single-phase induction motor using single phase AC voltage regulator.
7. To study speed control of dc motor using single-phase dual converter.
8. To study single phase diode clamp multi-level inverter.
9. To study three phase PWM inverter using IGBT.
10. To study single phase inverter with square wave quasi square wave and SPWM control.
11. To study six pulse fully controlled rectifier feeding R and RL loads.
12. To study of single phase cyclo-converter.
13. To study of three phase cyclo-converter.

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

ELECTRICAL MACHINES-II LABORATORY

General Course Information:

Course Code: PCC-EE204-P Course Credits: 1.5 Mode: Practical Type: Program Core Contact Hours: 3 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 rotating electric machines.	**L1(Remembering)**
CO2.	Discuss and learn about different characteristics and working design of AC rotating electric machines.	**L2(Understanding)**
CO3.	Demonstrate and interpret the working of electric machines at different operational conditions.	**L3(Apply)**
CO4.	Examine and analyze various performance characteristics of electric machines.	**H1(Analysis)**
CO5.	Select the electrical machines with ratings on the basis of their utilization and performance.	**H2 (Evaluating)**
CO6.	Design machine models for various engineering problems	**L6 (Creating)**

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

List of Experiments

1. Determine mechanical losses by light running of a three phase Induction Motor.
2. To perform Load test on a 3-phase induction motor & DC generator set and to determine the efficiency of induction motor.
3. To perform light running and block rotor test to determine the parameters of the equivalent circuit of single phase induction motor.
4. To perform the open circuit test and block rotor test on three phase induction motor and draw the circle diagram.
5. To find out the rotor resistance of a poly phase induction motor.
6. To calculate regulation by synchronous impedance method:-
    a. Conduct open and short circuit test on a three phase alternator.
    b. Determine and plot variation of synchronous impedance with If.
    c. Determine S.C.R.
    d. Determine regulations for 0.8 lagging power factor, 0.8 leading power factor and unity power factor.
7. To plot V-Curves of a synchronous machine.
    a. Determination of Xo of a synchronous machine.
    b. Measurement Xd' + Xq' (Direct axis and Quardiantant axis).
8. To measure Xq of synchronous machine (negative sequence reactance).
9. To calculate regulation of synchronous machine by ZPF method.
10. To conduct the load test to determine the performance characteristics of the I.M.
11. To study the parallel operation of synchronous generators.

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.

POWER SYSTEMS - I LABORATORY

General Course Information:

Course Code: **PCC-EE206-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.	Draw the single line diagram of the power system and power angle characteristics of transmission line.	**L2 (Understanding)**
CO2.	Calculate the parameters of transmission line from the given model and determine the voltage regulation and efficiency.	**L3 (Apply)**
CO3.	Observe and analyze the Ferranti's effect in transmission line model.	**L4 (Analyzing)**
CO4.	Modeling of 3 winding transformer and synchronous machines by determining the sequence impedances	**L6 (Creating)**

LIST OF EXPERIMENTS:

1. To draw single line diagram of distribution system of nearby area of college concerned.
2. To plot power angle characteristics of transmission line.
3. To find ABCD Parameters of a model of transmission line.
4. To find efficiency and voltage regulation of transmission line
5. To observe Ferranti effect in a model of transmission line.
6. To determine positive, negative and zero sequences of a 3 winding transformer.
7. To determine sequence impedances of a cylindrical rotor Synchronous Machine.
8. To measure the dielectric strength of transformer oil.
9. To study different types of power cables and methods of laying underground cables
10. To Study different types of Insulators
11. To find string efficiency of string insulator.
    i) Without guard ring
    ii) With guard ring.
12. To locate cable fault using cable fault locator.
13. To Study the performance of wind turbine generator system under variable load, wind speed and pitch angle.

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

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 4^{th} 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),													Semester: VI		
	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”, 4*th* Edition, 2002, Oxford University Press.
2. Donald M. Wiberg, “State Space and Linear Systems”, 1*st* Edition, 1971, Schuam’s Outline Series,
3. Katsuhiko Ogata, “Discrete-Time Control Systems”, 2*nd* Edition, 2015, Prentice-Hall.
4. M. Gopal, “Digital Control and State Variable Methods”, 4*th* Edition, 2012, Tata McGrow Hill.
5. B. C. Kuo, “Digital Control System”, 2*nd* Edition, 2006, Oxford University Press.
6. J. J. E. Slotine and W. Li, “Applied Nonlinear Control”, 1*st* Edition, 1991, Prentice Hall.
7. Hassan. K. Khalil, “Nonlinear Systems”, 3*rd* 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.

POWER SYSTEM OPERATION AND CONTROL

General Course Information:

Course Code: **PEC-EE417-T** Course Credits: 4.0 Mode: Lecture (L) Type: Program Elective 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.	Explain the operation and control of all the major components of power systems	**L1(Remembering)**
CO2.	Understand the unit commitment problems and methods to solve the problems	**L2(Understanding)**
CO3.	Deploy frequency control, voltage control, active and reactive power control schemes on power system	**L3(Apply)**
CO4.	Compare various reactive power compensation schemes	**L4(Analysis)**
CO5.	Assess the best possible control for power system operation	**L5(Evaluating)**
CO6.	Develop generation dispatching, power system monitoring and control schemes for optimal operation and control	**L6(Creating)**

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

Course Content

UNIT- I

AUTOMATIC GENERATION CONTROL: Introduction to AVR and ALFC loops, Modeling of turbine speed governing system, Generator Load model, load frequency control of an isolated area, its steady state performance and dynamic performance for first order approximate system, Load frequency Vs economic control, dead band, digital load flow control, decentralized control.

UNIT-II

EXCITATION & VOLTAGE CONTROL: Role of Exciter and its control, Classification of Excitation System, Rotating self excited and pilot excited type Voltage regulators, static excitation system, brushless excitation system, boost buck excitation system and development of block diagram and transfer function for it, Role of PID Controller in Excitation system, Voltage control through shunt compensation; Series compensation; Tap changing transformer; Booster transformer; induction regulators,

UNIT-III

Power Systems Stability: Definitions: angular stability- steady state stability, dynamic stability, transient stability, Dynamics of synchronous machine and swing equation, equal area criteria for various types of disturbances, critical clearing angle, solution of swing equation, technique of improving transient stability, Voltage stability, voltage stability concept for pure inductive load, Voltage collapse, voltage collapse proximate indicator.

UNIT-IV

ECONOMIC LOAD DISPATCH: Generators operation cost, Economic dispatch problem, Economic Dispatch including transmission loss, derivation of transmission loss formula, Classification of hydro plants, Long range and short range problem, Short range fixed head hydrothermal scheduling.

REFERENCES:

1. A. J. Wood, B. F. Wollenberg, “Power Generation Operation and Control”, Wiley India, 2nd edition, 2009.
2. Nagrath Kothari, “Modern Power System”, TMH Publication New Delhi.
3. S K Gupta, “Power Systems Operation Control and Restructuring”, Ik International Publishing House.
4. Abhijit Chakrabarti & Sunita Halder, “Power System Analysis- Operation & Control”, PHI NewDelhi, 3rd edition, 2010.
5. K Uma Rao, “Power System Operation & Control”, Wiley India, 1st edition, 2013.
6. Robert H.Miller, James H.Malinowski, “Power System Operation”, Tata McGraw-Hill, 2nd edition, 2009.
7. H. Saadat, “Power System Analysis”, PSA Pub., 3rd edition, 2011.
8. A Chakrabarti, D. P. Kothari, A. K. Mukhopadhyay, Abhinandan De, “An introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems”, PHI, 2010

Course Articulation Matrix:

Course/Course Code: Power System operation and Control (PEC-EE417-T), Semester: VII															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	1	-	1	-	2	2	3	2	1
CO2	3	3	1	1	2	1	1	-	1	-	2	2	3	2	1
CO3	2	3	2	3	2	2	1	-	1	-	2	2	2	2	1
CO4	2	3	2	2	2	1	1	-	1	-	2	2	2	2	1
CO5	2	3	2	2	2	1	1	-	1	-	2	2	2	2	1
CO6	3	3	3	2	3	1	1	-	1	-	2	2	2	2	2

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

MINOR PROJECT

Course Code: **PROJ-EE419-P** Course Credits : 4 Mode: Practical Contact Hours: 8/week	**Course Assessment Method: (Internal: 30; External: 70)**

Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able:	RBT Level
CO 1	Relate practical knowledge within the chosen area of technology for project development	L1
CO 2	Understand methodologies and professional way of documentation and communication.	L2
CO 3	Illustrate the key stages in development of the project.	L3
CO 4	Identify, analyze, formulate and handle projects with a comprehensive and systematic approach	L4
CO 5	Contribute as an individual or in a team in development of technical projects	L5
CO6	Develop effective communication skills for presentation of project related activities	L6

NOTE: The minor project will be completed and evaluated at the end of the 7^{th} semester on the basis of its implementation, presentation, viva-voce and report.

Course Articulation Matrix:

Course/Course Code: Minor Project (PROJ-EE419-P),													Semester: VII		
	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

PRACTICAL TRAINING-II

Course Code: **INT-EE421-P** Course Credits : 1 Type: Program Core Mode: Practical Contact Hours: 2/week	**Course Assessment Method: (Internal:100)** Assessment of Practical Training-II will be based on presentation/seminar, viva-voce, report and certificate for the practical training taken at the end of 6th 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-II (INT-EE421-P),															Semester: VII
	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

COMPUTER METHODS IN POWER SYSTEMS

General Course Information:

Course Code: PCC-EE402-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.	Memorize the formulation of various network matrices and model the powe system components	**L1(Remembering)**
CO2.	Understand the importance of computer applications in electrical power system operation	**L2(Understanding)**
CO3.	Investigate the state of power system of any size by applying various computer methods under steady state and fault condition	**L3(Applying)**
CO4.	Perform load flow, short circuit and stability applicable in various power system problems	**L4(Analyzing)**
CO5.	Compare and identify the most appropriate algorithm for load flow, short circuit and stability studies	**L5(Evaluating)**
CO6.	Develop appropriate mathematical models of power systems for performanc analysis, planning and control	**L6(Creating)**

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

Course Content

UNIT- I

Network Topology and Matrices: Elementary Graph theory, Incidence matrices, Primitive network and primitive network matrices, Formation of various network matrices by singular transformations, Building algorithm for Bus Impedance matrix (Z_{bus}), Modification of bus impedance matrix for change of reference bus and network changes, formation of bus admittance matrix.

