Tripura University

(A Central University)

Curriculum

For

B. Tech in Electrical Engineering

(EE)

(1st to 8th Semester)

Detailed Syllabus

2021

Curriculum Structure (Total Credit: 162)

COMMON SYLLABUS- FIRST SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Basic Science - 1	BS 101	Mathematics – I	3	1	0	4	4	100
2.	Basic Science - 2	BS 102	Physics	3	1	0	4	4	100
3.	Engineering Science - 1	ES 103	Basic Electrical Engineering	3	1	0	4	4	100
4.	Engineering Science - 2	ES 104	Engineering Graphics and Design	1	0	0	1	1	100
5.	Basic Science - 3	BS 105	Physics Laboratory	0	0	3	3	1.5	100
6.	Engineering Science - 3	ES 106	Engineering Graphics Practice	0	0	4	4	2	100
7.	Engineering Science - 4	ES 107	Basic Electrical Engineering Laboratory	0	0	2	2	1	100
8.	Mandatory Course - 1	MC 108	Induction Program	3 weeks in the beginning of the semester				0	100
			Total :	**10**	**3**	**9**	**22**	**17.5**	**800**

COMMON SYLLABUS- SECOND SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hours/ week	Credit	Full Marks
1.	Humanities Science - 1	HS 201	English	2	0	0	2	2	100
2.	Basic Science - 4	BS 202	Mathematics-II	3	1	0	4	4	100
3.	Basic Science - 5	BS 203	Chemistry	3	1	0	4	4	100
4.	Engineering Science - 5	ES 204	Programming for Problem Solving	3	0	0	3	3	100
5.	Engineering Science - 6	ES 205	Manufacturing Practices	1	0	0	1	1	100
6.	Humanities Science - 2	HS 206	Language Laboratory	0	0	2	2	1	100
7.	Basic Science - 6	BS 207	Chemistry Laboratory	0	0	3	3	1.5	100
8.	Engineering Science - 7	ES 208	Programming for Problem Solving Lab	0	0	4	4	2	100
9.	Engineering Science - 8	ES 209	Workshop on Manufacturing Practices	0	0	4	4	2	100
10.	Mandatory Course - 2	MC 210	Environmental Engineering	3	0	0	3	0	100
			Total :	**15**	**2**	**13**	**30**	**20.5**	**1000**

3rd SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/ week	Credit	Full Marks
1.	Humanities Science - 2	HS 301	Effective Technical Communication	3	0	0	3	3	100
2.	Basic Science - 7	BS 302	Mathematics-III	2	1	0	3	3	100
3.	Basic Science - 8	BS 303	Biology for Engineers	2	0	0	2	2	100
4.	Engineering Science - 5	ES 304	Engineering Mechanics	2	1	0	3	3	100
5.	Program Core - 1	PC EE 305	Electrical Circuits Analysis	3	1	0	4	4	100
6.	Program Core - 2	PC EE306	Analog Electronics	3	1	0	4	4	100
7.	Program Core - 3	PC EE307	Electrical Estimation & Design Practices	0	0	2	2	1	100
8.	Program Core - 4	PC EE308	Electrical Circuits Laboratory	0	0	2	2	1	100
9.	Program Core - 5	PC EE309	Analog Electronics Laboratory	0	0	2	2	1	100
10.	Mandatory Course - 3	MC 310	Indian Constitution	2	0	0	2	0	100
			Total :	**17**	**4**	**6**	**27**	**22**	**1000**

4th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science - 3	HS 401	Engineering Economics and Accountancy	3	0	0	3	3	100
2.	Humanities Science - 4	HS 402	Universal Human Values-II: Understanding Harmony	2	1	0	3	3	100
3.	Program Core - 6	PC EE 403	Electromagnetic Fields Theory	3	1	0	4	4	100
4.	Program Core - 7	PC EE 404	Electrical Machines-I	3	1	0	4	4	100
5.	Program Core - 8	PC EE 405	Digital Electronics	3	0	0	3	3	100
6.	Program Core - 9	PC EE 406	Power Electronics	3	0	0	3	3	100
7.	Program Core - 10	PC EE	Electrical Machines	0	0	2	1	1	100

		407	laboratory-I						
8.	Program Core - 11	PC EE 408	Power Electronics Laboratory	0	0	2	1	1	100
9.	Program Core - 12	PC EE 409	Basic Electrical Measurements Laboratory Practices	0	0	2	1	1	100
10.	Mandatory Course - 4	MC 410	Essence of Indian Knowledge Tradition	2	0	0	2	0	100
			Total:	19	3	6	28	**23**	**1000**

5th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science -5	HS501	Professional Practice, Law and Ethics	2	0	0	2	2	100
2.	Program Core-13	PC EE 502	Electrical Machines-II	3	0	0	3	3	100
3.	Program Core-14	PC EE 503	Power System-I	3	0	0	3	3	100
4.	Program Core-15	PC EE 504	Microprocessors &Micro-controller	3	0	0	3	3	100
5.	Program Core-16	PC EE 505	Industrial Measurements and Instrumentation Systems	3	0	0	3	3	100
6.	Program Core-17	PC EE 506	Control Systems	3	0	0	3	3	100
7.	Program Core-18	PC EE 507	Electrical Machines laboratory-II	0	0	4	4	2	100
8.	Program Core-19	PC EE 508	Industrial Measurements and Instrumentation Lab	0	0	2	2	1	100
9.	Program Core-20	PC EE 509	Microprocessors & Microcontroller lab	0	0	2	2	1	100
10.	Summer Internship-	SI EE 510	Industry Internship - I	0	0	0	0	1	100
			Total	17	0	8	25	**22**	**1000**

6th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Total Marks
1.	Program Core-21	PC EE 601	Power System-II	3	0	0	3	3	100
2.	Program Core-22	PC EE 602	Electric Drives	3	0	0	3	3	100
3.	Program Core-23	PC EE 603	Power System Protection & Switchgear .	3	0	0	3	3	100
4.	Program Core-24	PC EE 604	Signal and Systems	3	0	0	3	3	100
5.	Program Core-25	PC EE 605	Electrical Engineering Simulation laboratory	0	0	2	2	1	100
6.	Program Core-26	PC EE 606	Control Systems Laboratory	0	0	2	2	1	100
7.	Program Core-27	PC EE 607	Power System Laboratory	0	0	2	2	1	100
8.	Program Elective-1	PE EE 608/1	Digital Signal Processing	3	0	0	3	3	100
		PE EE 608/2	Wind and Solar Energy						
		PE EE 608/3	High Voltage Engineering						
9.	Project - 1	PR EE 609	Mini Project	0	0	6	6	3	100
			Total :	15	0	12	27	**21**	**900**

7th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Program Elective-2	PE EE 701/1	Advanced Electric Drives	3	0	0	3	3	100
		PE EE 701/2	Digital Control Systems						
		PE EE 701/3	Electromagnetic Waves						
2.	Program Elective-3	PE EE 702/1	Electrical Machine Design	2	0	0	2	2	100
		PE EE 702/2	Power Quality & Facts						
		PE EE 702/3	Bio-Medical Instrumentation						
3.	Open Elective-1	OE EE 703	Refer Annexure - I	3	0	0	3	3	100
4.	Open Elective-2	OE EE 704	Refer Annexure - II	2	0	0	2	2	100
5.	Project - 2	PR EE 705	Project Work Intermediate	0	0	12	12	6	*200*
6.	Summer Internship- 2	SI EE- 706	Internship - II	0	0	0	0	1	*100*
7.	Seminar - 1	SE EE 707	Seminar on Contemporary Engineering Topics - I	0	0	2	2	1	*100*
Total :				10	0	14	24	**18**	**800**

8th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Program Elective-4	PE EE 801/1	Power System Dynamics & Control	3	0	0	3	3	100
		PE EE 801/2	Electrical and Hybrid Vehicles						
		PE EE 801/3	Industrial Process Control						
2.	Program Elective-5	PE EE 802/1	HVDC transmission System	2	0	0	2	2	100
		PE EE 802/2	Electrical Energy Conservation and Auditing						

		PE EE 802/3	Line-Commutated and Active PWM Rectifiers						
3.	Open Elective-1	OE EE 803	Refer Annexure - III	3	0	0	3	3	100
4.	Open Elective-2	OE EE 804	Refer Annexure - IV	2	0	0	2	2	100
5.	Project - 3	PR EE 805	Project Work Final	0	0	12	12	6	200
6.	Seminar – 2	SE EE 806	Seminar on Contemporary Engineering Topics - II	0	0	2	2	1	100
7.	Online Course	SW EE 807	SWAYAM Courses[#]	0	0	0	0	1	100
			Total :	10	0	14	24	**18**	**800**

TRIPURA UNIVERSITY
(A CENTRAL UNIVERITY)

CURRICULUM STRUCTURE

OF

4 YEARS

BACHELOR OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING(EE)

3rd Semester

2021

3rd SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/ week	Credit	Full Marks
1.	Humanities Science - 2	HS 301	Effective Technical Communication	3	0	0	3	3	100
2.	Basic Science - 7	BS 302	Mathematics-III	2	1	0	3	3	100
3.	Basic Science - 8	BS 303	Biology for Engineers	2	0	0	2	2	100
4.	Engineering Science - 5	ES 304	Engineering Mechanics	2	1	0	3	3	100
5.	Program Core - 1	PC EE 305	Electrical Circuits Analysis	3	1	0	4	4	100
6.	Program Core - 2	PC EE 306	Analog Electronics	3	1	0	4	4	100
7.	Program Core - 3	PC EE 307	Electrical Estimation & Design Practices	0	0	2	2	1	100
8.	Program Core - 4	PC EE 308	Electrical Circuits Laboratory	0	0	2	2	1	100
9.	Program Core - 5	PC EE 309	Analog Electronics Laboratory	0	0	2	2	1	100
10.	Mandatory Course - 3	MC 310	Indian Constitution	2	0	0	2	0	100
			Total :	**17**	**4**	**6**	**27**	**22**	**1000**

EFFECTIVE TECHNICAL COMMUNICATION

Course Code	HS 301
Course Title	Effective Technical Communication
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	1st year B.Tech
Course Category	Humanities Science (HS)
Number of classes	36 hours

Course Outcomes:

At the end of the course, the student will be able to –

CO Number	CO Description	K-level
CO-1	Understand the nature and objective of Technical Communication relevant for the work place as Engineers	K2
CO-2	Utilize the technical writing for the purposes of Technical Communication and its exposure in various dimensions.	K3
CO-3	Develop effective verbal and non-verbal communication skills.	K3
CO-4	Analyze ethical, legal, cultural, and global issues affecting Technical Communication and Develop appropriate life skills.	K4

Module 1: Essentials of Communication (09 hrs):

What is Communication, Process of Communication, Levels of communication, The flow of Communication: Downward, Upward, Lateral or Horizontal (Peer group) Communication Barriers to communication, Non-verbal Communication, , Technology Enabled communication, Impact of Technology, Selection of appropriate communication Technology, Importance of Technical Communication, Differences between general and technical communication.

Module 2: Technical Writing Skills (09 hrs):

Technical writing process – Choosing right words, phrases and sentence patterns, clarity of purpose, planning content, effective style of writing, formatting, proofreading. Technical Reports & Proposals: Definition & importance; Thesis/Project writing: structure & importance; synopsis writing: Methods; Technical research Paper writing: Methods & style; Seminar & Conference paper writing; Writing of Reports & Proposals. Business letters: Sales & Credit letters; Claim and Adjustment Letters; Letters of Enquiry, Order Placement letters Email Writing: Reasons for popularity; guiding principles for composition; some common pitfalls; maintaining common etiquette.

Module: 3 Workplace Communication (09 hrs):

Applying for a job: Skimming advertisements; Writing job applications; Preparing CV, Resume. Group Discussions: Group Discussion types; GD as a part of selection process; Key skills to succeed in group discussions; Dos and Don'ts of group discussions; Use of body language in GDs. Job Interviews: Objectives; Types; Stages of Interview, Face to face Interviews; Telephonic Interviews. Effective Business Presentations: Importance in workplace communication; Planning, Preparing, Organizing, Rehearsing, and Delivering Oral presentations, Handling Questions; Visual aids in presentations; Power Point Presentations Ethics in Communication: Communication challenges in culturally diverse workforce; Bias-free communication

Module: 4 Developing soft skills/ Life Skills (09 hrs):

Introduction to soft skills: Soft skills as a competitive weapon in today are changing workplace. Classification of soft skills: Time management, Attitude, Responsibility, Ethics & Values, self-confidence, Teamwork and Interpersonal skills, Problem solving skills. Personality Development: Developing Right personality to enhance Life Skills, Personality types; Personality attributes; and Leadership Qualities. Body Language : Emotions displayed by body language: Aggressive, Submissive, Attentive, Nervous, Upset, Bored, Relaxed, Defensive; Hand Shake; Eye Contact; Posture and Positioning. Personality traits and soft skills in early stages of career advancement and for future career advancement.

List of Software/Learning Websites

1. http://www.free-english-study.com/
2. http://www.english-online.org.uk/course.htm
3. http://www.english-online.org.uk/
4. http://www.talkenglish.com/
5. http://www.learnenglish.de/

Recommended Books:

1) Sanjay Kumar & Pushp Lata Communications Skills , 2nd Edition, Oxford University Press
2) Meenakshi Raman & Sangeeta Sharma Technical Communication: Principles & Practice Oxford University Press
3) Barun Kumar Mitra, Personality Development and Soft Skills Oxford University Press.
4) Personality Development, Harold R. Wallace & L. Ann Masters, Cengage Learning, New Delhi.
5) Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
6) Communication Skills for Engineers and Scientists, Sangeeta Sharma et.al. PHI Learning Pvt. Ltd, 2011, New Delhi.

7) Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, McGraw Hill & Co. Ltd., 2001, New Delhi.
8) A Text Book of Scientific and Technical Writing by S.D. Sharma; Vikas Publication, Delhi.
9) Skills for Effective Business Communication by Michael Murphy, Harward University, U.S

MATHEMATICS-III

Course Code	BS 302
Course Title	Mathematics-III
Number of Credits	3 (L: 2, T: 1, P: 0)
Prerequisites	B.Tech 1st Year Mathematics
Course Category	Basic Science (BS)
Number of classes	36 hours

Course Outcome:-

After completion of the course, students will be able to:

CO No	CO Description	K-level
CO-1	Solve problems in 1st and 2nd order linear Partial Differential Equations	K3
CO-2	Show fourier series expansion of a given function and solve PDEs by variables separable method	K3
CO-3	Identify mean and variance of a given probability distribution	K3
CO-4	Solve numerically algebraic/transcendental equation and ordinary differential equations	K3

Course Content:-

Module 1: Partial Differential Equations (10 hrs)

First order partial differential equations, solutions of first order linear and quasi-linear partial differential equation (Pp + Qq=R) by Lagrange method. Homogeneous and non-homogeneous type of second order linear differential equation with constant coefficients by complimentary function and particular integral method.

Module 2: Fourier series (08 hrs)

Expansion of a function in Fourier series for a given range - Half range sine and cosine expansions. One-dimensional wave equation and one-dimensional heat flow equation - method

of separation of variables - Fourier series solution.

Module 3: Probability (08 hrs)

Classical and axiomatic definition of probability, conditional probability, Bayes' theorem, independent events, random variables, expectation and higher order moments, probability mass function and probability density function, distribution function, Sample space, Events, Random Variables; Definitions of probability, conditional Probability, examples of discrete and continuous distributions: Normal, Poisson, Binomial distributions.

Module 4: Numerical Analysis (10 hrs)

Numerical solution of algebraic and transcendental equations by Regula-Falsi method Newton-Raphson's method; Finite Differences - Newton's Forward, backward difference interpolation formulae - Lagrange interpolation; Numerical Integration with Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule; Solving first order differential equations –Taylor's series method, Euler's method, modified Euler's method, Runge-Kutta method of 4th order.

References / Suggested Learning Resources:-

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 1965.
2. Rajnish Verma & H.K. Dass, Higher Engineering Mathematics, S Chand, 2014.
3. S. J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, 1993
4. Jain, Iyengar and Jain, Numerical methods for Scientific and Engineering Computation, New Age International Publications, 2008.
5. Erwyn Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2008.

BIOLOGY FOR ENGINEERS

Course Code	BS-303
Course Title	Biology for Engineers
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	-
Course Category	Basic Science (BS)
Number of classes	26 hours

Course Outcome:

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Demonstrate the understanding of biology and its branches, major classifications of life, Cells, Cellular systems their functions and biological molecules.	K2
CO-2	Illustrate the molecular basis of genetic information and the flow of genetic information from DNA to RNA to protein and the concept of mutations, re-combinations and its applications.	K2
CO-3	Classify microorganisms, growth, nutrition with their various methods used for the isolation, identification, control and maintenance of microbial cultures.	K4
CO-4	Explain the fundamental principles of energy transactions in physical and biological and physiological systems, basic metabolisms.	K2

Course Content:

Module 1: Introduction to Biology, Classification and Biomolecules (8 hours)

Detailed content of the module: Introduction to Biology and its branches. Molecular taxonomy-three major kingdoms of life. Prokaroytic and Eukaryotic cells. Energy and Carbon utilization. Cells: Animal and Plant cell structures and functions. Cell cycle and Cell division. Transport across cell membrane. Cell signaling. Molecules of life. Monomeric units and polymeric structures. Sugars, starch and cellulose. Lipids, Amino acids and proteins. Nucleotides, DNA and RNA. Proteins- structure and function. Proteins as enzymes, transporters, receptors and structural elements. Enzyme classification. Mechanism of enzyme action. Enzyme kinetics.

Module 2: Fundamentals of genetics and flow of informations (6 hours)

Detailed content of the module: General principles of genetics, Concept of segregation and independent assortment. Molecular basis of information transfer, molecular basis of coding and decoding genetic information. DNA as genetic material. Concept of genetic code. Define gene in terms of complementation and recombination. Mutation. Recombinant DNA technology. Gene mapping. Application of recombinant DNA technology, recombinant products available in the market and at laboratory scale.

Module 3: Microbiology and applications (6 hours)

Detailed content of the module: Microorganisms and environment: Identification and classification of microorganisms. Ecological aspects of single celled organisms. Microbial integrations. Growth, nutrition and reproduction. Growth kinetics. Isolation and identification of microorganisms. Pure cultures and their characteristics. Maintenance of cultures. Sterilization. Physical and chemical methods of control of microorganisms. Management of toxic industrial wastes.

Module 4: Fundamentals of energy transaction and metabolism (6 hours)

Detailed content of the module: Thermodynamics –laws and its application in biological systems. Energy yielding and energy consuming biochemical processes. Metabolism-Glycolysis & Krebs cycle, Role of ATP and concept of energy change. Equilibrium constant.

Physiological steady-state, Living body as a thermodynamic system. Fundamental aspects of analysis of living systems; quantitative aspects of physiology and engineering applications to clinical medicine based on body fluid balance, solute transport, basic endocrinology, reproduction physiology, neurophysiology, skeletal and smooth muscle physiology.

References / Suggested Learning Resources:

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd. 12th Edition, 2020

2. Guyton and Hall, Medical Physiology, 14th Edition, Elsevier Saunders, 2020.

3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company.

4. Principles of Genetics, D. Peter Snustad and Michael J. Simmons. 7th Edition, Wiley Publisher, 2015

5. Prescott's Microbiology, Joanne Willey and Kathleen Sandman and Dorothy Wood, 2020. 11th Edition McGraw Hill

ENGINEERING MECHANICS

Course Code	ES 304
Course Title	Engineering Mechanics
Number of Credits	3 (L: 2, T: 1, P: 0)
Prerequisites	Physics
Course Category	Engineering Science (ES)
Number of classes	36 hours

Course Outcome:-

After completion of the course, students will be able to:

CO No	CO Description	K-level
CO-1	Differentiate coplanar, concurrent & non-concurrent forces and their resultants and confidently tackle equilibrium equations and its applications.	K3
CO-2	Explain centroid of simple figures, centre of gravity, moment of inertia of composite sections & mass moment of inertia of circular plates, cylinder, cone, sphere & hook.	K2
CO-3	Analyze simple truss, compound truss, frame & virtual work.	K4
CO-4	Understand and be able to apply other basic dynamics concepts - the Work-Energy principle, analyze D'Alembert's principle and	K2

	differentiate longitudinal, transverse, torsional and damped vibrations.	

Course Content:-

Module 1: Fundamentals of Engineering Mechanics: (9 Periods):
Introduction to Engineering Mechanics covering, Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy -Friction covering, Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack.

Module 2: Centre of Gravity & Moment of Inertia: (9 Periods):
Centroid and Centre of Gravity covering, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; -Area moment of inertia-Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.

Module 3: Trusses, Frames & Virtual Work: (9 Periods)

Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines; Virtual Work and Energy Method- Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.

Module 4: Dynamics & Mechanical Vibrations: (9 Periods):

Dynamics - Basic terms & General principles of dynamics, Types of motion, Instantaneous centre of rotation in plane motion, D'Alembert's principle and its application, Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation. Vibration - Basic concepts of Longitudinal, Transverse and Torsional vibrations, Free & Forced vibration, Resonance and its effects, Damped vibration.

Text Books / References:
1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, –Dynamics, 9th Ed, Tata McGraw Hill

3. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
6. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education
7. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics
8. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
9. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
10. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications
11.Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson Education.
12.Bansal R.K. (2010), A Text Book of Engineering Mechanics by Laxmi Publications.
13.Irving, H.Shames, Engineering Mechanics-Statics and Dynamics, by Prentice-Hall of India.
14.Khurmi R. S. (2010), Engineering Mechanics, S. Chand & Co.
15.NPTEL web or video courses on Engineering Mechanics.
16.Timoshenko & D.H.Young, Engineerring Mechanics,Tata McGraw-Hill publishing Co. Ltd.

ELECTRICAL CIRCUITS ANALYSIS

Course Code	PCEE-305
Course Title	Electrical Circuits Analysis
Number of Credits	4 (L : 3, T :1, P:0)
Prerequisites	Basic Electrical Engineering, Mathematics-differential equations and Laplace Transformation
Course category	Program Core-1
Number of Classes	48

Course outcomes

CO Number	Course description	K-level
	After the completion of the course students will be able to	
PCEE-305:OC.01	Apply Network theorems for the analysis of Electrical Circuits.	K3
PCEE-305:OC.02	Understand about the applications of transient and steady-state response of Electrical Circuits.	K2
PCEE-305:OC.03	Understand the applications of Standard test signals, periodic wave forms and Indefinite Admittance Matrices in Electrical circuits and their Analysis.	K2
PCEE-305:OC.04	Apply the Fourier series analysis and use of Network	K3

	parameters for the Analysis of Electrical Networks in the higher courses of Electrical Engineering.	

Module 1: Network Theorems, Resonance & Magnetically coupled Circuits (12 Hours)

Superposition theorem, Thevenin's theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Magnetically Coupled Circuits: Mutual Coupled Circuits, Dot convention, numerical analysis of magnetically coupled circuits. Resonance in series & Parallel Circuits.

Module 2 : Transient & Steady-state Analysis of Electrical Circuits (12 Hours)

Review of Laplace transformation, Standard Signals and their Laplace Transformation, Independent and dependent sources and equivalence of sources. Circuit elements and their transformed equivalents, Transient and steady-state response of R-L, R-C and RLC circuits in transient with or without stored energy – solutions in t & s domains. Concept of Transfer function, natural frequency and damping ratio and Poles & Zeroes. Sketching transient response, determination of peak values. Practical applications. Loop and node variable analysis of transformed circuits.

Module 3: Standard Signals and IAM in Electrical Circuits (12 Hours)

Standard test signals and their Laplace Transformations, Laplace transformation of standard periodic waveforms and responses in Series circuits due to standard signals & periodic wave forms. Concept of cascade connected network systems and their time responses. Relationships between time responses due to input of standard signals, Convolution integral & Dhumel's Integral and their applications in Electrical Circuits, Indefinite admittance matrix (IAM) and its applications in active & Passive circuits.

Module 4: Fourier Series, Fourier Transforms and Two Port Networks (12 Hours)

Fourier series of periodic functions and waveforms and their applications in electrical circuits. Fourier transform of periodic functions, Some properties of Fourier transform, Parseval's theorem and its applications. Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks – and their Analysis.

Text / References:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.
3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education,2013.
4. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
5. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.
6. S. Ghosh, Network Theory Analysis and Synthesis, Prentice Hall India, 2005

ANALOG ELECTRONICS

Course Code	PC EE 306
Course Title	Analog Electronics
Number of Credits	4 (L: 3; T: 1; P: 0)
Prerequisites	Physics
Course Category	Program Core-2
Number of Classes	48

Course Outcome: After Completion of this course students will able to

CO Number	CO Description	K-level
CO-1	Explain the characteristics of transistors.	K2
CO-2	Illustrate various rectifier and amplifier circuits.	K4
CO-3	Model sinusoidal and non-sinusoidal oscillators.	K3
CO-4	Demonstrate the functioning of OP-AMP and model of OP-AMP based circuits.	K3

Module 1: Diode and BJT Circuits (12 Hours):
P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits. Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, Biasing circuits, current mirror; common-emitter, common-base and common-collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits.

Module 2: MOSFET circuits (12 Hours):
MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

Module 3: Differential, multi-stage and operational amplifiers (10 Hours):
Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

Module 4: Linear and Nonlinear applications of op-amp (14 Hours):
Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift). Analog to Digital Conversion. Nonlinear applications of op-amp Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators. Precision rectifier, peak

detector. Monoshot.

References / Suggested Learning Resources:

1. A. S. Sedra and K. C. Smith, "Microelectronic Circuits", New York, Oxford University Press, 1998.
2. J. V. Wait, L. P. Huelsman and G. A. Korn, "Introduction to Operational Amplifier theory and
applications", McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, "Microelectronics", McGraw Hill Education, 1988.
4. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1989.
5. P.R. Gray, R.G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.
6. V.K. Mehta, "Principles of Electronics",S Chand, 2004
7. Robert Boylestad and Louis Nashelsky, "Electronic devices and circuit theory" Pearson Education India.

ELECTRICAL ESTIMATION & DESIGN PRACTICES

Course Code	PC EE 307
Course Title	Electrical Estimation & Design Practices
Number of Credits	1(L : 0, T :0, P:2)
Prerequisites	Basic Electrical Engineering
Course category	ProgramCore – 3
Number of Classes	24

Course Outcomes:

CO Number	Course description	K-level
	After the completion of the course students will be able to	
CO1	Understand the electrical wiring systems for residential, commercial and industrial consumers.	K2
CO2	Understand various components of residential and commercial electrical systems.	K2
CO3	Categorize various lighting systems	K4
CO4	Analyze and select various Industrial electrical system.	K4

Module 1: Electrical System Components (7 Hours).

LT system wiring components, selection of cables, wires, switches,

distribution box, metering
system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current
characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices.

Module 2: Residential and Commercial Electrical Systems (7 Hours)

Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Module 3: Illumination Systems (6 Hours)

Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency,
specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

Module 4: Industrial Electrical Systems (4Hours):
DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Text/Reference Books
1. S.L. Uppal and G.C. Garg, "Electrical Wiring, Estimating & Costing, Khanna publishers, 2008.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.
3. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.

4. Web site for IS Standards.
5. H. Joshi, Residential Commercial and Industrial Systems, McGraw Hill Education, 2008.

ELECTRICAL CIRCUITS LABORATORY

Course Code	PC EE308
Course Title	Electrical Circuits Laboratory
Number of Credits	1(L : 0, T :0, P:2)
Prerequisites	Basic Electrical Engineering, Mathematics-differential equations and Laplace Transformation.
Course Category	Program Core-4
Number of Classes	24

Course outcomes

Course Outcomes:	**CO description**	Knowledge Level
	After Completing this course, students will be able to	
PCEE-308:OC.01	Understand to apply condition of resonance in Electrical Circuits and also to determine the Circuit Parameters and Mutually Coupled Circuits analysis.	K2
PCEE-308:OC.02	Determine the Transient and Steady-state performances of Electrical Circuits	K3
PCEE-308:OC.03	Analyze characteristics and time responses of Electrical Circuits due to different continuous signals.	K4
PCEE-308:OC.04	Determine the Parameters of Two Port Networks and their applications in the higher courses of Electrical Engineering	K3

Course Content:

List of experiments

1. Experiments for the Proof of Thevenin's and Maximum Power Transfer Theorem.
2. Study of series R-L-C Resonance Circuits and determination of Resonance frequency and Bandwidth.
3. Study of Transient Responses of R-L & R C series circuits and determination of time constants of these circuits.
4. Study of Transient Characteristics of R-L-C series Circuit and observation of Characteristics of Under damped, Over damped and Critically damped 2ndOrder R-L-C

Circuit by varying circuit elements.

5. Study of Characteristics of time responses of Series Circuits due to continuous periodic Triangular wave form at different frequency.
6. Study of frequency response of1storder and 2nd Order series Circuits and determination of Transfer Function of Circuits.
7. Determination of Open Circuit Z-parameters and Short Circuit Y-Parameters of a two Port D.C. circuit and verifications of them.
8. Determination of Transmission and hybrid Parameters of a two Port D.C. Network.
9. Determination of overall Short Circuit Y Parameters of a Parallel connected two Identical two port Networks.
10. Determination of overall Transmission Parameters of Cascade combination of two identical two ports Network.

Text / References:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.
3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education,2013.
4. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
5. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.
6. S. Ghosh, Network Theory Analysis and Synthesis, Prentice Hall India, 2005

ANALOG ELECTRONICS LABORATORY

Course Code	PC EE 309
Course Title	Analog Electronics laboratory
Number of Credits	1 (L: 0; T: 0; P: 0)
Prerequisites	Physics
Course Category	Program Core-5
Number of Classes	24

Course Outcome: After Completion of this course students will able to

CO Number	CO Description	K-level
CO-1	Determine the value of Resistance by colour codes, use of different components used in Electronic Circuits and their testing methods.	K3
CO-2	Explain the Characteristics of Diodes, Transistors and their	K2

	applications.	
CO-3	Demonstrate the basics of different Transtorised Amplifiers in the fields of Electrical Engineering	K3
CO-4	Interpret the applications of Rectifiers and their characteristics.	K2
CO-5	Explain different types of Oscillators.	K2

Course Content:

List of experiments

1. Identification, Specifications, Testing of R, L, C Components (Colour Codes), Potentiometers, Switches (SPDT, DPDT and DIP), Bread Boards and Printed Circuit Boards (PCBs), Identification, Specifications, Testing of Active Devices – Diodes, Power Transistors.
2. Study and Operation of Digital Multi Meter, Function / Signal Generator, Regulated Power Supply (RPS), Cathode Ray Oscilloscopes: Amplitude, Phase and Frequency of Sinusoidal Signals using Lissajous Patterns on CRO. Component testing by CRO.
3. Experimental Verification of PN Junction Diode Characteristics in A) Forward Bias B) Reverse Bias and C) Zener Diode Characteristics.
4. Study of Characteristics of Semiconductor diode based Half wave and Full Wave Rectifiers.
5. Study of different Biasing Techniques of Transistors at different modes.
6. Study of Input and Output Characteristics of Common Emitter (CE), Common base (CB) Transistor Amplifiers.
7. Study of Characteristics of Class A, AB and Push Pull Transistorized Amplifiers.
8. Study of Drain and Transfer Characteristics of JFET in Common Source (CS) Configuration.
9. Study of Transistorized RC Phase Shift and Wien bridge Oscillators.

References / Suggested Learning Resources:

1 S. Sedra and K. C. Smith, “Microelectronic Circuits”, New York, Oxford University Press, 1998.

2 J. V. Wait, L. P. Huelsman and G. A. Korn, “Introduction to Operational Amplifier theory and applications”, McGraw Hill U. S., 1992.