UNIT- II

Load-Flow Studies: Introduction, Importance of load flow studies, Classification of buses, load-flow equations, Iterative methods, Computer algorithms and load flow solutions using Gauss-Seidel and Newton-Raphson methods, Decoupled and fast decoupled Load-flow solutions, Representation of regulating and off-nominal ratio transformers, Comparison of load-flow solution methods.

UNIT- III

Fault studies: Symmetrical faults, Calculation of fault currents, Use of current limiting reactors, Unsymmetrical faults, Symmetrical components theory, Transformation matrix, Unsymmetrical short circuit analysis: LG, LL, LLG using matrix method,

UNIT- IV

Stability Studies: Steady state and transient stability, swing equation, Steady state stability analysis, Transient stability analysis, Equal area criterion, Algorithms and flow charts for transient stability solution using Runge-Kutta and modified Euler methods, multi-machine stability analysis

REFERENCES:

1. G. W. Stagg and A. EI-Abiad, "Computer Methods in Power System Analysis", McGraw-Hill, 1986.
2. L.P Singh, "Advanced Power System Analysis and Dynamics", New Age International.
3. B. R. Gupta, "Power System Analysis and Design", S. Chand, 7th edition, 2014.
4. G. L. Kusic, "Computer-Aided Power Systems Analysis", PHI
5. J. J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw-Hill, 2003.
6. D. P. Kothari, I. .J Nagrath, "Modern Power System Analysis", 3rd Edition, 2011.
7. H. Saadat, 'Power System Analysis ', Tata McGraw - Hill Education, 2nd Edition, 2002.
8. M.A. Pai, "Computer Techniques in Power System Analysis", Tata McGraw-Hill, Education2005.
9. K.U. Rao, "Computer Methods and Models in Power Systems", I.K. International, 2009.

Course Articulation Matrix:

Course/Course Code: Computer Methods in Power Systems (PCC-EE402-T), Semester: VIII															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1	2	2	-	-	2	-	1	1	3	2	1
CO2	3	2	2	1	2	2	-	-	1	-	1	1	3	3	1
CO3	3	2	2	2	3	2	-	-	1	-	1	1	3	2	1
CO4	3	3	2	2	3	2	-	-	1	-	1	1	3	3	1
CO5	3	3	2	3	3	2	-	-	1	-	2	1	3	3	2
CO6	3	3	3	2	3	3	-	-	1	-	2	1	3	3	2

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

COMPUTER METHODS IN POWER SYSTEMS LABORATORY

General Course Information:

Course Code: **PCC-EE402-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.	Learn the applications and working of software tools for electrical power system analysis	**L2 (Understanding)**
CO2.	Calculate the state of power system of any size by applying various computer methods under steady state and fault condition	**L3 (Apply)**
CO3.	Analyze the impact of changes in power system parameters on the state and stability of the system	**L4 (Analyzing)**
CO4.	Acquire the skill of implementing the various methods and create Software tools for analysis of real time power systems	**L6 (Creating)**

LIST OF EXPERIMENTS:

The following experiments may be performed with the help of MATLAB based power system analysis tools PSAT, PST, PSCAD, ETAP etc.

1. Formation of Y_{bus} matrix by inspection / analytical method
2. Formation of Z_{bus} using building algorithm
3. Load flow analysis using Gauss Seidal method
4. Load flow analysis using Newton Raphson method
5. Load flow analysis using Fast decoupled method
6. Simulation of single line to ground fault
7. Simulation of single line to Line fault
8. Simulation of double line to ground fault
9. Simulation of Three Phase Short Circuit fault
10. Transient stability simulation for single machine and multi-machine 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 as per the scope of the syllabus.

MAJOR PROJECT

Course Code: **PROJ-EE420-P** Course Credits : 6 Mode: Practical Contact Hours: 12/week	**Course Assessment Method: (Internal: 30; External: 70)**

Course Outcomes:

Sr. No.	**Course Outcomes** **At the end of the semester, students will be able:**	**RBT Level**
CO 1	Extend or use the idea in minor project for major project.	L1
CO 2	Describe a through and systematic understanding of project contents	L2
CO 3	Use effectively oral, written and visual communication	L3
CO 4	Identify, analyze, and solve problems creatively through sustained critical investigation.	L4
CO 5	Demonstrate an awareness and application of appropriate personal, societal, and professional ethical standards.	L5
CO6	Know the key stages in development of the project.	L6

NOTE: The major project will be completed and evaluated at the end of the 8^{th} semester on the basis of its implementation, presentation, viva-voce and report.

Course Articulation Matrix:

Course/Course Code: Major Project (PROJ-EE420-P),													Semester: VIII		
	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	3	3	2	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	2	3	1	2	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	1	2	3	2	3	3	3	2	3
CO6	3	3	3	3	2	3	2	2	3	3	3	3	3	2	2

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

RENEWABLE ENERGY RERSOURCES

General Course Information:

Course Code: PEC-EE308-T Course Credits: 3 Mode: Lecture (L) Type: Compulsory Teaching Schedule L T P: 3 0 0 Examination Duration: 03 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 and 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 various conventional and renewable energy resources and technologies	**L1 (Remembering)**
CO2.	Recognize the impact of renewable energy utilization on society and environment	**L2 (Understanding)**
CO3.	Interpret and apply the concepts of renewable energy sources for electricity generation and grid integration	**L3 (Applying)**
CO4.	Make comparisons among renewable energy resources and technologies	**L4(Analyzing)**
CO5.	Assess and select the options among renewable energy resources and technologies	**L5 (Evaluating)**
CO6.	Do the basic design of various renewable energy systems for different requirements	**L6 (Creating)**

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

Course Content

UNIT-I

Introduction: Over view of conventional & renewable energy sources, Limitations of conventional energy sources, need & development of alternate energy sources, basic schemes and applications of direct energy conversion types of renewable energy systems, Future of Energy Use, Global and Indian Energy scenario, Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy, concept of Hybrid systems. ENERGY STORAGE: Sizing and Necessity of Energy Storage.

UNIT-II

Solar and Wind Energy:

Solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability, Photovoltaic effect, characteristics of photovoltaic cells, conversion efficiency, solar batteries and applications, Design of standalone PV system, Solar energy in India, solar collectors, solar furnaces & applications, Design of solar water heater,

History of wind power, wind generators, theory of wind power, wind speed statistics-probability distributions, wind speed and power- cumulative distribution functions characteristics of suitable wind power sites, scope in India, advantages and limitations.

UNIT-III

Thermo-electric and MHD Generators: Seeback effect, Peltier effect, Thomson effect, Thermo-electric convertors, Brief description of the construction of thermoelectric generators, Applications and economic aspects.

Hall Effect, Basic principles of MHD generator, Different types of MHD generators, Conversion effectiveness, Practical MHD generators, Applications and economic aspects.

UNIT-IV

Fuel Cells and Miscellaneous Sources: Principle of action, Gibbs free energy, general description of fuel cells, types, construction, operational characteristics and applications, Geo-thermal system, characteristics of geothermal resources, Low head hydro-plants, Network Integration Issues: Overview of grid code technical requirements, Power system interconnection experiences in the world

REFERENCES:

1. G.D. Rai, Non-Conventional sources of Energy, Khanna Publishers, 2009
2. R.A. Coobe, An Introduction to Direct Energy Conservation, Pitman, 1968
3. M. A. Kettani, Direct Energy Conversion, Addison-Wesley Educational Publishers Inc, 1970
4. Robert L. Loftness, Energy Hand book, Van Nostrand Reinhold, 1984
5. D. M. Considine, Energy Technology Hand Book, McGraw-Hill; 1977
6. S. S. Rao, B. B. Parulekar, Energy Technology, Khanna Publishers, 1994
7. A. Ter-Gazarian, Energy storage for Power system, Peter Peregrinus Ltd, 1994
8. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004
9. S. A. Abbasi. and N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, 2001
10. G. S. Sawhney, Non-Conventional Energy Resources, PHI Learning, 2012
11. B. H Khan., Non-Conventional Energy Resources, Tata McGraw Hill, 2009

Course/Course Code: Renewable energy Resources (PEC-EE308-T),														Semester: VI
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	2	-	-	2	3	-	-	-	-[	2	1	2	1
CO2	-	-	2	-		3	3	-	-	-	-	2	1	1	1
CO3	2	-	2	-	1	2	3	-	-	-	1	1	2	2	1
CO4	2	-	2	1	1	2	3	-	-	-	2	1	2	2	2
CO5	1	-	2	1	2	3	3	-	-	-	2	1	1	3	2
CO6	1	-	3	1	2	2	3	-	-	-	1	1	1	2	3

Course Articulation Matrix:

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

NETWORK SYNTHESIS AND FILTER

General Course Information:

Course Code: PEC-EE310-T Course Credits: 3.0 Mode: Lecture (L) Type: Program Elective 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.	Recall the knowledge about the reliability of network functions	**L1(Remembering)**
CO2.	Convert the mathematical driving point or transfer relations into realizable electrical circuits	**L2(Understanding)**
CO3.	Solve the numerical problem for system stability checking stability of the network function.	**L3(Apply)**
CO4.	Compare the different type of electrical components and materials.	**L4(Analysis)**
CO5.	To select the electrical circuit and filters in the field of engineering application.	**L5(Evaluating)**
CO6.	Convert the mathematical expression in the design form.	**L6(Creating)**

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

Course Content

UNIT- I

Fundamental Concepts: Energy considerations, positive real condition, Hurwitz polynomials, Bounded realness, scattering description of networks.