3 J. Millman and A. Grabel, “Microelectronics”, McGraw Hill Education, 1988.

4 P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press, 1989.
5 P.R. Gray, R.G. Meyer and S. Lewis, “Analysis and Design of Analog Integrated Circuits”, John Wiley & Sons, 2001.
6 V.K. Mehta, “Principles of Electronics”, S Chand, 2004

TRIPURA UNIVERSITY
(A CENTRAL UNIVERITY)

CURRICULUM STRUCTURE

OF

4 YEARS

BACHELOR OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING(EE)

4th Semester

2021

4th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science - 3	HS 401	Engineering Economics and Accountancy	3	0	0	3	3	100
2.	Humanities Science - 4	HS 402	Universal Human Values-II: Understanding Harmony	2	1	0	3	3	100
3.	Program Core - 6	PC EE 403	Electromagnetic Fields Theory	3	1	0	4	4	100
4.	Program Core - 7	PC EE 404	Electrical Machines-I	3	1	0	4	4	100
5.	Program Core - 8	PC EE 405	Digital Electronics	3	0	0	3	3	100
6.	Program Core - 9	PC EE 406	Power Electronics	3	0	0	3	3	100
7.	Program Core - 10	PC EE 407	Electrical Machines laboratory-I	0	0	2	1	1	100
8.	Program Core - 11	PC EE 408	Power Electronics Laboratory	0	0	2	1	1	100
9.	Program Core - 12	PC EE 409	Basic Electrical Measurements Laboratory Practices	0	0	2	1	1	100
10.	Mandatory Course - 4	MC 410	Essence of Indian Knowledge Tradition	2	0	0	2	0	100
			Total:	19	3	6	28	**23**	**1000**

ENGINEERING ECONOMICS AND ACCOUNTANCY

Course Code	HS 401
Course Title	Engineering Economics and Accountancy
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	-
Course Category	Humanities Science (HS)
Number of classes	38 hours

Course Outcomes:

At the end of the course, the student will be able to

CO Number	CO Description	K-level
CO-1	Understand the importance of engineering economics in business.	K2
CO-2	Demonstrate the necessary knowledge and skills for running a business organisation.	K2
CO-3	Understand the financial statement and position of an organisation.	K2
CO-4	Analyze the accounting information for decision making.	K4
CO-5	Develop the knowledge & skill on business and management.	K3

Course Content:

Module 1: Engineering economics (9 hrs)

- Engineering economy and its importance;
- Demand & supply: Wants, satisfaction of wants, demand, supply, elasticity of demand, estimation of demand, supply chain economy;

- Production-Factors of production (land, labor, capital, and entrepreneurship), Laws of return.
- Money – Value of money, quantity theory; inflation and deflection.

Module 2: Business Skills for Engineers (9 hrs)

- Business Structure: Proprietorship, Partnership and Joint Stock Company;
- Basic management for businesses: Basic functions of management,
- Risk Management: Type of risk, Risk management steps
- Entrepreneur and Leadership: Leadership styles, Qualities of a good leader for a business;
- Financing and the business: Objectives and sources of funds;
- Taxation: Basics of Income tax & Goods and Services Tax (GST)

Module 3: Financial Accounting for Business (10 hrs)

- Transactions: Financial event, Features of transactions; Recording of transactions;
- Basic accounting: Ledger, Trail balance, Cash book (double column only);
- Final account: Objectives, Preparation of final accounts (Trading A/C, Profit & Loss A/C and Balance Sheet).

Module 4: Managerial Accounting for Decision-making (10 hrs)

- Cost classifications – Material cost control, labor cost control and overhead cost control (only theory);
- Cost sheet: Objective and preparation of Cost sheet (Basic problem);
- Capital budgeting: Objectives Pay-back period and NPV method for feasibility testing of investment
- Working capital management: Factors and sources of WC
- Ratio analysis: Interpretation for industrial control, Basic ratios- Current Ratio, Debt-equity ratio, proft ratio

References / Suggested Learning Resources:

- Fundamentals of Engineering Economics, 4th Edition, by Chan S. Park, Pearson Publishing;
- Engineering Economics And Financial Accounting Paperback, by Arasu, Scitech publication
- Engineering Economics and Financial Accounting for Anna University Paperback by A. Bagad, Technical Publications;
- Financial Management- An analytical framework , Nayak & Manna, Parul Library;
- Principles of Management, Ghose and Basu,ABS Publishing House;

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY

Course Code	HU-402
Course Title	Universal Human Values-II: Understanding Harmony
Number of Credits	3(L: 2, T: 1, P: 0)
Prerequisites	Induction Programme and Universal Human Values –I
Course Category	Humanities Science (HS)
Number of classes	36 hours

Course Outcome:

At the end of the course, the student will be able to

CO Number	CO Description	K-level
CO-1	Explain the term self-exploration and its application for self-evaluation and development.	K2
CO-2	Identify the holistic perception of harmony at level of self, family, society, nature and explain it by various examples.	K3
CO-3	Illustrate the role of a human being in ensuring harmony in society and nature.	K2
CO-4	Distinguish between ethical and unethical practices, and start identifying a strategy to actualize a harmonious environment wherever they work.	K4

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education (8 Hrs)

Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration.

Continuous Happiness and Prosperity- A look at basic Human Aspirations.

Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority.

Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario.

Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

Module 2: Understanding Harmony in the Human Being (10 Hrs)

Understanding human being as a co-existence of the sentient 'I' and the material

'Body'.
Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
Understanding the characteristics and activities of 'I' and harmony in 'I'.
Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.
Understanding the meaning of Trust; Difference between intention and competence
Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals

Module 3: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence (8Hrs)

Understanding the harmony in the Nature Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence.

Module 4: Implications of the above Holistic Understanding of Harmony on Professional Ethics (10Hrs)

Natural acceptance of human values. Definitiveness of Ethical Human Conduct.
Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.
Competence in professional ethics:
a. Ability to utilize the professional competence for augmenting universal human order
b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems,
c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

References / Suggested Learning Resources:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
2. Jeevan Vidya: EkParichaya, A Nagaraj,Jeevan Vidya Prakashan, Amarkantak, 1999
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Bharat Mein Angreji Raj - PanditSunderlal
6. Rediscovering India - by Dharampal
7. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi

8. India Wins Freedom - Maulana Abdul Kalam Azad
9. Vivekananda - Romain Rolland (English)
10. Gandhi - Romain Rolland (English)

Course Code	PC EE 403
Course Title	Electromagnetic Field Theory
Number of Credits	4(L: 3, T: 1, P: 0)
Prerequisites	10+2 Mathematics & Physics
Course category	Program Core - 6
Number of Classes	48

CO Number	CO Description	k-level
CO-1	Apply vector calculus to static electric-magnetic fields in different engineering situations	K3
CO-2	Apply their knowledge on higher Courses of Electrical Engineering like Electrical Machine, Power System, Instrumentation etc.	K3
CO-3	Analyse Maxwell's equation in different forms (differential and integral) and apply them to diverse engineering problems	K4
CO-4	Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering	K4

ELECTROMAGNETIC FIELD THEORY

Course Outcomes: After Completion of this course students will able to

Module 1: Review of Vector Calculus and Electrostatics (18 hrs)

Review of Vector Analysis, Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications, Orthogonal Coordinate Systems: rectangular, cylindrical and spherical coordinate systems, gradient, divergence, curl, Laplacian in different rectangular, cylindrical and spherical coordinate system, Divergence theorem, Stoke's theorem. Electric vector field and scalar potential field, Relation between electric field intensity and potential, Gauss's integral law for electric displacement field, Gauss's law in differential and integral

form, Poisson's and Laplace's equation.

Module-2 : Conductors and Dielectrics (10 hrs)
Matching boundary conditions at the interface of different dielectric media, Electric stress and mechanical force in charged conductors, Energy stored in electric field, Electric dipole fields, Electric polarization, and its relation to the permittivity of dielectric media Solution of Laplace's equation by separation of variables method, Capacitance of coaxial cables and two wire transmission lines and related electric fields, Numerical analysis of electric fields by solving Laplace's equation, Iterative methods, Finite elements. Uniqueness theorem, Method of Images for the solution of electric fields.

Module-3: Electromagnetics (10 hrs)

Magnetic field intensity, Scalar and Vector magnetic potential, Lorentz force, Motoring and generating principles, Faraday's Law of electromagnetic induction, Ampere's law in both integral and differential forms, Biot-Savart's law, Boundary conditions, Solution of field problem by image method, Self and mutual inductance, Inductance of coaxial cable and two wire transmission lines.

Module-4: Electromagnetic Wave (10 hrs)
Energy in magnetic field, Force due to magnetic field in magnetic medium. Maxwell's field equations, Displacement current density and continuity equation, Electromagnetic wave equation in loss-free and lossy media, Plane and polarized waves and their propagation as solutions of wave equation, Poynting's vector, Power flow through electromagnetic media.

Text/Reference Books

1. R. K. Shevgaonkar, **"**Electromagnetic Waves**"**, Tata McGraw Hill, 2005.

2. D. K. Cheng, "Field and Wave Electromagnetics**"**, Addison-Wesley, 1989.

3. M. N.O. Sadiku, "Elements of Electromagnetics**"**, Oxford University Press, 2007.

4. C. A. Balanis, "Advanced Engineering Electromagnetics", John Wiley & Sons, 2012.

5. C. A. Balanis, "Antenna Theory: Analysis and Design**"**, John Wiley & Sons, 2005.

ELECTRICAL MACHINES - I

Course Code	PC EE 404
Course Title	Electrical Machines - I
Number of Credits	4 (L: 3, T: 1, P:0)
Prerequisites	10+2 Physics and Basic Electrical Engineering
Course Category	PC
Number of Classes	48

Course Outcomes:-

After completion of this course the students will be able to:

CO Number	CO Description	K-level
CO1	Remember the concepts of magnetic circuits.	K-1
CO2	Understand the operation of dc machines.	K-2
CO3	Apply the differences in operation of different dc machine configurations.	K-3
CO4	Analyse single phase and three phase transformers circuits.	K-4

Course Contents:-

Module- 1: Magnetic Circuits and Electromagnetic force (14 hours)

Review of magnetic circuits – MMF, flux, reluctance, inductance; review of Ampere Law and BiotSavart Law; Visualization of magnetic fields produced by a bar magnet and a current carrying coil – through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines.B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples – galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency.

Module- 2: DC Machines (8 hours)

Basic construction of a DC machine, magnetic structure – stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation – Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation. Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

Module- 3: DC Machines (Motoring and Generation) (14 hours)

Armature circuit equation for motoring and generation, Types of field excitations – separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines.

Module- 4: Transformers (12 hours)

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency. Testing – open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses. Three-phase transformer – construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers. Autotransformers – construction, principle, applications and comparison with two winding transformer. Phase conversion – Scott connection, three-phase to six-phase conversion, Tap-changing transformers – No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

References / Suggested learning Resources :-

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
4. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
5. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

DIGITAL ELECTRONICS

Course Code	PCEE 405
Course Title	Digital Electronics
Number of Credits	03 (3L:0T:0P)
Prerequisites	Basic circuit laws, Engineering Physics.
Course Category	Program Core (PC)
Number of classes	38

Course Outcomes:

After Completing this course, students will be able to		Knowledge Level
CO -1	Understand the fundamental concepts and techniques used in digital electronics.	K2
CO -2	Understand and examine the structure of various number systems and its application in digital design.	K2
CO-3	Analyze and design various combinational and sequential circuits	K4
CO -4	Identify basic requirements for a design application in digital electronics.	K3

Course Content:

Module 1: Fundamentals of Digital Systems and logic families (10 Hours)

Number Systems: Decimal, Binary, Octal and Hexadecimal systems, conversion from one base to another. Codes: BCD, Excess- 3, Gray Code, Algebra for logic circuits: Logic variables; Logic constants; Logic functions & gates- NOT, AND, OR, NAND, NOR, Ex-OR; Boolean algebra, Half adder, Full adder, Sub tractors. Families of logic circuits: Transistor inverter, RTL, Diode logic, DTL, TTL, Brief introduction to DCTL, IIL, HTL, ECL and MOS gates.

Module 2: Combinational Digital Circuits (10 Hours)

Canonical representations-min-term, max-term; Karnaugh map simplification. Analysis and synthesis of combinational circuits, Multiplexer, Demultiplexer, Encoder, Decoders and their uses & expansion, Code-converter, Adder, Sub-tractor, 2' complement Adder cum Sub tractor, Carry look-a header, Comparator, Parity generator/checker, Priority encoder.

Module 3: Sequential circuits and systems (8 Hours):

Sequential logic elements like RS, JK, T & D type flip flops. Implementation of Flip flops, Uses of flip flops in binary Counters: Asynchronous and Synchronous counters. Cascading of counters. Shift registers: serial / parallel input and serial / parallel output. Cascading of shift registers. Counters & Special functions like latch, decoder,

Module 4: A/D and D/A Converters (10 Hours)

Binary-weighted register, R-2R ladder. DAC characteristics & specifications. DAC errors. ADC: parallel comparator method, counter method, Successive-approximation, Dual-slope, Delta-sigma. ADC codes and errors.
Types: RAM, ROM, EAROM, EEROM, EEPROM and their Constructional features, their uses. Different Memory interfacing techniques, Bus contention, Expansion of Memory Capacity of digital System-different techniques.

Text/References:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

POWER ELECTRONICS

Course Code	PCEE406
Course Title	Power Electronics
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Basic Electrical Engineering and Basic Electronics

Course Category	Program Core-9 (PC-9)
Number of classes	36 hours

Course Outcome:-

After completion of the course, students will be able to:

CO No	CO Description	K-level
PCEE406.1	Illustrate the knowledge on basic principles and characteristics of different Power semiconductor Devices.	K2
PCEE406.2	Analyze various single phase and three phase power converter circuits and understand their applications.	K4
PCEE406.3	Explain the basic principles and characteristics of power Electronic based different Chopper Circuits and interpret the operation of inverters and cycloconverters.	K2
PCEE406.4	Apply the use of Power Electronic based Converters in the higher courses of Electrical Engineering.	K3

Course Content:-

Module- 1: Power semiconductor devices (10 hours):

Concept of power electronics, scope and applications, types of Power semiconductor devices and their V-I characteristics- Diode, SCR, GTO, TRIAC, Power BJT, Power MOSFET, IGBT , Thyristor ratings and protection, Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT. Protection using snubber circuit. Steady and switching power loss in devices: its effect & minimization. Cooling and Heat-sinks.

Module- 2: Diode rectifiers and Phase Controlled rectifiers (8 hours):

Single-phase half-wave and full-wave Diode rectifiers with R, RL, RC and RLE load. Study of same with highly inductive load. Effect of Freewheeling diode. Three-phase half-wave and full-wave Diode rectifiers with highly inductive load. Single-phase half-wave and full-wave SCR rectifiers with R, RL and RLE load. Study of same with highly inductive load. Effect of Free-wheeling diode. Three-phase half-wave and full-wave SCR rectifiers with highly inductive load. Commutation effects, overlap angle and voltage loss. Effect of load and source inductances. Single phase and three-phase dual converters. Principle of generation of control pulses for SCR converters: cosine, ramp and equidistant pulse methods.

Module- 3: DC-DC Converters (8 hours):

Introduction, Basic principles of step-down and step-up operation, chopper control strategies, types of chopper circuits, chopper classification-buck, boost and buck-boost Choppers. Principles of isolated dc/dc converters and SMPS- Fly back, Push-pull, half-bridge and full-bridge converters.

Module- 4: **Inverters, AC voltage controllers and Cycloconverters (10 hours):**
Inverters- Introduction , principle of operation, performance parameters, single phase bridge inverters with R, RL and RLC loads, 3-phase bridge inverters- 120 and 180 degrees mode of operation, Voltage control of single phase inverters- single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation. Current Source Inverters. AC voltage controllers- Introduction, principle of operation of single phase voltage controllers for R & RL loads and its applications. Principle operation of the Cyclo-converter.

References/ Suggested Learning Resources:-

1. P. S. Bimbhra, "Power Electronics", 4th Edition, Khanna Publishers.
2. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
3. N. Mohan, T.M. Undeland & W.P. Robbins, "Power Electronics", John Wiley & Sons.
4. V. Subramanian, "Power Electronics", New Age International (P) Ltd.
5. P.C. Sen, "Power Electronics", Tata McGraw-Hill Publishing Co. Ltd.
6. B.W. Williams, "Power Electronics", Macmillan.
7. G.K. Dubey, S.R. Doradla, A. Joshi & R.M.K. Sinha, "Thyristorised Power Controllers", Wiley Eastern Ltd.

ELECTRICAL MACHINES LABORATORY– I

Course Code	PC EE 407
Course Title	Electrical Machines Laboratory- I
Number of Credits	1 (L: 0, T: 0, P:2)
Prerequisites	Electrical Machines - I
Course Category	PC
Number of Classes	20

Course Outcomes:-
After completion of this course the students will be able to:

CO Number	CO Description	K-level
CO1	Understand the basic concept of Transformers.	K-2
CO2	Understand the basic knowledge of DC Machines.	K-2
CO3	Apply the knowledge of transformer for Industrial Applications	K-3
CO4	Apply the knowledge of DC machines for Industrial Applications.	K-3

Course Content:-
List of Experiments:

1. O.C and S.C test on single phase transformer
2. Parallel operation of two single phase transformers
3. Study of dc machine starter and variation of speed of dc shunt motor by armature and field control method.
4. No load characteristics of dc shunt generator
5. Load characteristics of dc series motor
6. Load characteristics of dc compound generator
7. Load test on dc shunt motor
8. To study the characteristics of Auto-Transformer

References/ Suggested Learning Resources:-

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
4. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
5. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

POWER ELECTRONICS LABORATORY

Course Code	PCEE408
Course Title	Power Electronics Laboratory
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Basic Electrical Engineering and Power Electronics
Course Category	Program Core-11
Number of classes	20 hours

Course Outcome:-
After completion of the course, students will be able to:

CO No.	CO Description	K-level
PCEE408.1	Demonstrate the characteristics of the Power Semiconductor devices.	K2
PCEE408.2	Illustrate the different triggering techniques of Power Electronic devices for their applications in Electrical Engineering.	K2
PCEE408.3	Examine the characteristics of Single and three-phase half and fully controlled Converters.	K4
PCEE408.4	Apply the use of power electronic based converter	K3

	circuits in the higher courses of Electrical Engineering.	

List of Experiments ***(Minimum 6 experiments to be performed). Use of virtual laboratory to perform few experiments if available may be explored.***

1. Study of VI characteristics of SCR
2. Study of VI characteristics of TRIAC.
3. Study of VI characteristics of MOSFET.
4. Study of VI characteristics of IGBT.
5. Study of R firing circuits for SCR.
6. Study of RC firing circuits for SCR.
7. Study of UJT firing circuits for SCR.
8. Study of Characteristics of SCR based Half controlled Single Phase Converters with R and RL Load.
9. Study of Characteristics of SCR based Fully controlled Single Phase Converters with R and RL load.
10. Study of Characteristics of SCR based Half and Fully controlled Three Phase Converters.
11. Study of DC Jones Chopper.
12. Study of Thyristorised speed control of a DC motor.

References/ Suggested Learning Resources:-

1. P. S. Bimbhra, "Power Electronics", 4th Edition, Khanna Publishers.
2. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
3. N. Mohan, T.M. Undeland & W.P. Robbins, "Power Electronics", John Wiley & Sons.
4. G.K. Dubey, S.R. Doradla, A. Joshi & R.M.K. Sinha, "Thyristorised Power Controllers", Wiley Eastern Ltd.
5. P.C. Sen, "Power Electronics", Tata McGraw-Hill Publishing Co. Ltd.

BASIC ELECTRICAL MEASUREMENTS LABORATORY PRACTICES

Course Code	PC EE-409
Course Title	Basic Electrical Measurements Laboratory Practices
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Electrical Measurements
Course Category	Program Core-12
No of Classes	20

Course Outcome:

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Apply the DC and AC bridges in measurement.	K3

CO-2	Demonstrate the application of various measurement devices, their characteristics, operation and limitations.	K3
CO-3	Understand the characteristics of different sensors	K2
CO-4	Understand the application of different transducers	K2

List of Experiments ***(Minimum 6 experiments to be performed).***

1. Measurement of L using a bridge technique.
2. Measurement of C using a bridge technique.
3. Measurement of Low Resistance using Kelvin's double bridge.
4. Measurement of High resistance and Insulation resistance using Megger.
5. Measure power in 3-phase load by Two-wattmeter method .
6. Use and Limitations of DC Ammeter and DC Voltmeters
7. Determination of Characteristics of Thermistors.
8. Study of Characteristics of RTD for the Measurement of Temperature
9. Temperature Measurement using Thermocouple and study of its characteristics.
10. Strain measurement using strain gauges and cantilever assembly.
11. Determination of sensitivity of Strain gauges and cantilever assembly trainer.
12. To study the Input-Output characteristic of LVDT
13. To determine the sensitivity of LVDT.

References / Suggested Learning Resources:-

1. A course in Electrical & Electronics Measurement – A. K. Sawhney

2. Experiments on basic electrical engineering by S.K. Bhattacharya & K.M. Rastori.

3. Basic electrical engineering by Nagrath & Kothari

4. Electrical & Electronic Measurements by J.B. Gupta – S. K. Kataria Publication.

5. Electrical Measurements & Measuring Instruments by Golding & Widdis – Wheeler Publications.

6. Experiments on electrical engineering by A.K.Chakraborty.

INDIAN CONSTITUTION

Course Code	MC 410
Course Title	Indian Constitution
Number of Credits	0 (L: 2, T: 0, P: 0)
Prerequisites	Nil
Course Category	Mandatory Course (MC)
Number of classes	25 hours

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Explain about framing and nature of Indian Constitution.	K2
CO-2	Identify the fundamental rights and duties of individual and demonstrate the knowledge on Directive Principles of State Policy.	K3
CO-3	Outline the Federal Structure, Centre- State relation, Union Executive and Amendment Procedure	K2
CO-4	Demonstrate the meaning of local self govt., types of local self govt. in rural and urban areas.	K2

Course Content:

Module 1: Constitutional Framework (05 hours)
1. Meaning of Constitutional Law and Constitutionalism.
2. Historical perspective of the Constitution of India.
3. Salient features of the Constitution of India.

Module 2: Fundamental Rights, Duties and Directive Principles of State Policy (06 hours)
1. Fundamental Rights- Articles 14, 19 and 21.
2. Fundamental Duties.
3. Directive Principles of State Policy; Its Legal Status and Significance

Module 3: Nature of India's Political system (07 hours)

1. Federal structure, Distribution of Legislative and Financial Powers between the Union and States.
2. Parliamentary Form of Government- Powers and Position of President of India.
3. Emergency Provisions.
4. Amendment Procedures of the Constitution of India.

Module 4: Rural and Urban Local Self Govt. (07 hours)

1. 73rd Amendment of the Constitution and Panchayati Raj Institutions.
2. 74th Amendment of the Constitution and Urban Local Self Govt. (Municipal Corporation, Municipal Council and Nagar Panchayat).
3. TTAADC

References / Suggested Learning Resources:

1. Fadia, B.L- "Indian Govt. and Politics" Sahitya Bhawan, Agra.
2. D.D.Basu- "An introduction to the Constitution of India" Lexis Nexis publichers.
3. M.V.Pylee- "Constitutional Govt. in India" S.Chand and Company Ltd.
4. S.C.Kashyap(ed)- "Perspectives on the constitution" Shipra Publication.
5. B.K. Sharma- "Introduction to the Constitution of India" Prentice Hall India Private Ltd.
6. Bhattacharya, D.C. and Banerjee, Malay- "Indian Govt. and Politics" Vijaya Publishing House

7. J.C. Johari- “Indian Govt. and Politics” (2 vols)
8. Das Nityananda- “Grassroot Democracy and Panchayati Raj in Tripura” Progressive Publichers

TRIPURA UNIVERSITY
(A CENTRAL UNIVERITY)

CURRICULUM STRUCTURE

OF

4 YEARS

BACHELOR OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING(EE)

5th Semester

2021

5th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science -5	HS501	Professional Practice, Law and Ethics	2	0	0	2	2	100
2.	Program Core-13	PCEE 502	Electrical Machines-II	3	0	0	3	3	100
3.	Program Core-14	PCEE 503	Power System-I	3	0	0	3	3	100
4.	Program Core-15	PCEE 504	Microprocessors &Micro-controller	3	0	0	3	3	100
5.	Program Core-16	PCEE 505	Industrial Measurements and Instrumentation Systems	3	0	0	3	3	100
6.	Program Core-17	PCEE 506	Control Systems	3	0	0	3	3	100
7.	Program Core-18	PCEE 507	Electrical Machines laboratory-II	0	0	4	4	2	100
8.	Program Core-19	PCEE 508	Industrial Measurements and Instrumentation Lab	0	0	2	2	1	100
9.	Program Core-20	PCEE 509	Microprocessors & Microcontroller lab	0	0	2	2	1	100
10.	Summer Internship-	SIEE 510	Industry Internship - I	0	0	0	0	1	100
			Total	17	0	8	25	**22**	**1000**

PROFESSIONAL PRACTICE, LAW AND ETHICS

Course Code	HS 501
Course Title	Professional Practice, Law & Ethics
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	-
Course Category	Humanities Science (HS)
Number of classes	26 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K Level
CO 1	Develop ideas of the professionalism, values and ethics in a profession	K3
CO 2	Develop a good insight into contracts and contracts management in engineering, arbitration and dispute resolution mechanisms	K3
CO 3	Interpret laws governing engagement of labour in construction related works and other related areas	K2
CO 4	Demonstrate an understanding of Intellectual Property Rights and Patents	K2

Module 1: Professionalism, Values and Ethics in Profession (6 hrs)

Professionalism: Professional characteristics, professional education, professional development in Industry. Values and Ethics in Profession- Value system- goodness, means and ends; Ethics-ethical premises, expectation, conflicts and practices; Moral and ego, Ethics and morality Right, virtue ethics and justice, utility and justice, privacy, challenges to privacy,

privacy on the Internet. Professional Ethics – Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics as defined in the website of Institution of Engineers (India); Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistleblowing, protected disclosures.

Module 2: General Principles of Contracts Management and Arbitration (10 hrs)

Indian Contract Act, 1972 and amendments covering General principles of contracting; Valid & Voidable Contracts; Prime and Subcontracts Tenders, Request For Proposals, Bids & Proposals; Bid Evaluation; Cost escalation; Delays, Suspensions & Terminations; Time extensions & Force Majeure; Delay Analysis; Liquidated damages & Penalties; Insurance & Taxation.

Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system*:* Arbitration – meaning, scope and types – distinction between laws of 1940 and 1996; Arbitration agreements – essential and kinds, validity, reference and interim measures by court; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Award including Form and content, Grounds for setting aside an award, Enforcement, Appeal and Revision.

Module 3: Engagement of Labour & other construction-related Laws (5 hrs)

Role of Labour in Civil Engineering; Methods of engaging labour- on rolls, labour sub-contract, piece rate work; Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen's Compensation Act, 1923; Building & Other Construction Workers (regulation of employment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017

Module 4: Law relating to Intellectual property (5 hrs)

Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Copy Rights Act, 1957, Meaning of copyright – computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patents law in India. Process of obtaining patent – application, examination, opposition and sealing of patents. Duration of patents – law and policy considerations, Infringement and related remedies;

Text/Reference Books:

1.B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.

2. The National Building Code, BIS, 2017

3.Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edn. Professional Offset

4. Neelima Chandiramani (2000), The Law of Contract: An Outline, 2nd Edn. Avinash Publications Mumbai

5. Avtarsingh (2002), Law of Contract, Eastern Book Co. 7. Dutt (1994), Indian Contract Act, Eastern Law House

6. T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House 9. Bare text (2005), Right to Information Act

7. O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers

8. Ethics in Engineering- M.W.Martin& R.Schinzinger, McGraw-Hill

9. Engineering Ethics, National Institute for Engineering Ethics, USA.

10. Ethics & Mgmt and Ethos , Ghosh, VIKASH

11. Business Ethics; Concept and Cases, Velasqez, Pearson

ELECTRICAL MACHINES – II

Course Code	PCEE 502
Course Title	Electrical Machines – II
Number of Credits	4 (4L:0T:0P)
Prerequisites	Basic Electrical & Electronics, Electrical Machines – I.
Course Category	Program Core-13
Number of classes	48 hours

Course Outcome:-

After completion of the course, students will be able to:

CO No	CO Description	K-level
CO-1	Understand the concepts of rotating magnetic fields	K2

CO-2	Understand the operation of AC Induction machines	K2
CO-3	Understand the operation of Single-phase induction motors	K2
CO-4	Analyse performance of AC Synchronous machines	K4

Course Content:

Module 1: Fundamentals of AC machine windings and revolving magnetic fields (12 hours)
Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil -active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis,3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding-concentrated and distributed, sinusoidal distributed winding, winding distribution factor. Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

Module 2: Induction Machines(12 hours)
Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.

Module 3: Single-phase induction motors (12 hours)
Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Starting methods, Split-phase starting methods and applications, starting & running characteristics. Stepper Motor: Principle of operation, Different types, Constructional features, Different characteristics, Applications.

Module 4: Synchronous machines (12 hours)
Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators -synchronization and load division.

References / Suggested Learning Resources:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.

POWER SYSTEM I

Course Code	PCEE 503
Course Title	Power System I
Number of Credits	03 (3L:0T:0P)
Prerequisites	Basic circuit laws, Engineering Mathematics & Physics.
Course Category	Program Core (PC)
Number of classes	38

Course Outcomes:

After Completing this course, students will be able to		Knowledge Level
CO -1	Understand the concepts of power systems.	K2
CO -2	Understand the various power system components.	K2
CO-3	Understand the insulation and coordination generation of over-voltages.	K2
CO -4	Evaluate fault currents for different types of faults.	K5

Course Content:

Module 1: Basic Concepts (8 hours)

Evolution of Power Systems and Present-Day Scenario. Structure of a power system. Conventional and Renewable Energy Sources. Distributed Energy Resources. Transmission and Distribution Systems- DC 2 –wire and 3 – wire systems, AC single phase, three phase and 4-wire systems, Comparison of copper efficiency. Distribution Systems: primary and secondary distribution systems, concentrated & uniformly distributed loads on distributors fed at one and both ends, ring distribution, sub-mains and tapered mains, voltage drop and power loss calculations, voltage regulators.

Module 2: Power System Components (13 hours)

Overhead Transmission Lines and Cables: Electrical and Magnetic Fields around conductors, Parameters of lines and cables. Capacitance and Inductance calculations for simple configurations. Types of Conductors, Classification of transmission lines. Characteristics of transmission lines: Generalized ABCD constants and equivalent circuits of short, medium and long lines. Line Performance: regulation and efficiency of short, medium and long lines, Power factor improvement.

Module 3: Insulation and Over Voltages (10 hours)

Overhead Line Insulators- Types, string efficiency, voltage distribution in string of suspended insulators, grading ring, preventive maintenance. Mechanical Design of Transmission Lines- Different types of tower. Sag-tension calculations. Generation of Over-voltages: Lightning and Switching Surges. Corona-corona losses, radio & audio noise, transmission line – communication line interference.

Module 4: Fault Analysis and Tariffs (10 hours)

Method of Symmetrical Components (positive, negative and zero sequences). Per unit System Balanced and unbalanced Faults. Representation of generators, lines and transformers in sequence networks. Computation of fault Currents. Tariffs & Load Curves- Definition & different tariffs for domestic, commercial, industrial application, Different Load and Load duration curves and their significance. Location of substation and grid substation.