UNIT-II

Lossless one port network functions, Foster reactance functions and theorem, canonical forms: Cauer's and Foster's, Synthesis of lossless LC Immitance functions, Synthesis of lossy RL and RC functions, Certain RLC function realizations. Fundamentals of two port network synthesis.

UNIT-III

Passive Filter Design: Analysis and Design of Constant K and m-derived filters, Active Filter Design: Amplitude and phase functions, amplitude approximations, phase approximations, simultaneous amplitude and phase approximations, Group delay response and equidistant linear phase approximations.

UNIT-IV

Maximally flat and Equi-ripple filters, Magnitude and frequency normalizations, frequency transformations; high Pass, Band-Pass, Band-stop filters, Impedance matching networks, Phase shift networks.

REFERENCES:

1. M.E. Vanvalkenburg, “Network Analysis”, PHI, 3rd Edition, 2014.
2. H. Baher, “Synthesis of Electrical Networks”, John Wiley & Sons, 1984.
3. S. P. Ghosh, A.K. Chakraborthy, “Network Analysis and Synthesis” McGraw Hill, 2010
4. Franklin Kuo, “Network Analysis and Synthesis”, Second Edition, Wiley, 2009.
5. D. Roy Choudhury, “Networks and Systems”, New Age International Publications, 1988.
6. W. H. Hayt and J. E. Kemmerly, “Engineering Circuit Analysis”, 9th Edition, McGraw Hill Education, 2018.

Course Articulation Matrix:

Course/Course Code: Network Synthesis And Filter(PEC-EE310-T),														Semester: VI
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	1	-	-	-	1	2	3	3	1
CO2	3	2	3	2	2	3	1	-	-	-	1	1	2	3	1
CO3	3	3	3	2	1	1	1	-	-	-	1	2	2	2	1
CO4	3	2	3	1	3	2	2	-	-	-	2	1	3	2	1
CO5	2	3	2	2	1	2	2	-	-	-	2	1	2	3	-
CO6	1	2	3	2	2	1	2	-	-	-	2	1	2	3	1

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

DIGITAL SIGNAL PROCESSING

General Course Information:

Course Code: PEC-EE312-T Course Credits: 3 Mode: Lecture (L) Type: Compulsory Teaching Schedule L T P: 3 0 0 Examination Duration: 03 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 and 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.	Understand the concept and advantages of digital signal processing.	**L1 (Remembering)**
CO2.	Summarize differences between time domain and frequency domain analysis tools.	**L2 (Understanding)**
CO3.	Apply DFT and FFT tools to determine the spectral components of a discrete time signal.	**L3 (Applying)**
CO4.	Examine the realization of digital filters using different realization structures.	**L4(Analyzing)**
CO5.	Design and implement Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) digital filters for processing of discrete time signals.	**L6 (Creating)**

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

Course Content

UNIT-I

Discrete Fourier Transform (DFT): Frequency Domain Sampling and Reconstruction of Discrete-Time signals, Discrete Fourier Transform, DFT as a Linear Transformation, Properties of DFT, Linear filtering methods based on DFT: use of DFT in linear filtering, Filtering of long data Sequences.

Fast Fourier Transform (FFT): Fast Fourier Transform Algorithms, Radix-2 and Radix-4 FFT Algorithms, Applications of FFT Algorithms: Efficient Computation of the DFT of Two Real Sequences, Efficient Computation of the DFT of a 2N-Point Real Sequence, use of FFT in Linear filtering and correlation.

UNIT-II

Structures for FIR Systems: Direct Form Structures, Cascade Form Structures, Frequency Sampling Structures, Lattice Structure.

Structures for IIR Systems: Direct Form Structures, Signal Flow graphs & Transposed Structures, Cascade Form Structures, Parallel Form Structures; Lattice & Lattice-Ladder Structures for IIR Systems.

UNIT-III

FIR & IIR Filter Design: FIR and IIR filters properties, Design of FIR filters: importance of Linear Phase response, Design of linear phase FIR filters using Windows, Desirable Window function properties for FIR filter design, Frequency Sampling method for Linear Phase FIR Filter Design. Design steps for IIR Filter design, Design of IIR low pass analog filters: Butterworth, Chebyshew, Elliptic; Conversion of analog system to digital system by: Approximation of Derivatives, Impulse Invariance, Bilinear Transformation, Frequency Transformations.

UNIT-IV

Multirate Digital Signal Processing: Introduction to Multirate digital signal processing, interpolation and decimation, sampling rate conversion by rational factor, filter design and implementation for sampling rate conversion, multistage decimator and interpolators, Applications of Multirate Signal Processing.

REFERENCES:

1. J. G. Proakis, D. G. Manolakis, "Digital Signal Processing, Principles, Algorithms, & Applications", Prentice –Hall India.
2. T.K. Rawat, "Digital Signal Processing" Oxford University Press.
3. S. Mitra, "Digital Signal Processing- A computer based approach" TMH.
4. L. R. Rabiner & B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall India.
5. A. V. Oppenheim, R. W. Schafer, J. R. Buck, "Discrete-Time Signal Processing", Prentice Hall India.
6. A. V. Oppenheim, R. W. Schafer, "Digital Signal Processing", Prentice Hall India.
7. Salivahanan, Vallavaraj and Gnanapriya, "Digital Signal Processing", TMH.

Course Articulation Matrix:

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

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

MODELLING AND SIMULATION

General Course Information:

Course Code: PEC-EE314-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.

Course Outcomes

Sr. No.	**Course outcomes** At the end of the course students will be able to:	RBT* Level
CO1.	Recall the mathematical formulation.	**L1(Remembering)**
CO2.	Illustrate the complexity of real life problems with stochastic modeling	**L2(Understanding)**
CO3.	Solve the real life problems with comprehensive solution.	**L3(Apply)**
CO4.	Compare the performance of different frameworks.	**H1(Analysis)**
CO5.	Judge and utilize the simulation model on the basis of their performance.	**H2 (Evaluating)**
CO6.	Formulate the solution of different problems in the field of research and development.	**H3 (Creating)**

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

Course Content

UNIT-I

Review of Probability and Random Number generation, Generating continuous and discrete time random variables, Discussions on deterministic and stochastic modeling of engineering systems, Need for stochastic models, Ideas of model validation.

UNIT-II

Modeling of systems as discrete event systems (DES), Continuous time and discrete time Markov chains, Properties of DES (observability and controllability), Supervisory control of DES, Queuing models.

UNIT-III

Heuristic modeling, Neural, Fuzzy and Neuro-Fuzzy modeling and simulation of dynamical systems, Modeling of time delays and introduction to networked dynamical systems.

UNIT-IV

Dynamical system simulation, Monte Carlo simulations, generation of simulation data and its statistical analysis, Statistical validation techniques, Goodness of fit test $\chi 2$, and others, Agent based simulation, Numerical issues in simulation of dynamical systems.

REFERENCES:

1. Sheldom Ross, “Simulation”, Academic Press, Elsevier Imprint, 2006.
2. Sankar Sen Gupta. “System Simulation and Modeling”, Pearson Education, 2013.
3. J. Banks, J. S. Carson, B. Nelson and D. M. Nicol, “Discrete Event system simulation”, Pearson Education, 5th Edition, 2014.
4. J. R. Jang and C. Sun, “Neuro-Fuzzy Modeling and Control”, Proceedings of IEEE, Vol. 83, No. 3, March 1995.

Course Articulation Matrix:

Course/Course Code: Modeling and Simulation (PEC-EE314-T)												Semester: VI			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	-	-	-	1	-	1	1	3	2	1
CO2	2	2	2	2	2	2	-	-	-	1	1	1	3	2	-
CO3	2	2	2	2	2	2	-	-	-	1	2	2	3	1	-
CO4	2	3	3	3	2	1	-	-	-	1	2	2	3	2	-
CO5	2	2	2	2	2	1	-	-	-	1	2	2	3	2	-
CO6	2	2	3	2	3	1	1	1	1	1	3	3	3	2	1

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

Electrical Machine Design

General Course Information:

Course Code: PEC-EE403-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.

Course Outcomes

Sr. No.	**Course outcomes** At the end of the course students will be able to:	RBT* Level
CO1.	Recall the basics of electric machines	**L1(Remembering)**
CO2.	Understand the performance of different types of electric machines.	**L2(Understanding)**
CO3.	Solve the problems related with electric machines.	**L3(Apply)**
CO4.	Compare the performance characteristics of electric machines.	**H1(Analysis)**
CO5.	Judge and use the machines on the basis of their utilization and performance.	**H2 (Evaluating)**

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

Course Content

UNIT-I

INTRODUCTION TO DC MACHINES: Major considerations in Electrical Machine Design, Electrical Engineering Materials, Space factor, Choice of Specific Electrical and Magnetic loading, Thermal considerations, Heat flow, Temperature rise, Rating of machines, Standard specifications.

DC machines, Output Equations, Design of main dimensions, Magnetic circuit calculations, Carter's Coefficient, Net length of Iron, Real and Apparent flux densities, Selection of number of poles, Design of Armature, Design of commutator and brushes.