References/Suggested Learning Resources:

1. Grainger John, J. and Stevenson, Jr. W.D., "Power System Analysis", McGraw Hill, 1994.
2. Harder Edwin, I., "Fundamentals of Energy Production", John Wiley and Sons, 1982.
3. Deshpande, M.V., "Elements of Electric Power Station Design", A.H. Wheeler and Co. Allahabad, 1979.
4. Burke James, J., "Power Distribution Engineering; Fundamentals and Applications" Marcel Dekker 1996.
5. Chakraborthy, Soni,Gupta & Bhatnagar, "Power System Engineering", Dhanpat Rai & Co.
6. Wadhwa, C.L., "Electric Power Systems", Second Edition, Wiley Eastern Limited, 1985.
7. Nagrath, I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1995.

MICROPROCESSOR AND MICROCONTROLLER

Course Code	PCEE 504
Course Title	Microprocessors &Micro-controller
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	10+2 Mathematics & Physics, Digital Electronics
Course Category	Program Core (PC)
Number of Classes	38 hours

Course Outcome: After Completion of this course students will able to

CO Number	CO Description	K-level
CO-1	Understand the Architecture and Instruction set of 8085 Microprocessor.	K2
CO-2	Illustrate the Architecture and Instruction set of 8086 Microprocessor.	K2
CO-3	Analyse the operation of Microprocessor with Interfacing Circuits.	K4
CO-4	Understand the Architecture and Instruction sets of 8051 Microcontroller.	K2

Module 1:Introduction to 8 Bit Microprocessors (12 hours)

Introduction to 8085 Microprocessor, Architecture-Register organization, Pin description and features of 8085 Microprocessor. Interrupts of 8085. Instruction Set, Addressing Modes, T States, Instruction Cycle, Machine Cycles, stack operation & subroutine, Examples of programming in assembly language.

Module 2: Architecture and Instruction set of 8086 Microprocessor (8 Hours)

8086 Arhitecture, Functional diagram, Register Organisation, Memory segmentation, Architecture of 8086,Signal Description of 8086,Timing Diagrams, Interrupts of 8086, Instruction Set.

Module 3: Microprocessor-Interfacing Circuits (10 Hours):

Interfacing of support chips with 8085 Microprocessor & their applications: Programmable Peripheral Interface 8255 & 8155, Programmable timer/counter (8253), Programmable Keyboard and display controller 8279, DMA Controller 8257, I/O interfacing of ADC & DAC chips, Generation of different periodic signals using DAC.

Module 4: 8051 Architecture and its Instruction set (8 Hours):

Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles Addressing modes of 8051 Microcontroller. 8051 Instruction sets.

References / Suggested Learning Resources:

1. Ramesh S. Gaonkar, Microprocessor Architecture,Programming and Applications with the8085A/8080A, Wiley Eastern Limited.

2. The 8051 Microcontroller and Embedded Systems: Using Assembly and C, by Muhammad-Ali_Mazidi, Janice Gillispie Mazidi and Rolin McKinlay, Pearson Education.

3. K. J. Ayala, "8051 Microcontroller", Delmar Cengage Learning, 2004. 3. R. Kamal, "Embedded System", McGraw Hill Education, 2009.

4. D. V. Hall, "Microprocessors & Interfacing", McGraw Hill Higher Education, 1991.

NDUSTRIAL MEASUREMENTS AND INSTRUMENTATION SYSTEMS

Course Code	PCEE-505
Course Title	Industrial Measurements and Instrumentation Systems
Number of Credits	3 (L : 3, T :0, P:0)
Prerequisites	Basic Electrical Engineering, Analog Electronics.
Course category	Program Core-16
Number of Classes	38 Hours

Course outcomes

CO Number	Corse description	K-level
	After the completion of the course students will be able to	
PCEE-505:OC.01	Understand the different measurement techniques for industries using Sensors & Transducers.	K2
PCEE-505:OC.02	Understand the Measurements techniques for flow, Level and Pressure.	K2
PCEE-505:OC.03	Analyse the techniques for using the PLC for Industrial Systems.	K4
PCEE-505:OC.04	Examine the techniques for controlling different variables for Industrial Systems.	K4

Module 1: Sensors & Transducers –characteristic and their implementation (11 Hours)

Sensors & Transducers- classifications and characteristics, Linearization of sensors. Measurement of displacement using linear variable differential transducers (LVDTs), Introduction to rotary variable differential transducers (RVDTs), Stain Gauge-its characteristics & working Principles, Capacitive transducers: variable air gap, variable plate overlap, variable dielectric. Level gauge, Thickness gauge. Thermocouples-classifications, characteristics and its

compensation technique, Signal conditioning circuits for capacitive transducers: reactive bridges, transformer ratio bridges, Piezoelectric transducers: fundamental concepts, materials, charge sensitivity, voltage sensitivity.

Module 2: Measurements of Flow, Pressure and Level for Industries (10 hrs.)

Measurement of flow. Hot wire anemometers: constant-current and constant temperature varieties for measurement of static and dynamic flow rate. Dynamic compensation. Electromagnetic flow meters: dc, ac and interrupted dc excitation for magnet system. Pressure transducers: Primary sensing elements: bourdon tube, diaphragm, bellows. Electronic pressure gauges. Level Measurement techniques. Industrial Standard Current to Pressure and Pressure to Current converters-their constructions and their working principles.

Module 3: Programmable Logic Controller and its Programming Techniques (8 Hours.)

Introduction to Programmable logic Controllers (PLC): Architecture and functional components, I/O Processing Methodologies, Programming Languages. Sequence Function Chart, Relay logic and switching algebra, Ladder diagram representation of sequential systems & design, PLC input/output Diagram. Applications of PLC in Industries-case studies.

Module 4: Instrumentation & control techniques of Flow, Pressure, Level in Industries. (9 Hours.):

Concepts of Industrial instrumentation Systems for industrial production processes and their terminologies, Industrial Process dynamics of different type of Industrial production processes. Modeling of Standard first order Industrial production processes, instrumentation systems for flow rate control, level control, temperature Control and Pressure control. Time and frequency responses of standard first order Industrial production process systems with and without delay.

References / Suggested Learning Resources:

1. Anand, M.M.S., Electronic Instruments & Instrumentation techniques, PHI, 2004
2. D. Patranabish, Industrial Industrial Instrumentation
3. Krishna Kanth, Computer based Industrial Control, PHI, 2005.
4. SeborG-Edgar-Doyle, Process Dynamics and Control, John wiley, 2011
5. C. D. Johnson, Process Control Instrumentation Technology, PHI, 2004
6. Gray Dunning, Introduction of Programmable Logic Controller, Thomson Press, 2005.
7. Surekha Bhanot, Process Control Principal and Applications, PHI, 2008.
8. Chemical Process Control, Stephanopoulous, PHI, 1984

CONTROL SYSTEMS

Course Code	PCEE 506

Course Title	Control Systems
Number of Credits	3 (L : 3, T :0, P:0
Prerequisites	Analog Electronics, Electrical Circuits Analysis and Practical experience of Basic Measurements.
Course category	Program Core-17
Number of Classes	38

Course outcomes

CO Number	Corse description	K-level
	After the completion of the course students will be able to	
PCEE-506:OC.01	Understand the modeling & characteristics of time response of control systems.	K2
PCEE-506:OC.02	Understand about AC & DC Servomechanisms and frequency response analysis of closed loop systems.	K2
PCEE-506:OC.03	Analyse the Stability of control Systems and their necessity in control systems.	K4
PCEE-506:OC.04	Illustrate the State Variable Analysis of Control Systems for applications in higher courses of Electrical Engineering.	K2

Module 1: Introduction to control problem and Time Response Analysis (10 hours):

Introduction to Control Systems: Classification of control systems with examples. Block diagram representation and Signal flow graph representation of Systems. Properties of Control Systems: System dynamics, sensitivity, steady-state & transient errors, Error constants, System types. Time response of system: Time domain specifications, Step response of second order system, concept of dominant poles, Effect of addition of Poles & Zeroes in second Order Systems. Basic Control actions: Proportional, integral, derivative, and their combinations.

Module 2: Control System Components and frequency response of systems (8-Hours.)

Control System Components: DC & AC Servo motors, Amplidyne, Synchros, Position & velocity Sensors, encoders, Gears and different Mechanical Parameters, Examples of DC and AC servomechanisms, Effect of velocity feedback with or without controller. Frequency response of Second order System: Frequency Domain Specifications in open loop, closed loop systems and their significance, Concept of Bandwidth and Cut-off frequency, frequency responses of different function of Systems.

Module 3: Stability analysis of Control Systems (10 Hours)

Concept of Stability of Control Systems: Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci. Relationship between time and frequency response in Control systems, Stability analysis: Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margins.

Module 4: State variable Analysis of Control Systems(10 Hours)

Concepts of state variables. State space model. Diagonalisation of System Matrix. Solution of state equations. Representation of State space systems in cascade form, Parallel form, Controllable canonical form and Observable canonical form. Eigen values, Eigen Vectors and concept of Modal Matrix, Concepts of controllability and Observability with physical examples. Testing methods of Controllability & Observability, Control law design for full state feedback design of linear control systems, Pole-placement by state feedback.

References / Suggested Learning Resources:

1. Norman S. Nise, Control Systems Engineering, 6th edition, Wiley, 2011.
2. I.J.Nagrath and M.Gopal, Control Systems Engineering, 5th edition, New Age International, 2009.
3. D. Roy Chowdhury, Modern Control Engineering, PHI Pulication.
4. Benjamin C. Kuo and Farid Golnaraghi, Automatic Control Systems, 9th edition, Wiley; 2009.
5. M. Gopal, Control Systems Principles and Design, 3rd edition, Tata Mgraw Hill, 2008.
6. Naresh K. Sinha, Control Systems, 3rd edition, New Age International, 2004.
7. Richard C. Dorf and Robert H. Bishop, Modern linear Control Systems, 12th Edition
8. B. C. Kuo, Digital Control System.
9. Ogata, Discrete Data Control System.

ELECTRICAL MACHINES LAB-II

Course Code	PCEE 507
Course Title	Electrical Machines Lab-II
Number of Credits	1(0L:0T:2P)
Prerequisites	Theory of AC Machines
Course Category	Program Core-18
Number of classes	24 hours

Course Outcome:

After end of the lab course students will be able to

CO Number	CO Description	K-level
CO-1	Experiment with synchronous motors for obtaining different parameters	K3
CO-2	Demonstrate various tests on alternators and obtain their	K2

	performance indices using standard analytical as well as graphical methods.	
CO-3	Demonstrate various tests on induction machines.	K2
CO-4	Apply the knowledge synchronous motor and induction motor in different area.	K3

Course Content:

List of experiments

1. To Perform the Brake Test 3 Phase AC Induction Motor.
2. To Perform the No load and Blocked Rotor Test on 3-Phase AC Induction Motor.
3. To Perform the No load and Blocked Rotor Test of Single Phase Induction Motor.
4. To study the V-curve of Synchronous Motor.
5. To study the Inverse V-curve of Synchronous Motor.
6. To observe the effect of excitation and speed on induced e.m.f of a three-phase alternator and plot the O.C.C. of the alternator.
7. To observe the effect of excitation and speed on armature current of a three-phase alternator and plot the S.C.C. of the alternator.
8. To Observe the Pre Determination of Regulation of Synchronous Machine by EMF and MMF Method.
9. To Observe the Predetermination of Regulation of Alternator by ZPF Method.
10. To Observe the Synchronization of alternator with main power supply or another alternator.
11. To Observe the Determination of Transient and Sub transient Reactance of synchronous generator.
12. To Study of characteristics of SCR based speed control of squirrel cage 3-phase Induction motor at different firing angles.
13. To Study of static Kramer drive using slip-ring Induction motor at different Electric loads.
14. To Study the Open and Closed loop speed control of IGBT based 3-phase squirrel cage Induction motor keeping the constant V/f ratio.

References / Suggested Learning Resources:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.

INDUSTRIAL MEASUREMENTS AND INSTRUMENTATION LABORATORY

Course Code	PCEE-508
Course Title	Industrial Measurements and Instrumentation laboratory
Number of Credits	1(L : 0, T :0, P:2)
Prerequisites	Hand on Practices on laboratory Experiments of Basic Electrical Engineering, Analog Electronics Laboratory.
Course category	Program Core-20
Number of Classes	24 Hours

Course outcomes

CO Number	Corse description	K-level
	After the Completion of the Course students will be able to	
PCEE-508:OC.01	Describe different measurement techniques for industries using Sensors & Transducers.	K2
PCEE-508:OC.02	Apply the knowledge of different techniques for measurement of flow, Level and Pressure.	K3
PCEE-508:OC.03	Examine the techniques of PLC system for Industrial application.	K4
PCEE-508:OC.04	Understand the techniques for controlling different variables for Industrial Systems using Instrumentation Systems.	K2

List of Experiments

1. Study of Measurements of Temperature using Thermocouple and its compensation technique.
2. Study of Characteristics of LVDT and Linear Variable Capacitor (LVC) for the measurement of displacement.
3. Study of Characteristics of Strain Gauge by developing Analog Circuit.
4. Hand on practices on Programming techniques of PLC.
5. Hand on practice on Programming PLC for bidirectional rotation of a Small incremental D.C. Motor and also for sorting the Sizes of Metallic pieces on a moving Conveyor belt.
6. Experiment for the Measurements of flow rate and its control techniques.
7. Experiment for the Measurements of Level of liquid and its control techniques.
8. Experiment for the Measurement of Air Pressure and its control techniques.

References / Suggested Learning Resources:

1. Anand, M.M.S., Electronic Instruments & Instrumentation techniques, PHI, 2004

2. D. Patranabish, Industrial Industrial Instrumentation
3. Krishna Kanth, Computer based Industrial Control, PHI, 2005.
4. SeborG-Edgar-Doyle, Process Dynamics and Control, John wiley, 2011
5. C. D. Johnson, Process Control Instrumentation Technology, PHI, 2004
6. Gray Dunning, Introduction of Programmable Logic Controller, Thomson Press, 2005.
7. Surekha Bhanot, Process Control Principal and Applications, PHI, 2008.
8. Chemical Process Control, Stephanopoulous, PHI, 1984

MICROPROCESSORS AND MICROCONTROLLER LAB

Course Code	PC EE 509
Course Title	Microprocessors and Microcontroller Lab
Number of Credits	1 (L: 0; T: 0; P: 2)
Prerequisites	Microprocessors and Microcontroller
Course Category	Program Core-20
Number of Classes	24

Course Outcome: After Completion of this course students will able to

CO Number	CO Description	K-level
CO-1	Develop Simple programming in Assembly Language of 8085 Microprocessor.	K3
CO-2	Build the connection of peripheral devices with microprocessor using Programming in Assembly level Language	K3
CO-3	Apply ADC and DAC to find various parameters/waveforms	K3
CO-4	Analyze, comprehend, design microprocessor/microcontroller based systems used for control and monitoring.	K4

Course Content:

List of experiments

1. Hands on practices of Simple programming in Assembly Language of 8085 Microprocessor.
2. Study of 8255 PPI in Input/output (I/O) and Bit set Reset (BSR) Modes using Programming in Assembly level Language of 8085 Microprocessor.
3. Study of 8253 timer / Counter in different Modes using programming in Assembly level Language of 8085 Microprocessor.
4. Study of DMA Mode of data transfer techniques using Programming in Assembly

level language of 8085 Microprocessor.

5. Measurement of Voltage, Current & physical quantities with the help AD Conversion technique using Programming in Assembly level language of 8085 Microprocessor.
6. Generation of different periodic wave forms with the help of D/A Conversion technique using Programming in Assembly level language of 8085 Microprocessor.
7. Study of Speed control of Small Incremental DC servo motor / Stepper Motor using Programming in Assembly level language of 8085 Microprocessor.
8. Study of interfacing & triggering techniques of SCRs at different angles using Micro-processor based programming in Assembly language of 8085 Microprocessor//8051 Microcontroller.
9. Study of interfacing & characteristics of SCR based Half controlled /Fully controlled converter using Micro-processor based Programming in Assembly level language of 8085 Microprocessor/8051 Microcontroller

References / Suggested Learning Resources:

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and Applications with the8085A/8080A, Wiley Eastern Limited.
2. The 8051 Microcontroller and Embedded Systems: Using Assembly and C, by Muhammad-Ali_Mazidi, Janice Gillispie Mazidi and Rolin McKinlay, Pearson Education.
3. K. J. Ayala, "8051 Microcontroller", Delmar Cengage Learning, 2004. 3. R. Kamal, "Embedded System", McGraw Hill Education, 2009.
4. D. V. Hall, "Microprocessors & Interfacing", McGraw Hill Higher Education, 1991.

INDUSTRY INTERNSHIP – I

Course Code	SI EE 510
Course Title	Industry Internship – I
Number of Credits	1 (L: 0, T: 0, P: 0)
Prerequisites	Nil
Course Category	Summer Internship (SI)
Number of classes	-

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Solve real life challenges in the workplace by analysing work environment and conditions, and selecting appropriate skill sets acquired from the course of study	K3
CO-2	Develop a right work attitude, self-confidence,	K3

	interpersonal skills and ability to work as a team in a real organisational setting	
CO-3	Demonstrate the skill to communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means	K2
CO-4	Show professional ethics by displaying positive disposition during internship.	K2
CO-5	Decide career options by considering opportunities in company, sector, industry, professional, educational advancement and entrepreneurship;	K5

Course Content:-

The industry internship aims to provide the student with:

1. A practice-oriented and 'hands-on' working experience in the real world or industry, and to enhance the student's learning experience.

2. An opportunity to develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting.

3. An opportunity to further develop and enhance operational, customer service and other life-long knowledge and skills in a real world work environment.

4. Pre-employment training opportunities and an opportunity for the company or organisation to assess the performance of the student and to offer the student an employment opportunity after his/her graduation, if it deems fit.

Each student shall

1) Identify an internship program of relevance in his/her branch of engineering to undergo during summer break between 4^{th} and 5^{th} semester,
2) Get approval of the concerned HOD,
3) Undergo the industry internship program for minimum 4 weeks duration
4) Prepare their own report
5) Present in the class among fellow students and faculty members / deliver viva voce.
6) Submit the report and participation/course completion certificate.

TRIPURA UNIVERSITY
(A CENTRAL UNIVERITY)

CURRICULUM STRUCTURE

OF

4 YEARS

BACHELOR OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING (EE)

6th Semester

2021

6th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Total Marks
1.	Program Core-21	PC EE 601	Power System-II	3	0	0	3	3	100
2.	Program Core-22	PC EE 602	Electric Drives	3	0	0	3	3	100
3.	Program Core-23	PC EE 603	Power System Protection & Switchgear.	3	0	0	3	3	100
4.	Program Core-24	PC EE 604	Signal and Systems	3	0	0	3	3	100
5.	Program Core-25	PC EE 605	Electrical Engineering Simulation laboratory	0	0	2	2	1	100
6.	Program Core-26	PC EE 606	Control Systems Laboratory	0	0	2	2	1	100
7.	Program Core-27	PC EE 607	Power System Laboratory	0	0	2	2	1	100
8.	Program Elective-1	1.PE EE 608/1	Digital Signal Processing	3	0	0	3	3	100
		2. PE EE 608/2	Wind and Solar Energy						
		3. PE EE 608/3	High Voltage Engineering						
9.	Project - 1	PR EE 609	Mini Project	0	0	6	6	3	100

Total :	15	0	12	27	**21**	**900**

POWER SYSTEM – II

Course Code	PCEE 601
Course Title	Power System II
Number of Credits	03 (3L:0T:0P)
Prerequisites	Power System-I, basic circuit laws, Engineering Mathematics &Physics.
Course Category	Program Core (PC)
Number of classes	38

Course Outcomes:

After Completing this course, students will be able to		Knowledge Level
CO -1	Use numerical methods to analyse a power system in steady state	K3
CO -2	Understand stability constraints in a synchronous grid.	K2
CO-3	Understand methods to control the voltage, frequency and basics of power system economics	K2
CO -4	Understand the monitoring and control of a power system	K2

Course Content:

Module 1: Power Flow Analysis (8 hrs.)

Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of nonlinear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.

Module 2: Stability Constraints in synchronous grids (10 hrs.)

Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance. Transient stability studies by equal area criterion. Power Control: Concept of Load frequency control in multi- area system and static response of two area system.

Module 3: Short Circuit Studies, Travelling waves and Basic Pricing (10 hrs.)

Short circuit studies: Formation of bus impedance matrix, systematic three phase fault computation using bus impedance matrix. Unbalanced fault analysis using bus impedance matrix. Travelling wave concept- step Response- Bewely's lattice diagram- Standing waves and natural frequencies- reflection and refraction of travelling waves. Surge Impedance Loading. Basic Pricing Principles: Incremental fuel rate curves, incremental fuel cost curve, constraints in economic operation power system. Cost function for economic operation of a two-area power system.

Module 4: Control and Monitoring (10 hrs.)

Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Tap Changing Transformers. Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems.

References/Suggested Learning Resources:

1. A.Chakraborthy and S. Halder, "Power System Analysis, Operation and Control", PHI.
2. T.K Nagsarkar & M.S. Sukhija, "Power System Analysis" Oxford University Press, 2007.
3. Hadi Sadat; "Power System Analysis", Tata McGraw Hill.
4. Kabir Chakraborty & Abhiji Chakraborty, "Soft Computing Techniques in Voltage Security Analysis", Springer.
5. Kothari & Nagrath, "Modern Power System Analysis" Tata McGraw Hill.
6. Electrical power systems, Ashfaq Husain, CBS Publication.

ELECTRIC DRIVES

Course Code	PCEE602
Course Title	Electrical Drives
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Electrical Machine and Power Electronics
Course Category	Program Core-22(PC-22)
Number of classes	36 hours

Course Outcome:-

After completion of the course, students will be able to:

CO No.	CO Description	K-level
PCEE602.1	Explain basic terminology, Four quadrant representation and various braking in drives system.	K2
PCEE602.2	Extend knowledge about Electric traction System.	K2
PCEE602.3	Apply the concept of solid state control of DC and AC drives.	K3
PCEE602.4	Analyze the total converter system for AC and DC drives using various converters and starting of dc and ac motors.	K4

Course Content:-

Module 1: Introduction (10 hours):

Drive specifications, Basic terminology: base speed, speed ratio, constant torque drive, constant hp drive, etc. Four quadrant representation, dynamics of loading of motor with different types of mechanical load. Heating and cooling of motors, operating duty cycles. Choice of couplings and bearings. Acceleration time, energy loss in starting. Effect of flywheels. Regeneration in drives: Dynamic braking, regenerative braking, dc injection, plugging.

Module 2: Electric Traction System and DC drives (10 hours):

Electric Traction: General introduction and requirements, speed-time curve mechanics in train movement. DC and AC traction supplies. Current collectors. Traction motors. Linear motors and magnetic levitation. Solid state control of dc motors – basic principles. Armature current control with constant flux and field weakening. Simple modeling of a separately excited dc motor. Drive schemes with armature voltage feedback, IR compensation, and tacho feedback for both constant flux and field weakening.

Module 3: Induction Motor Drives (8 hours):

Solid state control of induction motors – basic principles of Induction motor based Drives, Detail description, specifications & implementation of Induction Motor based Static-Kramar Electric Drive System. V/f control with constant flux and field weakening using SCR & IGBT. Simple modelling of an induction motor. Drive schemes with terminal voltage feedback and slip-compensation, Implementation using speed feedback for both constant flux and field weakening.

Module 4: Realisation of the total converter system and starting methods (8 hours):

Realisation of the total converter system for ac and dc drives using choppers, Phase controlled rectifiers, Dual converters, Voltage Source Inverters (VSI), Current Source Inverters (CSI). Current Controlled VSI and Cycloconverters. Basic operating principles and characteristics of

the schemes. Protection schemes for overall drive systems. Power electronic controlled starting of dc and ac motors.

References/ Suggested Learning Resources:-

1. Fundamentals of Electrical Drives: G.K. Dubey.
2. Power Electronics and Motor Control : W. Shepherd, L.N. Hulley & D.T.W. Liang
3. Electric Drives : N.K. De, P.K. Sen.
4. Power Semiconductor Controlled Drives: G.K. Dubey
5. Control of Electric machines: Irving L. Kosow
6. Modern Electric Traction: H. Partab.
7. A First Course on Electrical drives: S.K. Pillai
8. Electric Motor Drives: R. Krishnan
9. Electric Drives: M. Chilikin.

POWER SYSTEM PROTECTION & SWITCHGEAR

Course Code	PC EE-603
Course Title	Power System Protection & Switchgear
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Power System
Course Category	Program Core (PC)
Number of classes	38 hours

Course Outcome: After the completion of the course Students will be able to

CO No	CO Description	K-level
CO-1	Identify the main components and features of protection scheme and explain the phenomena of circuit breaking	K3
CO-2	Explain the various types of existing circuit breakers, their design and constructional details and its use in power system protection.	K5
CO-3	Understand the various conventional relays, their design and latest developments and apply them in protective scheme.	K2
CO-4	Analyze and design the protection system for application in power system.	K4

Course Content:-

MODULE-1: Components of Protection system and Circuit Breaking (10 hrs.)

Substations Equipment's, arrangement of Circuit Breakers, Isolators, Bus bars, instrument transformers, current limiting Reactors in Power System. Types of earthing, Earthing Mat. General requirements of circuit breakers. Auto- reclosing feature. Formation of electric arc. Arc

build-up and quenching theory, recovery voltage and RRRV, Arc restriking phenomena.

MODULE-2: Circuit Breakers and Protective Relaying (9 hrs.)
Problems of capacitive and low inductive current interruptions. Rating of circuit breakers and effect of transient current on it. Different types of arc quenching media and special devices for arc quenching. Different types of circuit breakers - their relative merits and demerits. Specific field of usages. Testing of circuit breakers. D.C circuit breaking. Fundamental principles of protective relays, their properties and block diagrams. Zones of protection, Primary and Back-up protection.

MODULE-3: Different schemes of Protection (10 hrs.)
Single input relays, over current, earth fault relays. Reverse Power relay. Principle and application of directional over current and earth fault relays. Principle of 2-input comparison, two and multi-input comparators. Distance relays their settings, errors and remedies to errors. Differential relays current and voltage comparison. Time graded Feeder Protection: radial, ring mains protection.

MODULE-4: Equipment Protection and Protection against over-voltages (9 hrs.)
Transformer Protection-techniques & related Specifications. Motor & Generator protection Systems, Different types of pilot protection wire, carrier and wireless pilot. Carrier aided distance protection. Carrier phase comparison schemes. Protection against Over voltage due to lightning. Surge diverters, rod gap, horn gap, lighting arresters, surge absorber for surge protection.

References / Suggested Learning Resources:-

1. Switchgear & Protection, by J.B.Gupta.- S.K. Kataria & Sons
2. Power System Protection & Switchgear, by Badri Ram, D.N.Vishwakarma.- McGraw Hill.
3. Electrical Power System by C.L. Wadhwa,- New Age International
4. Protective Relays – Their theory And Practice Vol-I & II, by A.R.Van. C. Warrington, john Willey
5. Power System Protection, by S.P.Patra, S.K.Basu & S.Choudhuri,- Oxford & IBH
6. Power System Protection & Switchgear, by B.Ravindranath & M.Chander, Willey Eastern
7. Switchgear & Protection, by S. S. Rao, Khanna Publishers.
8. Power System Protection, Vols.I, II & III, by Electricity Council, Macdonald & Co.
9. The J & P Switchgear Book, Johnson & Philips Ltd. Newness Butterworths.
10. Power System Protection, Vols.I, II, III & IV, by The Electricity Training Association

SIGNALS AND SYSTEMS

Course Code	PC EE 604
Course Title	Signals and Systems

Number of Credits	3(L:3, T:0, P:0)
Prerequisites	10+2 Mathematics, Circuits Theory
Course category	Program Core-24
Number of Classes	38

Course Outcome: Students would be able to

CO number	CO Description	k-level
CO-1	Understand the Characteristics of different signals and functions.	K2
CO-2	Apply their knowledge on the characteristics of Fourier series and Transforms, spectral density and white noise	K3
CO-3	Design different active filters based on the concept of Frequency responses of LTI systems.	K6
CO-4	Develop the model of different Electrical, Mechanical, Electro-mechanical systems which are very much essential for analysis of any system using Fourier transform, Z-transform etc.	K6

MODULE-1: Basic Operations on Signals (10 hrs.):

Classification of signals: deterministic & random signals, continuous-time(CT) & discrete time (DT) signals, Power & Energy signals, causal & non-causal signals. Time-domain operations on CT signals. Mathematical descriptions of deterministic CT signals, Singularity functions. Impulse (Dirac Delta) function and its properties. Decomposition of simple aperiodic waveforms in terms of singularity-function components. Convolution Integral: analytical & graphical convolution, properties of convolution.

MODULE-2: Fourier Transform (10 hrs.):

Review of Trigonometric Fourier Series for CT periodic signals. Exponential Fourier Series and Line- Spectra. Gibbs phenomenon. Properties of Fourier Series. CT Fourier Transform & Integral. Generalized Fourier Transform. Parseval‟s theorem. Properties of Fourier Transform. Power Spectral Density of periodic signals. Energy Spectral Density. Concept of autocorrelation functions for deterministic signals. White Noise and its necessity.

MODULE-3: Filter Design (8 hrs.):

Frequency response of LTI systems: Definitions, significance, frequency responses of first-order & second-order systems. Standard description of Transfer function of 1st & 2nd order Active Filters and their frequency responses, Design of 2nd Order Active Filters. Design of Butterworth and Chebyshev active filters.

MODULE-4: Concept of Systems and Z-transform (10 hrs.):

General concept of Systems: Classification, Modeling of Dynamic Systems: Mechanical systems including rotary systems, gears, Electro-mechanical systems, DC motors, moving coil speakers, ballistic galvanometers, Thermal systems: first order and second order models, Electrical circuit analogues. Z-transformation, Inverse Z-transformation and theorems of Z-transformation.

References / Suggested Learning Resources:-

1. Simon Haykin and Barry Van Veen, ―Signals and Systems.
2. B.P. Lathi, ―Principles of Linear Systems and Signals. (International Version).
3. Tarun Kumar Rawat, ―Signals and Systems.
4. P. Ramesh Babu, ―Signals and Systems.
5. F.F. Kuo, ―Network Analysis and Synthesis.
6. B.C. Kuo, ―Automatic Control Systems.
7. I. J. Nagrath and M. Gopal, ―Control System Engineering.
8. D.K. Lindner, ―Introduction to Signals and Systems.
9. S. Dasgupta, ―Control System Theory.

ELECTRICAL ENGINEERING SIMULATION LAB

Course Code	PC EE 605
Course Title	Electrical Engineering Simulation Lab
Number of Credits	1 (L: 1; T: 0; P: 0)
Prerequisites	Advanced Computer Techniques in Power Systems; Control system; Network theory; Basic Electronics
Course Category	Program Core-25
Number of Classes	24

Course Outcome: Students will be able to

CO Number	CO Description	K-level
CO-1	Model different types of electrical power Transmission lines.	K3
CO-2	Develop Bus Admittance matrices for multi-bus power network.	K3
CO-3	Analyze time domain and frequency domain characteristics of different types of control systems	K4
CO-4	Design half wave and full wave uncontrolled rectifier circuit using MATLAB	K6

Course Content:

List of experiments:

1. Determination of transfer function and its pole and zeros of 1st, 2nd& 3rd order systems
2. Time response analysis of series RLC series circuit.
3. Time response analysis of a second order system by using Simulink.
4. Frequency domain stability analysis of 3rd order system.
5. Determination of ABCD parameter of short, medium and long transmission line.
6. Determination of voltage regulation and efficiency of transmission line.
7. Design a single phase half wave rectifier circuit and show voltage and current waveforms of load.
8. Design a single phase full wave rectifier circuit and show voltage and current waveforms of load.
9. Load flow analysis of power system network using ETAP.
10. Closed-loop speed control of D.C. motor: Stability analysis by root-locus method.
11. Formation of bus admittance matrix matrices for multi-bus power network.