UNIT-II

TRANSFORMERS: Output Equations, Main Dimensions, kVA output for single and three-phase transformers, Window space factor, Overall dimensions, Operating characteristics, Regulation, No load current, Temperature rise in Transformers, Design of Tank, Methods of cooling of Transformers

UNIT-III

INDUCTION MOTOR: Output equation of Induction motor, Design of main dimensions, Length of air gap, Rules for selecting rotor slots of squirrel-cage machines, Design of rotor bars and slots, Design of end rings.

SYNCHRONOUS MACHINES: Pole construction, run away speed, output equation, choice of specific loading, Short circuit ratio, shape of pole face, Armature design, Armature parameters, Estimation of air gap length, Design of field system.

UNIT-IV

COMPUTER AIDED DESIGN: Introduction, manual versus Computer aided design, Approach to Computer aided design, Design synthesis, Special Requirements, Program for Different machines, Computer aided design in industry, Illustrative design, limitations in Computer aided designs.

REFERENCES:

1. A. K. Sawhney, “A Course in Electrical Machine Design”, Dhanpat Rai & Sons, New Delhi, 2013
2. M.V. Deshpande, “Design and Testing of Electrical Machines”, PHI learning Pvt Ltd, 2015.
3. G. Veinot Cyril, “Computer Aided Design of Electrical Machinery”, MIT press London, UK.
4. H.M. Rai, “Electrical Machine Design”, Sathiya Prakashan Publications, Third edition, 2004.
5. A.Shanmugasundaram, G.Gangadharan, R.Palani, “Electrical Machine Design Data Book”, New Age Intenational Pvt. Ltd., Reprint 2007.

Course Articulation Matrix:

Course/Course Code: Electrical Machine Design (PEC-EE403-T)													Semester: VII		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	-	-	-	-	-	-	-	2	1	1	1
CO2	3	2	1	2	2	1	-	-	-	-	-	1	2	2	1
CO3	3	3	2	1	1	-	-	-	1	-	-	1	3	3	1
CO4	3	2	2	2	1	-	-	-	1	-	1	2	2	3	1
CO5	3	2	2	1	-	1	-	2	-	2	3	2	2	2	2

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

ADVANCE POWER ELECTRONICS

General Course Information:

Course Code: PEC-EE405-T Course Credits: 3.0 Mode: Lecture (L) Type: Program Elective 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.	Reproduce technical and intellectual capability in Power Electronics & Power System and to develop interest for life-long learning.	**L1(Remembering)**
CO2.	Identify the drawbacks of speed control of motor by conventional methods.	**L2(Understanding)**
CO3.	Solve problems satisfactorily in the field of Power Electronics and Power System and arrive at appropriate solution.	**L3(Apply)**
CO4.	Compare, formulate and analyze a power electronic software based circuit design and its control drive performance.	**L4(Analysis)**
CO5.	Select the simulation software based on alternative solutions in an industries.	**L5(Evaluating)**
CO6.	Formulate and design mathematical modeling for various engineering problems	**L6(Creating)**

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

Course Content

UNIT- I

Introduction to ordinary differential equation solvers, steps of using ODE solvers, Types of mathematical models, developing a model, Mathematical modeling of simple electrical, Mechanical and electro mechanical systems.

UNIT-II

Simulation of power electronic converters: State-space representation, Trapezoidal integration, M and N method.

UNIT-III

Modeling: Steady state analysis of converters, dynamic analysis of converters, state space average modeling, PWM modeling, modeling of converters operating in continuous and discontinuous conduction mode, converter transfer functions.

Simulation of electric drives: Modeling of different PWM Techniques, Modeling and simulation of Induction motor, Vector controlled 3-Ph Induction motor.

UNIT-IV

Control Techniques in Power Electronics: State space modelling and simulation of linear systems, conventional controllers using small signal models, Fuzzy control, Hysteresis controllers, Output and state feedback switching controllers. Modeling, simulation of switching converters with state space averaging, State Space Averaging Technique and its application in simulation and design of power converters.

REFERENCES:

1. M. B. Patil, V. Ramnarayanan and V. T. Ranganathan, “Simulation of Power Electronic Converters”1st Edition, Narosa Publishers, 2010.
2. Ned Mohan, T.M. Undeland and William P.Robbins, “Power Electronics-Converters, Applications”, 3rd Edition, John Wiley & Sons, 2009.
3. Chee-Mun Ong, “Dynamic Simulation of Electric Machinery”, Using Matlab/Simulink.

Course Articulation Matrix:

Course/Course Code: Advance Power Electronics (PEC-EE405-T), Semester: VII															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	2	1	-	-	-	2	3	2	3	1
CO2	2	2	2	1	2	2	1	-	-	-	3	3	2	2	1
CO3	3	3	3	2	3	1	1	-	-	-	1	2	2	2	-
CO4	2	3	2	1	2	2	-	-	-	-	2	2	2	3	1
CO5	3	1	2	2	1	2	1	-	-	-	1	2	3	2	-
CO6	3	3	1	2	2	2	1	-	-	-	3	2	2	3	1

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

RELIABILITY ENGINEERING

General Course Information:

Course Code: PEC-EE407-T Course Credits: 3.0 Mode: Lecture (L) Type: Program Elective 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.	Recall the concepts of probability and relate it with the reliability	**L1(Remembering)**
CO2.	Equip with fundamentals of reliability concepts and applications in the various fields of engineering with the focus on power systems	**L2(Understanding)**
CO3.	Apply various methods for reliability evaluation, prediction, allocation and optimization.	**L3(Apply)**
CO4.	Examine the failure modes & effects of different models of networks, generatic system and distribution systems.	**L4(Analysis)**
CO5.	Draw reliability logic diagrams, fault trees, market graphs and find reliability functions	**L5(Evaluating)**
CO6.	Apply reliability theory to assessment of reliability in engineering design and power system planning	**L6(Creating)**

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

Course Content

UNIT- I

Basic Reliability Concepts: Reliability and its importance, mortality curve, hazard rate, causes of failures, modes of failure, general reliability function and other reliability functions, Mean time to failure (MTTF), repair rate, mean-time-between failures (MTBF), availability, uptime, downtime, Failure frequency and failure distributions.

UNIT- II

Reliability models: Reliability models – statistical, structural, Markov and fault tree, Reliability evaluation using various models, Network modeling and reliability analysis of Series, Parallel, Series-Parallel networks and complex networks, Decomposition method.

UNIT- III

Redundancy techniques and Reliability Testing: Redundancy techniques, Reliability allocation and Redundancy optimization, Reliability Testing, Basic principles of maintainability, availability and security, Availability evaluation using Markov technique, Basic concepts of fuzzy reliability, failure frequency and loss of load probability

UNIT- IV

Generation and Distribution system reliability: Reliability model of a generation system, recursive relation for unit addition and removal, Load modeling, Merging of generation load mode, Evaluation of transition rates for merged state model, Cumulative probability, Cumulative frequency of failure evaluation – LOLP, LOLE.

Distribution system reliability analysis – radial networks, Weather effects on transmission lines, Evaluation of load and energy indices

REFERENCES:

1. E. Balaguruswamy, "Reliability Engineering", Tata McGraw-Hill Education, 1984

2. K. K. Aggarwal, "Reliability Engineering", Springer, 2012

3. M. L. Shooman, "Probabilistic Reliability-An Engineering approach", Krieger Pub Co.,1990

4. R. Ramkumar, "Reliability Engineering", Prentice Hall, 1st edition, 1996

5. A. K. Govil, "Reliability Engineering", McGraw-Hill Inc., 1983

6. R. Billinton, R. N. Allan, "Reliability Evaluation of Egg. System", Plenum Press, 1992

7. R. Billinton, R. N. Allan, "Reliability Evaluation of Power System", Plenum Press, 2008

8. S. E. Ebeling, "An Introduction to Reliability and Maintainability Engineering" Tata McGraw Hill,

Course Articulation Matrix:

Course/Course Code: Reliability Engineering (PEC-EE407-T),													Semester: VII	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	2	1	-	1	-	2	2	1	2	1
CO2	3	3	2	1	1	2	1	-	1	-	2	2	2	2	1
CO3	2	3	2	2	2	1	1	-	1	-	3	2	2	3	1
CO4	2	3	2	2	2	3	1	-	1	-	3	2	2	3	1
CO5	2	3	2	3	2	1	1	-	1	-	2	2	2	3	1
CO6	3	3	2	2	2	2	1	-	1	-	3	2	2	3	1

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

UTILIZATION OF ELECTRICAL ENERGY

General Course Information:

Course Code: PEC-EE409-T Course Credits: 3.0 Mode: Lecture (L) Type: Program Elective 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.	State the working principle of electric power utilization and their application in real life	**L1(Remembering)**
CO2.	Select proper traction systems depending upon application considering economic and technology up-gradation.	**L2(Understanding)**
CO3.	Employ mathematical and graphical analysis considering different practical issues to design of traction system; analyze the performance parameter of the traction system.	**L3(Apply)**
CO4.	Examine various applications in indoor and outdoor application areas where use of light sources are essential.	**L4(Analysis)**
CO5.	Develop a clear idea on various illumination techniques and hence design lighting scheme for specific applications.	**L5(Evaluating)**
CO6.	State the working principle of electric power utilization and their application in real life	**L6(Creating)**

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

Course Content

UNIT- I

Illumination: Terminology, Laws of illumination, Photometry, lighting calculations. Electric lamps – Different types of lamps, LED lighting and Energy efficient lamps. Design of lighting schemes – factory lighting - flood lighting – street lighting.

UNIT-II

Electric Heating: Types of heating and applications, Electric furnaces - Resistance, inductance and Arc Furnaces, Electric welding and sources of welding, Electrolytic processes – electro-metallurgy and electro-plating. Refrigeration-Domestic refrigerator and water coolers – Air -Conditioning-Various types of air conditioning system and their applications, smart air conditioning units - Energy Efficient motors

UNIT-III

Electrolytic Processes: Introduction, Electrolyte, Ionization, Definition of various terms used in Electrolysis, Faradays' laws of Electrolysis, Extraction of Metals, Refining of metals, Electro-Deposition, Power Supply for Electrolytic Processes.

UNIT-IV

Traction System: Requirement of an ideal traction system, power supply, traction drives, electric braking, Train movement (speed time curve, simplified speed time curve, average speed and schedule speed).Use of AC series motor and Induction motor for traction.

Traction motor control: DC series motor control, multiple unit control, braking of electric motors.

REFERENCES:

1. Dr. Uppal S.L. and Prof. S. Rao, "Electrical Power Systems", Khanna Publishers, New Delhi, 15th Edition, 2014.
2. Gupta, J.B., "Utilization of Electrical Energy and Electric Traction", S. K. Kataria and Sons, 10th Edition, 2012.
3. Rajput R.K., "Utilization of Electrical Power", Laxmi Publications, 1st Edition, 2006.
4. N. V. Suryanarayana, "Utilization of Electrical Power", New Age International Publishers, Reprinted 2005.
5. C. L. Wadhwa, "Generation Distribution and Utilization of Electrical Energy", New Age International Publishers, 4th Edition, 2011.
6. H. Partab, "Modern Electric Traction", Dhanpat Rai & Co., 3rd Edition, 2012.

Course Articulation Matrix:

Course/Course Code: Utilization Of Electrical Energy(PEC-EE409-T),														Semester: VII
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	2	1	-	-	-	1	3	3	3	1
CO2	3	2	2	1	2	2	1	-	-	-	3	3	2	2	1
CO3	2	3	1	2	3	2	2	-	-	-	2	2	3	2	-
CO4	3	3	2	1	2	2	-	-	-	-	2	2	2	3	1
CO5	3	2	2	2	1	2	1	-	-	-	1	2	2	2	-
CO6	3	3	1	2	2	2	2	-	-	-	2	2	2	3	1

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

ENERGY MANAGEMENT AND AUDITING

General Course Information:

Course Code: PEC-EE411-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.

Course Outcomes

Sr. No.	**Course outcomes** At the end of the course students will be able to:	RBT* Level
CO1.	Describe the basics of energy scenario	**L1(Remembering)**
CO2.	Describe the energy management and savings through the different levels during utilization	**L2(Understanding)**
CO3.	Solve the problems related with energy management and audit.	**L3(Apply)**
CO4.	Perform economic and energy efficiency analysis of various electrical devices on the behalf of their energy audit repot.	**H1(Analysis)**
CO5.	Create energy audit report for industrial, residential and commercial consumers	**H3 (Creating)**

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

Course Content

UNIT-I

Energy Scenario: Commercial and Non-Commercial Energy, Primary and Secondary Energy Resources, Conventional and non-conventional energy, Commercial Energy Production, Final Energy Consumption, Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy and Environment: Air Pollution, Climate Change, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future

UNIT-II

Energy Management Functions: Need for energy management, Energy management program, Organizational Structure, Energy Policy, Planning, Audit Planning, Educational Planning, Strategic Planning, Reporting

UNIT-III

Electrical Energy Management: Electricity tariff, Electrical Load Management and Maximum Demand Control, Maximum demand controllers, Power Factor & Its importance, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Energy efficient transformers, Electronic ballast, Energy efficient lighting controls

UNIT-IV

Energy Audit: Definition, Energy audit- need, Types of energy audit, Energy Auditing Services, Basic Components of an Energy Audit, Specialized Audit Tools, Industrial Audits, Commercial Audits, Residential Audits, Indoor Air Quality and basics of economic analysis.

REFERENCES:

1. Wayne C. Turner, Steve Doty, “Energy Management Hand book”, The Fairmont Press, 6th Edition, 2007
2. Amit K. Tyagi, “Handbook on Energy Audits and Management”, Tata Energy Research Institute, 2nd reprint, 2003.
3. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, “Guide to Energy Management”, CRC Press.
4. www.bee-india.nic.in, BEE Reference book: no.1/2/3/4.

Course Articulation Matrix:

Course/Course Code: Energy Management and Auditing (PEC-EE411-T)													Semester: VII		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	-	-	3	3	-	-	-	-	3	2	2	2
CO2	3	2	1	-	2	-	-	-	2	-	-	-	2	2	1
CO3	2	3	2	2	-	-	-	-	-	-	2	-	3	3	2
CO4	2	2	2	-	2	-	-	2	-	2	3	3	2	3	2
CO5	2	2	2	2	2	-	-	2	3	3	3	2	3	3	3

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

SOFT COMPUTING

General Course Information:

Course Code: PEC-EE413-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:

Course Outcomes

Sr. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1.	Recall the basics of power system.	**L1(Remembering)**
CO2.	Describe the performance of different soft computing techniques in the context of power system.	**L2(Understanding)**
CO3.	Solve the problems related with soft computing techniques in the context of power system.	**L3(Apply)**
CO4.	Compare the performance soft computing techniques for optimization of system.	**H1(Analysis)**
CO5.	Judge and analyze the performance of system with the implementation of soft computing techniques.	**H2 (Evaluating)**
CO6.	Create new algorithm (model) for the betterment of power system operation with economics parameters.	**H3 (Creating)**

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

Course Content

UNIT-I

Soft Computing: Introduction, requirement, different soft computing techniques and their characteristics, comparison with hard computing, applications.

UNIT II

Fuzzy sets and Fuzzy logic: Introduction, Fuzzy sets versus crisp sets, properties of fuzzy sets, operations on fuzzy sets, Extension principle, Fuzzy relations, Linguistic variables, linguistic terms, Linguistic hedges, Fuzzy reasoning, Mamdani and TSK fuzzy inference systems, Applications.

UNIT III

Artificial Neural Network: Introduction, comparison with biological neural network, basic models of artificial neuron, different architectures of ANN, Learning techniques, Applications.

UNIT IV

Evolutionary algorithms: Genetic Algorithm (GA), different operators of GA, convergence of Genetic Algorithm, Particle swarm optimization algorithm, other Applications of GA.

REFERENCES:

1. J.S.R.Jang, C.T.Sun, E.mizutani, “Neuro Fuzzy & Soft Computing”, Pearson Education.
2. S. Rajasekaran, GA Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic & Genetic Algorithms -Synthesis & Applications”, PHI Publication.
3. D.E.Goldberg, “Genetic Algorithms in Search optimization & Machine Learning”, Addison - Wesley Pub. Co.
4. J.M. Zurada, “Artificial Neural Systems”, West Publishing Co., New York.
5. Simon Haykin, “Neural Networks - A Comprehensive Foundation”, Prentice Hall.
6. Bart Kosko, “Neural Networks & Fuzzy Systems”, PHI Publication.

Course Articulation Matrix:

Course/Course Code: Soft Computing (PEC-EE413-T)							Semester: VII								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	-	-	-	-	-	-	1	2	1	1
CO2	2	2	2	2	3	-	-	-	-	-	-	1	2	2	1
CO3	3	2	2	2	2	-	-	-	-	-	-	1	3	3	1
CO4	3	2	2	2	2	-	1	-	-	-	-	1	2	3	1
CO5	3	2	2	2	2	-	1	-	-	-	-	1	2	2	1
CO6	3	2	2	2	3	1	1	1	2	1	3	2	2	2	1

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

SCADA SYSTEM AND APPLICATIONS

General Course Information:

Course Code: PEC-EE415-T Course Credits: 3.0 Mode: Lecture (L) Type: Program Elective 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.	Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications	**L1(Remembering)**
CO2.	Identify different elements of SCADA.	**L2(Understanding)**
CO3.	Solve the problems related to I/O module, Data Acquisition System and Communication Networks using Standard Devices.	**L3(Apply)**
CO4.	Examine the problem associated with the industrial application.	**L4(Analysis)**
CO5.	Evaluate the SCADA performance on the basis of application and behaviour.	**L5(Evaluating)**
CO6.	Design and analysis of general structure of an automated process for real time applications using SCADA	**L6(Creating)**

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

Course Content

UNIT- I

Introduction: Introduction to SCADA systems, Fundamental Principle of Modern SCADA Systems, Monitoring and supervisory functions, Application area of SCADA system.

UNIT- II

SCADA System Components, Remote Terminal Unit-(RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems.

UNIT- III

SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850 SCADA Communication: various industrial communication technologies -wired and wireless methods and fiber optics. Open standard communication protocols.

UNIT- IV

SCADA Applications: Utility applications- Transmission and Distribution sector -operations, monitoring, analysis and improvement. Industries - oil, gas and water. Case studies, Implementation, Simulation Exercises.

REFERENCES:

1. Stuart A. Boyer, “SCADA-Supervisory Control and Data Acquisition”, Instrument Society of America Publications,USA,2004
2. William T. Shaw, “Cybersecurity for SCADA systems”, Penn Well Books, 2006
3. David Bailey, Edwin Wright, “Practical SCADA for industry”, Newnes Publication, 2003
4. KLS Sharma, “Overview of Industrial Process Automation”, Elsevier Publication

Course Articulation Matrix:

Course/Course Code: SCADA System and Applications(PEC-EE415-T),														Semester: VII
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	1	-	-	-	-	2	3	2	3	2
CO2	3	2	3	2	3	2	-	-	-	-	2	3	2	3	1
CO3	2	3	3	2	2	3	-	-	-	-	3	2	3	3	1
CO4	3	2	2	2	3	1	-	-	-	-	3	1	2	2	1
CO5	2	3	3	2	2	1	-	-	-	-	2	1	2	2	2
CO6	2	3	2	2	2	2	-	-	-	-	2	2	2	1	1

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

INTERNET OF THINGS (IOT)

General Course Information:

Course Code: PEC-EE417-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.