References / Suggested Learning Resources:

1. Beginning MATLAB and Simulink: From Novice to Professional; Edition by Sulaymon Eshkabilov. Apress; 1st ed. edition (November 29, 2019)
2. MATLAB For Beginners: A Gentle Approach; by Peter I. Kattan; Create Space Independent Publishing Platform (April 11, 2008).
3. Chakraborthy, Soni,Gupta & Bhatnagar, "Power System Engineering", Dhanpat Rai & Co.
4. Wadhwa, C.L., "Electric Power Systems", Second Edition, Wiley Eastern Limited, 1985.
5. V.K. Mehta, "Principles of Electronics",S Chand, 2004.

CONTROL SYSTEMS LABORATORY

Course Code	PCEE-606
Course Title	Control Systems Laboratory
Number of Credits	1(L : 0, T :0, P:2)
Prerequisites	Electromagnetic Field Theory
Course category	Program Core-26
Number of Classes	24

Course outcomes: After the completion of the course students will be able to

CO Number	Course description	K-level
PCEE-606:OC.01	Determine the Transfer function of DC servomotor from Experimental results.	K3
PCEE-606:OC.02	Examine the characteristics of time response of Position control system from Hardware experiments and their	K4

	Steady-state analysis.	
PCEE-606:OC.03	Understand the effect of Velocity feedback in position control systems.	K2
PCEE-606:OC.04	Evaluate the effect of Pole Placement by state feedback for the better control of Electro-Mechanical Systems.	K5

List of Experiments:

The following Experiments are required to be carried out using Hardware based Control System Trainers, it is desirable that all Hardware based Control System Trainers are required to be interfaced with the computer for better understanding of Experiments for analysis. .

1. Determination of Transfer function of D.C. Servo Motor by applying Step input and verification of Transfer function from frequency response graph of D,C. Servomotor (at different Mechanical loadings)..
2. Determination of steady state error of DC Servomechanism due to Step, Ramp and Parabolic inputs.
3. Position Control of second order DC Servomechanism and determination of Parameters of the System fromthe experimental Results.
4. Study the effect of Velocity feedback on Position control of DC Servomechanism and determination of Parameters due to velocity feedback at different values.
5. Experiments for speed Control of D.C. Servo Motor with PI Controller + derivative output Compensation technique.
6. Position control of D.C. Servo Mechanism using P, P+I, P+D, P+I+D Controllers to study the characteristics of second order System and indication of Position Control using Gray-coded disk.
7. Position Control of Electro-Mechanical Plant having at least two mechanically coupled discs with feedback for the identification of controlled positions of discs using Pole placement of the Plant by State feedback of the System.
8. Study of disturbances of Torques on PD & PID Rigid body system using Electro-Mechanical Plant having at least two Mechanically Coupled discs with feedback arrangements.

References / Suggested Learning Resources:

1. Norman S. Nise, Control Systems Engineering, 6th edition, Wiley, 2011.
2. I.J.Nagrath and M.Gopal, Control Systems Engineering, 5th edition, New Age International, 2009.

3. D. Roy Chowdhury, Modern Control Engineering, PHI Pulication.
4. Benjamin C. Kuo and Farid Golnaraghi, Automatic Control Systems, 9th edition, Wiley; 2009.
5. M. Gopal, Control Systems Principles and Design, 3rd edition, Tata Mgraw Hill, 2008.
6. Naresh K. Sinha, Control Systems, 3rd edition, New Age International, 2004.
7. Richard C. Dorf and Robert H. Bishop, Moderlinearn Control Systems, 12th Edition
8. B. C. Kuo, Digital Control System.
9. Ogata, Discrete Data Control System.

POWER SYSTEM LABORATORY

Course Code	PC EE 607
Course Title	Power System Laboratory
Number of Credits	1 (L :0, T :0, P:2)
Prerequisites	Power System; Electrical machine
Course category	Program Core-27
Number of Classes	26

Course outcomes:

CO Number	Course description After the completion of the course students will be able to	K-level
CO1	Determine the constants of Transmission lines	K5
CO2	Identify different types of Distribution networks	K3
CO3	Analyse the characteristics of different types of relays.	K4
CO4	Understand different types of protection scheme of power network.	K2

List of Experiments:

1. No load test &Ferranti effect of electrical transmission lines.
2. Determination of transmission line constants (ABCD) by experimental measurement using 2-port method as well as by knowing components values and its verification.
3. Load Test & Calculation of Regulation, efficiency of Transmission Line.
4. Verification of practical results with theoretical calculations for symmetrical faults of transmission lines.
5. Verification of practical results with theoretical calculations for unsymmetrical faults of transmission lines.
6. Study the various type of dc distribution network system like
    - Distribution system fed at one end
    - Distribution system fed at both end

- Distribution system fed at centre
- Ring Main distribution system

7. Study the working principle of Bucholtz relay by Experiments.
8. Study of the working principle percentage biased single phase differential relay by Experiments.

9. Study (Practical) the three phase AC Motor protection using numerical type power systems relay consisting
    - Testing of motor protection relay with Over-Current Fault
    - Testing of motor protection relay with Motor Earth- Fault
    - Testing of motor protection relay with Motor Rotor Locked Fault
    - Testing of motor protection relay with Motor Un-Balanced Voltage Fault
    - Testing of motor protection relay with Under Current Fault
    - Testing of motor protection relay with Thermal Fault Protection
10. Study and testing of over voltage relay with different voltage & time setting multiplier.
    - Measurement of relay tripping time.
    - Plotting the IDMT characteristics of over voltage relay.

11. Study and testing of under voltage relay with different voltage setting multiplier.
    - Measurement of relay tripping time
    - Plotting the IDMT Characteristics of Under voltage relay.

DIGITAL SIGNAL PROCESSING

Course Code	PE EE 608/1
Course Title	Digital Signal Processing
Number of Credits	4(L:3, T:0, P:0)
Prerequisites	Signal and System
Course category	Program Elective-1
Number of Classes	38

Course Outcome
After Completion of the course student would be able to

CO Number	CO Description	k-level
CO-1	Understand the concept of signal processing for higher courses of Electrical Engineering and also for Industrial applications and research works.	K2
CO-2	Analyze real world signals in digital format and understand transform-domain (Fourier -transforms) representation of the signals.	K4
CO-3	Analyze the fundamental principles and techniques of digital signal	K4

	processing for understanding and designing new digital systems and for continued learning.	
CO-4	Design digital filters with different window techniques and learn the theory of different kind of modern digital signal processor.	K6

MODULE-1 Basics of Signal and Systems (10 hrs.):

Description of Signals and Systems: Types of signals and their characteristics, Analog Signal Processing versus Digital Signal Processing. Frequency domain representation of uniformly-sampled signals. Anti-alias filter. Power and energy sequences. Odd and even sequences. Causal, anti-causal and two sided sequences. Periodic sequences. Time-domain operation on sequences--- time scaling, time-reversal, time-shifting.. Discrete-time LTI systems, Discrete-time convolution, its properties and interconnection of LTI systems. Recursive and Non-recursive systems, FIR and IIR systems. Ideal interpolation formula for reconstructing analog signals from their samples. Image rejection post filtering, compensated reconstruction filter.

MODULE-2 Discrete Time Fourier Transform(10 hrs.):

Discrete-time Fourier transform: Definition of Fourier transform (FT), important properties of FT, properties of FT for real-valued sequences, use of FT in signal processing, FT of special sequences, the inverse FT, FT of the product of two discrete-time sequences, program to evaluate the FT by computer. Discrete Fourier Transform: The definition of the Discrete Fourier Transform (DFT), computation of the DFT from the discrete-time sequence, properties of the DFT, circular convolution, performing a linear convolution with the DFT, computations for evaluating the DFT, programming the DFT, increasing the computational speed of the DFT, intuitive explanation for the decimation-in-time FFT algorithm, analytic derivation of the decimation-in-time FFT algorithm, some general observations about the FFT.

MODULE-3 Digital Filter Structure (8 hrs.):

Digital filter: Definition and anatomy of a digital filter, frequency domain description of signals and systems, typical applications of digital filters, filter categories: IIR and FIR, recursive and non-recursive. Digital Filter Structures: The direct form I and II structures, Cascade combination of second-order sections, parallel combination of second-order sections, Linear-phase FIR filter structures, Frequency-sampling structure for the FIR filter. Design of digital filter by Fourier series method. Frequency response of digital filters, realization problems. Direct realization of linear phase FIR digital filters, effect of truncation of impulse response, circular complex convolution integral, Gibbs phenomenon.

MODULE-4 Design of Filter using window function (10 hrs.):

Frequency domain characteristic of common window functions. Design of brick-wall type low pass, high pass, band pass FIR digital filters. Design of linear phase FIR filters by the frequency

sampling method. Design of optimum equiripple linear phase FIR filters. FIR digital filters for off-line analysis for one-dimensional (1-D) and two-dimensional (2-D) data. 2-D finite impulse sequence of digital FIR filter. Digital signal processors: Processor architecture: Von Neumann architecture, Harvard architecture, modified Harvard architecture, multiply, accumulate operation, benchmarks.

References / Suggested Learning Resources:

1. Digital Signal Processing: Principles, Algorithms & Applications – J.G. Proakis and M. G. Manolakis.
2. Signals and Systems-- Simon Haykin and Barry Van Veen .
3. Network Analysis and Synthesis--- M.E. Van Valkenburg
4. Principles of Linear Systems and Signals (International Version)- B.P. Lathi.
5. Discrete-Time Signal Processing--- Oppeinham, Schaffer and Buck.
6. Digital Signal Processing-- P. Ramesh Babu.
7. Digital Signal Processing: A Computer Based Approach – S. K. Mitra.
8. Digital Signal Processing – J. R. Johnson.

WIND AND SOLAR ENERGY

Course Code	PEEE-608/2
Course Title	Wind and Solar Energy
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Power System
Course Category	Program Elective-1
Number of classes	36 hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	Understand the energy scenario and the consequent growth of the power generation from renewable energy sources	K2
CO-2	Understand the basic physics of wind and solar power generation	K2
CO-3	Apply the power electronic interfaces for wind and solar power generation	K3
CO-4	Analyze the issues related to the grid-integration of solar and wind energy systems	K4

Course Content:

Module 1: Solar Resource and Solar thermal power generation (8 hours):
Introduction, Solar Radiation Spectra, Solar Geometry, Earth Sun Angles, Observer Sun

Angles, Solar Day Length, Estimation of Solar Energy Availability. Solar Thermal Power Generation Technologies, Parabolic Trough, Central Receivers, Parabolic Dish, Fresnel, Solar Pond, Elementary Analysis.

Module 2: Wind Power and Wind generator topologies (10 hours):
History of Wind Power, Indian and Global Statistics, Wind Physics, Betz Limit, Tip Speed Ratio, Stall and Pitch Control, Wind Speed Statistics-Probability Distributions, Wind Speed and Power-Cumulative Distribution Functions. Review of Modern Wind Turbine Technologies, Fixed and Variable Speed Wind Turbines, Induction Generators, Doubly-Fed Induction Generators and Their Characteristics, Permanent-Magnet Synchronous Generators, Power Electronics Converters, Generator-Converter Configurations, Converter Control.

Module 3: Solar photovoltaic (8 hours):
Technologies- Amorphous, Monocrystalline, Polycrystalline; V-I Characteristics of a PV Cell, PV Module, PV Array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) Algorithms, Converter Control.

Module 4: Network Integration Issues (10 hours):
Overview of Grid Code Technical Requirements, Fault Ride-Through for Wind Farms - Real and Reactive Power Regulation, Voltage and Frequency Operating Limits, Solar PV and Wind Farm Behavior During Grid Disturbances, Power Quality Issues, Power System Interconnection Experiences in the World, Hybrid and Isolated Operations of Solar PV and Wind Systems.

References / Suggested Learning Resources:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems**",** John Wiley and Sons, 2004.
3. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
4. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems", John Wiley and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
6. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.

HIGH VOLTAGE ENGINEERING

Course Code	PEEE-608/3
Course Title	High Voltage Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Power System

Course Category	Program Elective-1
Number of classes	36 hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	Understand the different phenomena of over voltages, switching surges and practices of grounding	K2
CO-2	Understand the different phenomenon of high voltage power transmission and distribution	K2
CO-3	Understand breakdown of gases, liquid and solids	K2
CO-4	Apply different methods of generation of high voltages	K3
CO-5	Analyze the different high voltage measurement techniques	K4

Course Content:

Module 1: High Voltage Power Transmission and Distribution (8 hours):

High voltage power transmission and distribution, Insulators: Type of insulators and their applications, voltage distribution and string efficiency of disc insulators. Corona: Theory of corona formation, corona loss and radio interference. Overvoltage phenomena: Lightning and switching surges, Travelling waves: Reflection and refraction w.r.t. different type of line terminations, Overvoltage protection: Grounding practice and overvoltage due to earth fault, lightning arresters and surge suppressors.

Module 2: High Voltage Cables and Breakdown Mechanism (10 hours):
Insulation coordination scheme of open-air substation, High voltage cables: Single core, belted, XLPE and gas-filled. Inter-sheath grading, Requirement of extra high voltage cables, Bushings: Non-condenser and condenser bushings, field distribution. Breakdown in gases, Townsend mechanism, Paschen's law, Streamer breakdown, Breakdown under Surge Voltages, Different types of breakdown in solid dielectrics, Different types of breakdown in liquids, Partial discharge.

Module 3: Statistical Methods Generation of High Voltages (8 hours):
Statistical Methods Generation of High AC Voltage, Testing transformer and its cascade connection, single-phase series resonance circuit, Generation of High DC Voltage, Single-stage and multi-stage symmetric as well as asymmetric voltage multiplier circuits, Generation of Impulse Voltage Single-stage and multi-stage impulse generators circuits.

Module 4: Measurement of High Voltages (10 hours)
Triggering and synchronization with CRO for Measurement of Peak value of high AC Voltage, Frequency dependent method: Chubb & Fortescue Method, Frequency independent methods:

Davis-Bowdler Method, Rabus Method, Sphere-Gap Method Measurement of RMS value of high AC Voltage Capacitive Voltage, Transformer, Potential Dividers, Electrostatic Voltmeter Measurement of High DC Voltage Ammeter in series with high resistance Measurement of Dielectric Loss-factor High Voltage Schering Bridge, High Voltage type tests of insulators, Impulse test of transformers as per relevant Indian standards.

References / Suggested Learning Resources:

1. High Voltage Engineering: Kuffel and Zaengl
2. High Voltage Measurement Techniques: A.J.Schwab
3. High Voltage Engineering: D.V. Razevig
4. High Voltage Engineering: Naidu & Kamaraju

MINI PROJECT

Course Code	PR EE 609
Course Title	Mini Project
Number of Credits	3 (L: 0, T: 0, P: 6)
Prerequisites	Nil
Course Category	Project (PR)
Number of classes	70 hours

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Demonstrate a through and systematic understanding of project contents	K2
CO-2	Identify the methodologies and professional way of documentation and communication	K3
CO-3	Illustrate the key stages in development of the project	K2
CO-4	Develop the skill of working in a Team	K3
CO-5	Apply the idea of mini project for developing systematic work plan in major project	K3

Course Content:-

The mini project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Perform detailed study about various components of a project.
2) Study about methodologies and professional way of documentation and communication related to project work.
3) Develop idea about problem formulation.