Course Outcomes

Sr. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1.	Memorize the basic concepts of Internet, embedded system and wireless network.	**L1(Remembering)**
CO2.	Understand the concepts of Internet of Things	**L2(Understanding)**
CO3.	Choose the specific application to apply the concept of IOT.	**L3(Apply)**
CO4.	Analyze basic protocols in wireless sensor network.	**H1(Analysis)**
CO5.	Design IOT applications in different domain and be able to analyze their performance	**H3 (Creating)**

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

Course Content

UNIT-I

Introduction and Concepts of IOT: Introduction to IOT, definition and characteristics of IOT, Architecture of Internet of Things, Physical and logical design of IOT, IOT enabling technologies, IOT levels and deployment templates, Domain specific IOTs, home automation, cities, environment, Domain specific IOTs, Energy, retail, agriculture, industry, health and lifestyle.

UNIT-II

IOT Challenges & IOT-M2M Communication: Design challenges, Development challenges, Security challenges, Other challenges, Machine to Machine, Difference between IoT and M2M, Software define Network, Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination,

UNIT-III

Introduction to Hardware used for IoT: Microcontrollers, Microprocessors, Sensors, Introduction to Arduino, RF Protocols: RFID, NFC, Bluetooth Low Energy (BLE), IPv6 for Low Power and Lossy Networks (6LoWPAN) and Routing, Protocol for Low power and lossy networks (RPL).

UNIT-IV

Developing IOTs: Introduction to Python, Introduction to different IOT tools, Developing applications through IOT tools, Developing sensor based application through embedded system platform, Implementing IOT concepts with python.

REFERENCES:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things, A Hands -on Approach", 1st Edition University Press, 2015.
2. Oliver Hersent, David Boswarthick, Omar Elloumy, "The Internet of Things",1st Edition , 2015.
3. Michael Miller, "The Internet of Things, How Smart TVs, Smart Cars, Smart Homes, and Smart Cities are changing the World", 1st edition, Pearson 2015.

Course Articulation Matrix:

Course/Course Code: Internet of Things (PEC-EE417-T)													Semester: VII		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	2	-	-	2	2	2	3	2	1
CO2	3	2	2	2	3	2	1	-	1	2	2	1	3	2	-
CO3	2	2	2	2	3	2	2	-	1	1	2	2	3	2	-
CO4	2	3	3	2	3	1	2	-	2	1	2	2	3	2	1
CO5	2	2	3	2	3	2	2	1	2	2	3	3	3	2	1

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

FLEXIBLE AC TRANSMISSION SYSTEMS

General Course Information:

Course Code: PEC-EE404-T Course Credits: 3.0 Mode: Lecture (L) Type: Program Elective Teaching Schedule L T P: 3 0 0 Examination Duration: 03 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.	Revise the basics of power transmission networks and need for FACTS controllers	**L1(Remembering)**
CO2.	Understand and classify different power system FACTS Controllers	**L2(Understanding)**
CO3.	Demonstrate the scope of the specific FACTS controllers for power flow control issues in transmission lines.	**L3(Apply)**
CO4.	Analyze the operation of various FACTS controllers and solve simple powe systems with FACTS controllers	**L4(Analysis)**
CO5.	Select the specific FACTS controllers for power system compensation	**L5(Evaluating)**
CO6.	Design simple FACTS controllers	**L6(Creating)**

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

Course Content

UNIT- I

Introduction: Review of basics of power transmission networks, Control of power flow in AC transmission line, Analysis of uncompensated AC Transmission line, Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer, Need for FACTS controllers, Types of FACTS controllers.

UNIT- II

Static VAR compensator (SVC): Configuration of SVC, Voltage regulation by SVC, Modeling of SVC for load flow and stability analysis, Modeling of SVC for studies, Design of SVC to regulate the mid-point voltage of a SMIB system, Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line.

UNIT- III

Thyristor and GTO thyristor controlled series capacitors (TCSC and GCSC): Concepts of Controlled Series Compensation – Operation of TCSC and GCSC- Analysis of TCSC-GCSC – Modeling of TCSC and GCSC for load flow and stabilityanalysis, Applications of TCSC and GCSC

UNIT- IV

Voltage source converter based facts controllers: Static synchronous compensator (STATCOM), Static synchronous series compensator(SSSC), Operation of STATCOM and SSSC, Power flow control with STATCOM and SSSC, Modeling of STATCOM and SSSC for power flow and transient stability studies, Operation of Unified and Interline power flow controllers(UPFC and IPFC), Modeling of UPFC and IPFC for load flow studies, Applications.

REFERENCES:

1. R. M. Mathur, , R. K. Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.
2. K.R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd., Publishers, New Delhi, Reprint 2008,
3. A.T. John, "Flexible AC Transmission System", Institution of Electrical and Electronic Engineers (IEEE), 1999.
4. N. G. Hingorani, L. Gyugyi, "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Standard Publishers, Delhi 2001.
5. V. K. Sood, "HVDC and FACTS controllers- Applications of Static Converters in Power System", 2004, Kluwer Academic Publishers.
6. T. J. E. Miller, "Reactive Power Control In Electric Systems", Wiley Publications, 1982.

Course Articulation Matrix:

Course/Course Code: Flexible Ac Transmission System(PEC-EE404-T),														Semester: VIII
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	1	-	2	2	2	-	-	-	1	2	1	1	1
CO2	2	-	1	1	1	-	1	-	-	-	-	2	2	1	1
CO3	2	1	2	1	1	1	1	-	1	-	1	2	2	1	1
CO4	2	3	2	2	2	3	1	-	1	-	1	2	2	1	1
CO5	2	2	2	3	2	1	1	-	1	-	1	2	2	3	1
CO6	2	2	3	2	2	2	1	-	1	-	1	2	2	3	1

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

DISTRIBUTED GENERATION

General Course Information:

Course Code: PEC-EE406-T Course Credits: 3.0 Mode: Lecture (L) Type: Program Elective 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.	Describe the various technical and economic benefits of Distributed Generations.	**L1(Remembering)**
CO2.	Recognize the need of siting and sizing of distributed generation along with their effect on distribution system.	**L2(Understanding)**
CO3.	Apply economic feasibility analysis	**L3(Apply)**
CO4.	Examine the technical issue in Distributed Generations system	**L4(Analysis)**
CO5.	Evaluate the appropriate optimization technique suitable for Distributed Generations.	**L5(Evaluating)**
CO6.	Develop a Model a micro grid taking into consideration the planning and operational issues of the Distributed Generations to be connected in the system	**L6(Creating)**

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

Course Content

UNIT- I

Introduction: Conventional power generation: advantages and disadvantages, Energy crises, Nonconventional energy (NCE) resources: basics of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.

UNIT-II

Distributed Generations: Concept of distributed generations, Topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547, Energy storage elements: Batteries, ultra-capacitors, flywheels, Superconducting magnetic energy storage.

UNIT-III

Micro grids: Concept and definition of micro grid, micro grid drivers and benefits, review of sources of Micro grids, typical structure and configuration of a Micro grid, AC and DC Micro grids, Power Electronic interfaces in DC and AC Micro grids.

UNIT-IV

Impact of Grid Integration: Requirements for grid interconnection, limits on operational parameters: voltage, frequency, THD Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

REFERENCES:

1. D. N. Gaonkar, “Distributed Generation”, In-Tech publications.
2. Magdi S. Mahmoud, Fouad M. AL-Sunni, “Control and Optimization of Distributed Generation Systems”, Springer International Publishing.
3. Loi Lei Lai, Tze Fun Chan, “Distributed Generation: Induction and Permanent Magnet Generators”, October 2007, Wiley-IEEE Press.
4. M.Godoy Simoes, Felix A.Farret, ‘Renewable Energy Systems – Design and Analysis with Induction Generators’, CRC press.
5. F. Katiraei, M.R. Iravani, “Transients of a Micro-Grid System with Multiple Distributed Energy Resources”, International Conference on Power Systems Transients (IPST’05) in Montreal, Canada on June 19-23, 2005.

Course Articulation Matrix:

Course/Course Code: Distributed Generation(PEC-EE406-T),															Semester: VIII
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	-	-	2	3	-	-	-	1	2	1	2	1
CO2	-	1	2	-		3	3	-	-	-	-	2	1	1	1
CO3	2	2	2	-	1	2	3	-	-	-	1	1	2	2	1
CO4	2	2	2	1	1	2	3	-	-	-	2	1	2	2	2
CO5	2	2	2	1	2	3	3	-	-	-	2	1	1	3	2
CO6	2	3	3	1	2	2	3	-	-	-	1	1	1	2	3

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

POWER QUALITY

General Course Information:

Course Code: PEC-EE408-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.

Course Outcomes

Sr. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1.	Describe the basics of power electronic devices and quality of power supply.	**L1(Remembering)**
CO2.	Illustrate the issues related with power quality.	**L2(Understanding)**
CO3.	Solve the problems related with power quality.	**L3(Apply)**
CO4.	Compare the power quality problems.	**H1(Analysis)**
CO5.	Evaluate and judge the solutions related with power quality.	**H2 (Evaluating)**
CO6.	Design can be formulated as per required specification and issue.	**H3 (Creating)**

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

Course Content

UNIT-I

Introduction to Power Quality: Introduction to power distribution system- deregulated environment, Power Quality (PQ): definitions, concerns, and evaluations, Terminology: under-voltage, over voltage, transients, harmonics, voltage unbalance, voltage sags, voltage swells, flicker, interruptions, and power frequency variations, Concepts of transients - short duration variations such as interruption - long duration variation such as sustained interruption, International standards of power quality, Computer Business Equipment Manufacturers Associations (CBEMA) curve.

UNIT-II

Voltage Sags, Interruptions and Over voltages: Sources of sags and interruptions - estimating voltage sag performance, Voltage sag due to induction motor starting, Estimation of the sag severity, Active Series Compensator, Static transfer switches and fast transfer switches, Sources of over voltages - Capacitor switching - lightning, Mitigation of voltage swells - surge arresters - power conditioners, Lightning protection - shielding - line arresters.

UNIT-III

Power System Harmonics: Harmonic sources from commercial and industrial loads, locating harmonic sources, Power system response characteristics - Harmonics Vs transients, Effect of harmonics - harmonic distortion - voltage and current distortion - harmonic indices, Devices for controlling harmonic distortion - passive and active filters, IEEE and IEC standards.

UNIT-IV

Power Quality Monitoring and Distributed Generation: Power Quality Monitoring - Industry requirements - standards, Power Quality Measurement Equipment: Power line disturbance analyser, Harmonic analyser-Spectrum analyser, Flicker meters and Disturbance analyser.

Introduction to DG Technologies: Interface to the Utility System-Power Quality issues, Site study for Distributed Generation-Interconnection standards, Issue on Power Quality in Smart Grids and Micro Grids

REFERENCES:

1. Roger C. Dugan, Mark McGranaghan, Surya Santoso, H.Wayne, H. Wayne Beaty, “Electrical Power Systems Quality”, Tata McGraw Hill, Third edition, 2012.
2. J. Arrillaga, N.R. Watson, S. Chen, “Power System Quality Assessment”, Wiley, 2011.
3. Dash.S.S, Rayaguru.N.K, “Power Quality Management”, 2nd Edition, Vijay Nicole Publishers, 2016.
4. Jos Arrillaga, Neville R. Watson, “Power System Harmonics”, 2nd Edition, Wiley Publishers, 2015.
5. ArindamGhosh ,“Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, 2002.
6. G.T. Heydt, “Electric Power Quality”, 2nd edition, Stars in a Circle Publications, 1994.

Course Articulation Matrix:

Course/Course Code: Power Quality (PEC-EE408-T)												Semester: VIII			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	1	1	-	-	-	1	1	3	1	1
CO2	3	2	2	1	1	1	1	1	1	1	1	1	2	2	1
CO3	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
CO4	3	1	1	1	1	1	1	1	1	1	2	2	2	2	1
CO5	3	1	2	3	2	1	1	-	1	1	2	2	2	2	2
CO6	3	2	3	2	3	3	3	2	2	1	3	3	2	2	2

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

SMART GRID TECHNOLOGIES

General Course Information:

Course Code: PEC-EE410-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-EE206-T, PCC-EE302-T

Course Outcomes

Sr. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1.	Recall the basics of Power system and its design aspects.	**L1(Remembering)**
CO2.	Describe the structure of smart grid on the basis of traditional grid with the role of automation in transmission and distribution.	**L2(Understanding)**
CO3.	Demonstrate the operation, scheduling and economics using evolutionary algorithms for smart grid and maximum utilization of renewable energy resources.	**L3(Apply)**
CO4.	Compare its performance with conventional grid and analyze the role of frequency for the control of grid.	**H1(Analysis)**
CO5.	Judge and evaluate the efficiency of system on the basis of supply of electricity with its economic indices.	**H2 (Evaluating)**
CO6.	Formulate algorithm or automation so that maximum consumer can be benefitted and losses of the system can be minimized.	**H3 (Creating)**

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

Course Content

UNIT-I

Introduction to Smart Grid: Smart Grid, Need of Smart Grid, Working definitions of Smart Grid and associated concepts, Smart Grid Functions, Traditional Power Grid and Smart Grid, New Technologies for Smart Grid, Advantages, Whole sale energy market in smart grid, Indian Smart Grid, Key Challenges for Smart Grid.

UNIT-II

Smart Grid Architecture: Components and Architecture of Smart Grid Design, Review of the proposed architectures for Smart Grid, Fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation, Renewable Integration, Energy Management in smart grid.

UNIT-III

Tools and Distribution Generation Technologies: Introduction to Renewable Energy Technologies, Micro grids, Storage Technologies, Electric Vehicles and plug-in hybrids, Environmental impact and Climate Change, Economic Issues, Advanced metering infrastructure.

UNIT-IV

Communication Technologies and Smart Grid: Introduction to Communication Technology, Synchro Phasor Measurement Units (PMUs), Wide Area Measurement Systems (WAMS).

Control of Smart Power Grid System: Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System, Reactive Power Control in Smart Grid, Case Studies for the Smart Grids.

REFERENCES:

1. James Momoh, "Smart Grid - fundamentals of design and analysis", John Wiley and Sons, 2012.
2. Janaka Ekanayake, "Smart Grid -Technology and Applications", John Wiley and Sons, 2012.
3. Stuart Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, 2013.
4. Gil Masters, "Renewable and Efficient Electric Power System", Wiley-IEEE Press, 2004.
5. A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer Edition, 2010.
6. T. Ackermann, "Wind Power in Power Systems", Hoboken, NJ, USA, John Wiley, 2005.

Course Articulation Matrix:

Course/Course Code: Smart Grid Technologies (PEC-EE410-T)													Semester: VIII		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	-	-	-	-	1	1	1	3	2	1
CO2	3	2	3	1	1	1	1	1	1	1	1	1	3	2	1
CO3	3	2	2	1	2	2	2	1	2	1	2	2	3	2	1
CO4	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO5	3	2	2	1	1	1	2	1	1	1	2	2	3	2	2
CO6	3	3	3	2	3	3	3	2	2	1	3	3	3	3	3

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

EHV AC and DC TRANSMISSION

General Course Information:

Course Code: PEC-EE412-T Course Credits: 3.0 Mode: Lecture (L) Type: Program Elective 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.	Elicit the major components, advantages, limitations and applications of EHV AC and DC transmission Systems	**L1(Remembering)**
CO2.	Recapitulate the fundamental aspects of Extra High Voltage A.C and DC transmission design and analysis	**L2(Understanding)**
CO3.	Apply the remedial measures against the problems associated with EHVAC and DC transmission such as Corona, AN, RI, Over-voltages, Ferro-resonance, Harmonics in converters	**L3(Apply)**
CO4.	Perform in-depth analysis of various control techniques for controlling the power flow through a dc link and multi-terminal operation of HVDC	**L4(Analysis)**
CO5.	Critically evaluate AC and DC transmission system with respect to all aspects	**L5(Evaluating)**

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

Course Content

UNIT- I

Introduction: Need of EHV transmission, standard transmission voltage, Power handling capacity, Comparison of EHV AC & DC transmission systems and their applications & limitations, Bundled conductors, Surface voltage gradients in conductor, Distribution of voltage gradients on sub-conductors, mechanical considerations of transmission lines, modern trends in EHV AC & DC transmission.

UNIT- II

EHV AC Transmission: Corona, Corona loss formulae, corona current, Audible noise-generation and characteristics corona pulses their generation and properties, Radio interference

(RI) effects, Over voltage due to switching, Ferro-resonance, reduction of switching surges on EHV system, principle of half wave transmission**.**

UNIT- III

Components of EHV D.C.: Converter circuits, Rectifier and inverter valves, Reactive power requirements, Harmonics generation, Adverse effects, Classification, Remedial measures to suppress, Filters, Ground return, Converter faults & protection harmonics misoperation, Commutation failure, Multi-terminal D.C. lines.

UNIT- IV

Control of EHV D.C.: Desired features of control, control characteristics, Constant current control, Constant extinction angle control. Ignition Angle control, Parallel operation of HVAC & DC system, Problems & advantages.

REFERENCES:

1. R.D. Begamudre, "EHV AC Transmission Engineering", Wiley Eastern Press, 2011
2. S. S. Rao, "EHV AC & DC Transmission", Khanna publishers, 2008
3. E. Kimbark, "HVDC Transmission", John Wiley and Sons, 1971
4. J. Arrillaga, "HVDC Transmission", 2nd Edition, IEEE Press, 1998
5. K. R. Padiyar, "HVDC Transmission, New Age International", 2nd edition, 2012
6. P. Kundur, "Power System Stability and Control", Tata McGraw Hill, 1994

Course Articulation Matrix:

Course/Course Code: EHVAC and DC Transmission (PEC-EE412-T),														Semester: VIII
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	1	-	1	1	-	2	2	3	2	1
CO2	3	1	2	1	1	1	-	1	1	-	2	2	3	2	1
CO3	3	2	2	2	1	1	-	1	1	-	2	1	2	2	1
CO4	2	3	2	2	1	1	-	1	1	-	2	1	2	2	1
CO5	2	3	2	2	1	1	-	1	1	-	2	1	2	2	1

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

RESTRUCTURED POWER SYSTEM

General Course Information:

Course Code: PEC-EE414-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-EE206-T, PCC-EE302-T

Course Outcomes

Sr. No.	**Course outcomes** At the end of the course students will be able to:	RBT* Level
CO1.	Recall the basics of Power system and its design aspects.	**L1(Remembering)**
CO2.	Describe the structure of restructured power system on the basis of conventional power system design.	**L2(Understanding)**
CO3.	Demonstrate the operation, scheduling and economics of with an emphasis on recent research in this area.	**L3(Apply)**
CO4.	Compare its performance with conventional (bundled) power system.	**H1(Analysis)**
CO5.	Judge and evaluate the efficiency of system on the basis of supply of electricity with its economic indices.	**H2 (Evaluating)**
CO6.	Design can be formulated so that maximum consumer can be benefitted.	**H3 (Creating)**

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

Course Content

UNIT-I

Introduction: Measures for Energy Conservation, History of Electrical Power Generation, Laws, Efficient Transmission Arrangements, Measures for Energy Conservation, History of Electrical Power Generation, The Laws, Challenges and Issues in Competition Market, Competition in Generation, Efficient Transmission Arrangements. Role of different Authorities in Power Sectors.

UNIT-II

Power Trading: Term-Ahead Market (TAM), Short-Term Open Access in Inter-state Transmission, (Collective Transaction/Pool Transaction), Present Practice, Market Clearing Process (MCP), Linear Bid Market, Determination of MCP for Single Sided Linear Bid Market

UNIT-III

Load Frequency control: Power Industry Scenario, Introduction to AVR and ALFC Loops, review of modeling of an Isolated Generating System, Model for a Vessel, Reheat Type Steam Turbine Model, Complete Block Diagram Representation of LFC of an Isolated Area , Indian Power Industry Restructuring, Challenges in Load Frequency Control, Disco Participation Matrix (DPM), ACE Participation Factors, Transaction During Contract Violation/Pool Based Transaction, Mathematical Modeling of AGC with Restructuring

UNIT-IV

Available Power Transfer Capability: Fundamentals and Importance of ATC, Algorithm for ATC Determination, Methods of ATC Determination, Power Transfer Distribution Factors Based on D.C. Load Flow Approach, Static ATC Determination Using A.C. Power Transfer Distribution Factor.

REFERENCES:

1. L. L. Lai, "Power System Restructuring and Deregulation", John Wiley& Sons Inc., New York, HRD Edition, 2001.
2. S. K. Gupta, "Restructuring Electric Power Systems", I K International Publishing House.
3. Kankar Bhattacharya, Math H.J.Bollen and Jaap E. Daalder, "Operation of Restructured Power Systems", USA: Kluwer Academic Publishers, 2001.
4. Mohammad Shahidehpour, Hatim Yamin, "Market Operations in Electric Power Systems", John Wiley & Sons Inc., 2002.
5. Lorrin Philipson, H. Lee Willis, "Understanding Electric Utilities and Deregulation", Taylor & Francis, New York, 2nd Edition, 2006.
6. Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured Electrical Power Systems", Marcel Dekker, INC., New York, 1st Edition, 2001.
7. Overview of Power Sector in India 2005: Indian Core Publishing.

Course Articulation Matrix:

Course/Course Code: Restructured Power System (PEC-EE414-T)															Semester: VIII
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	2	1	2	2	1	1	1	3	3	1
CO2	3	2	3	1	1	1	1	1	1	1	1	1	3	2	1
CO3	3	1	2	1	2	2	2	1	2	1	2	2	3	2	1
CO4	3	1	1	1	1	1	1	1	1	1	1	1	3	2	1
CO5	3	1	2	1	1	1	2	1	1	1	2	2	3	2	2
CO6	3	2	3	2	3	3	3	2	2	1	3	3	3	2	3

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

HIGH VOLTAGE ENGINEERING

General Course Information:

Course Code: PEC-EE416-T Course Credits: 3.0 Mode: Lecture (L) Type: Program Elective 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.	Describe the Knowledge about high voltage generation	**L1(Remembering)**
CO2.	Discuss the testing methods of High Voltage Equipment	**L2(Understanding)**
CO3.	Find the problem occur in high voltage generation	**L3(Apply)**
CO4.	Test various apparatus and their measurement method for generating high voltages.	**L4(Analysis)**
CO5.	Select the reasons of overvoltage in power system and protection methods against them.	**L5(Evaluating)**
CO6.	Formulate the incidence, network matrices and model of the power system components.	**L6(Creating)**

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

Course Content

UNIT- I

Break Down Mechanism of Gaseous Materials: Mechanism of Breakdown of gases, Townsend's first Ionization Co-efficient, Townsend's second Ionization Co-efficient, Townsend's Breakdown Mechanism, and Streamer Theory of Breakdown in gases, Paschen's law.

UNIT-II

Breakdown in Liquid and Solid Dielectrics: Suspended Particle Theory, Cavity Breakdown, Electro- convection Breakdown, Breakdown in solid Dielectrics, Intrinsic Breakdown, Electromechanical Breakdown, Breakdown due to Treeing and Tracking, Thermal Breakdown, Electrochemical Breakdown

UNIT-III

Generation of High Dc and Ac Voltages: Introduction, Rectifier circuits, Cockcroft- Walton voltage multiplier circuit, electrostatic generator, generation of high ac voltages by cascaded transformers, series resonant circuit.

UNIT-IV

High Voltage Testing & Measurement: Sphere-Gap, Uniform field Spark gap, Rod Gap, Electrostatic Voltmeter, Generating Voltmeter, Impulse Voltage Measurement using Voltage divider, Measurement of high DC, AC and Impulse Current., Testing of line Insulator, Testing of Cable, Testing of Bushings, Testing of Power Capacitor, Testing of Power Transformers, Testing of Circuit Breaker.

REFERENCES:

1. M.S. Naidu & V. Kamaraju, "High Voltage Engineering", Publication TMH
2. S Kamakshaiah/V Kamaraju, "HVDC Transmission," McGraw Hill
3. Rakos Das Begamudre, "Extra EHV A.C Transmission" PHI Publication.
4. C.L Wadhwa, "High Voltage Engineering", New Age International Ltd.
5. Ravindra Arora & Wolfgang Mosch, "High voltage Insulation Engineering", New Age International Publishers, 2011.
6. E. Kuffel, W.S. Zaengl, J. Kuffel,"High voltage Engineering Fundamentals", Newnes Publishers, 2011.
7. M.S. Naidu & Kamaraju, "High voltage Engineering Fundamentals", TMH, 2008.

Course Articulation Matrix:

Course/Course Code: High Voltage Engineering(PEC-EE416-T),														Semester: VIII
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	1	2	1	1	-	-	-	1	1	3	2	1
CO2	3	2	2	2	1	2	1	-	-	-	2	1	2	1	1
CO3	2	2	2	3	2	1	-	-	-	-	1	1	3	3	1
CO4	2	2	1	2	3	2	1	-	-	-	-	-	2	2	1
CO5	3	3	2	1	1	3	1	-	-	-	2	1	2	1	1
CO6	2	2	3	2	1	3	1	-	-	-	1	2	2	2	1

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

OPTIMIZATION THEORY

General Course Information:

Course Code: PEC-EE418-T Course Credits: 3.0 Mode: Lecture (L) Type: Program Elective 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.	Describe the different optimization algorithms and formulate optimization problems	**L1(Remembering)**
CO2.	Understand the need of optimization theory and how it may be applied to different applications and areas of engineering	**L2(Understanding)**
CO3.	Apply classical and modern optimization techniques to solve engineering problems	**L3(Apply)**
CO4.	Differentiate between various optimization techniques	**L4(Analysis)**
CO5.	Select the appropriate optimization technique suitable for a given system and its model	**L5(Evaluating)**
CO6.	Formulate optimization problems and obtain an optimal solutions	**L6(Creating)**

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

Course Content

UNIT- I

Introduction and Classical Optimization Techniques: Statement of an Optimization problem, Design vector, Design constraints, Constraint surface, Objective function, Objective function surfaces, Classification of Optimization problems, Classical Optimization Techniques: Single variable Optimization and multi variable Optimization without constraints, Necessary and sufficient conditions for minimum/maximum, Multivariable Optimization with equality constraints, Solution by method of Lagrange multipliers, Multivariable Optimization with inequality constraints, Kuhn – Tucker conditions.

UNIT- II

Linear programming: Linear programming problem formulation, Simplex method, Two phase simplex method, Dual simplex method, Duality in linear programming, Sensitivity analysis and its applications, Integer linear programming, Cutting plane method, Linear programming approach to game theory, Dynamic programming problems.

UNIT- III

Nonlinear programming: Introduction to nonlinear programming, Unconstrained optimization: formulation of quadratic optimization problem, Newton Raphson method, Gradient method, Constrained optimization: Quadratic programming, Separable programming.

UNIT- IV

Dynamic programming and Evolutionary algorithms: Dynamic programming multistage decision processes, Types, Concept of sub-optimization and the principle of optimality, Computational procedure in dynamic programming, Examples illustrating the calculus method of solution, Examples illustrating the tabular method of solution, Evolutionary Algorithms: Genetic algorithms, simulated annealing, fuzzy optimization.

REFERENCES:

1. S. S. Rao, "Engineering Optimization: Theory and Practice", Wiley, 6th edition, 2019.
2. H. A. Taha, "Operations Research: An Introduction", 10th Edition, Pearson, 2017.
3. H. S. Kasana & K. D. Kumar, "Introductory Operations Research", Springer (India), Pvt. Ltd., 2004
4. V. Chvatal, W. H. Freeman, "Linear programming", New York, 1985
5. G. B. Dantzig, M. N. Thapa, "Linear programming", Springer, 3rd edition, 2003
6. D. P. Bertsekas, "Nonlinear Programming" Athena Scientific, 2nd edition, 2016,
7. P.K. Gupta and D.S. Hira, "Operations Research", S. Chand, Revised edition, 2014
8. K. Deb, "Multi-objective optimization using evolutionary algorithms", Wiley, 2001

Course Articulation Matrix:

Course/Course Code: Optimization Theory (PEC-EE418-T),													Semester: VIII		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	2	1	-	-	-	3	3	1	2	1
CO2	3	2	2	1	2	2	1	-	-	-	3	3	1	2	1
CO3	2	2	2	2	3	2	1	-	-	-	3	2	2	2	1
CO4	2	3	2	2	2	2	1	-	-	-	3	2	2	3	1
CO5	3	3	2	2	2	2	1	-	-	-	3	2	2	3	1
CO6	3	3	2	2	2	2	1	-	-	-	3	2	3	3	1

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