4) Knowledge of how to organize, scope, plan, do and act within a project thesis.
5) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
6) Demonstrate the implementation of a mini project work.

TRIPURA UNIVERSITY
(A CENTRAL UNIVERITY)

CURRICULUM STRUCTURE

OF

4 YEARS

BACHELOR OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING(EE)

7th Semester

2021

7th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Program Elective-2	PEEE 701/1	Advanced Electric Drives	3	0	0	3	3	100
		PEEE 701/2	Digital Control Systems						
		PEEE 701/3	Electromagnetic Waves						
2.	Program Elective-3	PEEE 702/1	Electrical Machine Design	2	0	0	2	2	100
		PEEE 702/2	Power Quality & Facts						
		PEEE 702/3	Bio-Medical Instrumentation						
3.	Open Elective-1	OEEE 703		3	0	0	3	3	100
4.	Open Elective-2	OEEE 704		2	0	0	2	2	100
5.	Project - 2	PREE 705	Project Work Intermediate	0	0	12	12	6	*200*
6.	Summer Internship- 2	SIEE- 706	Internship - II	0	0	0	0	1	*100*
7.	Seminar - 1	SEEE 707	Seminar on Contemporary Engineering Topics - I	0	0	2	2	1	*100*
Total :				10	0	14	24	**18**	**800**

ADVANCED ELECTRIC DRIVES

Course Code	PEEE701/1
Course Title	Advanced Electric Drives
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Electrical Machine, Power Electronics and Electric Drives
Course Category	Program Elective-2(PE-2)
Number of classes	36 hours

Course Outcome:-

After completion of the course, students will be able to:

CO No	CO Description	K-level
PEEE701/1.1	Explain the operation of power electronic converters and their control strategies.	K2
PEEE701/1.2	Interpret the vector control strategies for ac motor drives	K2
PEEE701/1.3	Apply the control schemes for PMSM, BLDC and Switched Reluctance Motor drives.	K3
PEEE701/1.4	Interpret the control strategies using digital signal processors.	K2

Course Content:-

Module- 1: Power Converters for AC drives (10 hours):
PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H bridge as a 4-Q drive.

Module- 2: Induction and Synchronous motor drives (8 hours):
Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC).

Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

Module- 3: PMSM, BLDC and Switched reluctance motor drives (10 hours) :
Introduction to various PM motors, BLDC and drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM. Switched reluctance motor drives: Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM.

Module- 4: **DSP based motion control (8 hours):**
Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.

References/ Suggested Learning Resources:-

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. P. C. Krause, O. Wasynczuk and S. D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 2013.
3. H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2003.
4. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.
5. Mohan, N., Advanced Electric Drives: Analysis, Control, and Modeling Using Simulink, MNPERE (2001).
6. Leonard, W., Control of Electric Drives, Springer-Verlag, New York, (1985)

DIGITAL CONTROL SYSTEMS

Course Code	PEEE-701/2
Course Title	Digital Control Systems
Number of Credits	3 (L: 3, T :0, P:0
Prerequisites	Control of Linear time in-variant Systems.
Course category	Program Elective-2
Number of Classes	38

Course outcomes

CO Number	Corse description	K-level
	After the Completion of the course students will be able to	

PEEE-701/2:OC.01	Explain the discrete-time representation of Linear time in-variant systems and their responses.	K2
PEEE-701/2:OC.02	Determine the stability analysis of Discrete time Systems.	K5
PEEE-701/2:OC.03	Analyze the State-space modeling of Digital Control Systems.	K4
PEEE-701/2:OC.04	Design the Controllers for Digital Control Systems.	K6

Module 1: Discrete Representation of Continuous Systems (12 hours):
Introduction to Digital Control system-components of digital Control System, Z-transformation and inverse Z-transformation, Pulse transfer function. Concept of difference equation-its solutions, Transfer function from difference equation. Sampler in digital Control system, Choice of sampling rate. Frequency response of discrete functions. Sampling Spectra and Aliasing. Sampling theorem, Zero order Hold, Transient response of discrete time systems.

Module 2: Stability Analysis of Digital Control Systems (10 hours):
z-plane pole-locations. Damping ratio and natural frequency, Steady State errors of Discrete-data System. Stability Analysis: Bilinear Transformation, Stability analysis using Routh-Hurwitz criterion, Jury's stability criterion, Stability analysis using Root-locus technique.

Module 3: State Space Approach for discrete time systems (8 hours):

State space models of discrete-time systems, State space analysis. Controllability and Observability and output Controllability of discrete data systems and proof of related theorems, Effect of pole zero cancellation on the controllability & observability of Discrete-data Systems.

Module : Design of Controllers for Digital Control System(10 hours):
Design of Discrete PI, PD and PID Controllers, Design of PID Controllers using different Algorithms, Design of discrete state-feedback controller. Design of set point tracker. Design of Discrete Observer for LTI Systems. Design of discrete output feedback controller. Periodic output feedback controller design for discrete-time systems.

References/ Suggested Learning Resources:-

1. I. J, Nagrath, M. Gopal, "Control System Engineering". New Age Publication
2. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
4. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems",Addison-Wesley, 1998.
5. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.
6. D. Roy Chowdhury "Control System Engineering", PHI

ELECTROMAGNETIC WAVE

Course Code	PE EE 701/3
Course Title	Electromagnetic Wave
Number of Credits	3 (L:3, T:0, P:0)
Prerequisites	Electromagnetic Field Theory
Course category	Program Elective-2
Number of Classes	38

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

CO Number	CO Description	k-level
CO-1	Analyse transmission lines and estimate voltage and current at any point on transmission line for different load conditions.	K4
CO-2	Analyse the field equations for the wave propagation in special cases such as conducting medium, lossy and low loss dielectric media etc.	K4
CO-3	Handle the Plane waves at medium interface.	K6
CO-4	Abstract TE and TM mode patterns of field distributions in a rectangular wave-guide and characterize radiation by antennas.	K6

Module 1: Transmission Lines (8 hours):

Introduction, Concept of distributed elements, Equations of voltage and current, Standing waves and impedance transformation, Lossless and low-loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

Module 2: Maxwell's Equations Uniform Plane Wave (10 hours):

Basic quantities of Electromagnetics, Basic laws of Electromagnetics: Gauss's law, Ampere's Circuital law, Faraday's law of Electromagnetic induction. Maxwell's equations, Surface charge and surface current, Boundary conditions at media interface. Homogeneous unbound medium, Wave equation for time harmonic fields, Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Pointing vector.

Module 3: Plane Waves at Media Interface (7 hours):

Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction of waves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.

Module 4 : Waveguides and Antenna(7 hours):

Parallel plane waveguide: Transverse Electric (TE) mode, transverse Magnetic (TM) mode, Cut-off frequency, Phase velocity and dispersion. Transverse Electromagnetic (TEM) mode, Analysis of waveguide-general approach, rectangular waveguides. Radiation parameters of antenna, Potential functions, Solution for potential functions, Radiations from Hertz dipole, Near field, Far field, Total power radiated by a dipole, Radiation resistance and radiation pattern of Hertz dipole, Hertz dipole in receiving mode.

References/ Suggested Learning Resources:-

1. R. K. Shevgaonkar, **"**Electromagnetic Waves**"**, Tata McGraw Hill, 2005.
2. D. K. Cheng, "Field and Wave Electromagnetics**"**, Addison-Wesley, 1989.
3. M. N.O. Sadiku, "Elements of Electromagnetics**"**, Oxford University Press, 2007.
4. C. A. Balanis, "Advanced Engineering Electromagnetics", John Wiley & Sons, 2012.
5. C. A. Balanis, "Antenna Theory: Analysis and Design**"**, John Wiley & Sons, 2005.

ELECTRICAL MACHINE DESIGN

Course Code	PE EE 702/1
Course Title	Electrical Machine design
Number of Credits	2 (L: 2; T: 0; P: 0)
Prerequisites	Magnetic circuits and Electrical machine
Course Category	Program Elective-3
Number of Classes	26

Course Outcome: After Completion of this course students will able to

CO Number	CO Description	K-level
CO-1	Summarize the construction and performance characteristics of electrical machines.	K2
CO-2	Determine the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines	K3
CO-3	Explain the principles of electrical machine design and carry out a basic design of an AC machine.	K2
CO-4	Formulate design calculations using software tools	K6

Module 1: Introduction and Design of Transformer (8 hours):

Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines. Sizing of a transformer, 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 cooling tank, methods for cooling of transformers.

Module 2: Design of Induction Motors (6 Hours):

Sizing of an induction motor, main dimension, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, and short circuit current.

Module 3: Design of Synchronous Machines (6 hours):

Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of airgap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

Module 4: Computer aided Design (CAD (6 hours):

Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design.

References / Suggested Learning Resources:

1. K. Sawhney, “A Course in Electrical Machine Design”, Dhanpat Rai and Sons, 1970.
2. . M.G. Say, “Theory & Performance & Design of A.C. Machines”, ELBS London.
3. S. K. Sen, “Principles of Electrical Machine Design with computer programmes”, Oxford and IBH Publishing, 2006.
4. K. L. Narang, “A Text Book of Electrical Engineering Drawings”, SatyaPrakashan, 1969.
5. A. Shanmugasundaram, G. Gangadharan and R. Palani, “Electrical Machine Design Data Book”, New Age International, 1979.
6. K. M. V. Murthy, “Computer Aided Design of Electrical Machines”, B.S. Publications, 2008.

7. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

POWER QUALITY AND FACTS

Course Code	PEEE 702/2
Course Title	Power Quality and FACTS
Number of Credits	2(2L:0T:0P)
Prerequisites	Power Electronics, Power Systems and Control Systems.
Course Category	Program Elective-3
Number of classes	26 hours

Course Outcome:-

After completion of the course, students will be able to:

CO No	CO Description	K-level
CO-1	Understand the characteristics of ac transmission and the effect of shunt and series reactive compensation	K2
CO-2	Explain the working principles of FACTS devices and their operating characteristics	K2
CO-3	Understand the basic concepts of power quality	K2
CO-4	Apply the knowledge of FACTS devices to improve power quality	K3

Course Content:-

Module 1:Transmission Lines, Series/Shunt Reactive Power Compensation and Thyristor-based FACTS (8 hours):

Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation, Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation.

Module 2: Voltage Source Converter based (FACTS) controllers and Application of FACTS (6 hours)

Voltage Source Converters (VSC), STATCOM: Principle of Operation, Reactive Power Control, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller

(UPFC): Principle of Operation and Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator. Application of FACTS devices for power-flow control and stability improvement.

Module 3: Power Quality Problems in Distribution Systems (6 hours)
Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve, Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters.

Module 4: DSTATCOM, Dynamic Voltage Restorer and Unified Power Quality Conditioner (6 hours):
Synchronous Reference Frame Extraction of Reference Currents. Current Control Techniques in for DSTATCOM, Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies.

References / Suggested Learning Resources:

1. N. G. Hingorani and L. Gyugyi, "Understanding FACTS: Concepts and Technology of FACTS Systems",Wiley-IEEE Press, 1999.
2. K. R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd. 2007.
3. T. J. E. Miller, "Reactive Power Control in Electric Systems", John Wiley and Sons, New York, 1983.
4. R. C. Dugan, "Electrical Power Systems Quality", McGraw Hill Education, 2012.
5. G. T. Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991

BIOMEDICAL INSTRUMENTATION

Course Code	PEEE 702/3
Course Title	Biomedical Instrumentation
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Electrical measurement and instrumentation, physics, basic electrical engineering
Course Category	Program Elective-3
Number of classes	26 hours

Course Outcome: After the successful completion of the course Students will be

PEEE 702/3:OC.01	Demonstrate the philosophy of the heart, lung, blood circulation and respiration system and also explain the basic components of a biomedical Instrumentation system.	K2
PEEE 702/3:OC.01	Recall the knowledge on various sensing and measurement devices of electrical origin and safety aspects.	K1
PEEE 702/3:OC.01	Use of modern methods of imaging techniques and their analysis	K3
PEEE 702/3:OC.04	Explain the medical assistance/techniques and therapeutic equipments.	K2

MODULE –1: Fundamentals of Biomedical Engineering (6 hrs.)

Cell and its structure – Resting and Action Potential – Nervous system and its fundamentals Basic components of a biomedical system- Cardiovascular systems- Respiratory systems – Kidney and blood flow - Physiological signals and transducers - Transducers – selection criteria – Piezo electric, ultrasonic transducers–Temperature measurements.

MODULE –II: Electrical Parameters Acquisition and Analysis (7 hrs.)

Electrodes – Limb electrodes –floating electrodes – Micro, needle and surface electrodes – ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms - Electrical safety in medical environment, shock hazards – leakage current-Instruments for checking safety parameters of biomedical equipment

MODULE 3: Different Types of Analytical and Diagnostic Instruments (7 hrs.):

Measurement of blood pressure. Measurement of heart rate and heart sound. Blood flow and cardia coutput measurement. Pulmonary function measurements. Spirometer. Plethysmography: Photo Plethysmography and Body Plethysmography.

MODULE 4: Imaging Modalities and Analysis (6 hrs.)

Introduction to Medical Imaging: Computed tomography, MRI, ultrasonography. Doppler ultrasonography and contrast ultrasonography. Pacemakers – Defibrillators – Ventilators – Heart –Lung machine

References / Suggested Learning Resources:

1. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Prentice Hall of India, New Delhi, 2007.

2. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw-Hill, New Delhi,2nd edition, 2003
3. Joseph J Carr and John M.Brown, Introduction to Biomedical Equipment Technology, John
4. W.F. Ganong, Review of Medical Physiology, 8th Asian Ed, Medical Publishers, 1977.
5. R. Ananda Natarajan, Biomedical Instrumentation and Measurements, PHI.

PROJECT WORK INTERMEDIATE

Course Code	PR EE 705
Course Title	Project Work Intermediate
Number of Credits	6 (L: 0, T: 0, P: 12)
Prerequisites	Nil
Course Category	Project (PR)
Number of classes	130 hours

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Demonstrate a sound technical knowledge of their selected project topic	K2
CO-2	Develop the skill of working in a Team	K3
CO-3	Design engineering solutions to complex problems utilizing a systematic approach	K6
CO-4	Design the solution of an engineering project involving latest tools and techniques	K6
CO-5	Develop the skill of effective communication with engineers and the community at large in written an oral forms	K3
CO-6	Demonstrate the knowledge, skills and attitudes of a professional engineer	K2

Course Content:-

The project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Develop sound knowledge about the domain of the project work.
2) Perform detailed study about various components of a project.
3) Learn to be an important member of a team for successful execution of a project work.
4) Study about methodologies and professional way of documentation and communication related to project work.
5) Develop idea about problem formulation, finding the solution of a complex engineering problem.
6) Develop project report as per the suggested format to communicate the findings of the project work.
7) Acquire the skill of effective oral communication to the fellow engineers and people in the society at large.
8) Develop knowledge of how to organize, scope, plan, do and act within a project thesis.
9) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
10) Demonstrate the implementation of a project work.

INDUSTRY INTERNSHIP – II

Course Code	SI EE 706
Course Title	Industry Internship – II
Number of Credits	1 (L: 0, T: 0, P: 0)
Prerequisites	Nil
Course Category	Summer Internship (SI)
Number of classes	-

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Solve real life challenges in the workplace by analysing work environment and conditions, and selecting appropriate skill sets acquired from the course of study	K3
CO-2	Develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organizational setting	K3
CO-3	Demonstrate the skill to communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means	K2
CO-4	Show professional ethics by displaying positive disposition during internship	K2
CO-5	Decide career options by considering opportunities in company, sector, industry, professional and educational advancement	K5

Course Content:-

The industry internship aims to provide the student with:

1. A practice-oriented and 'hands-on' working experience in the real world or industry, and to enhance the student's learning experience.

2. An opportunity to develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting.

3. An opportunity to further develop and enhance operational, customer service and other life-long knowledge and skills in a real world work environment.

4. Pre-employment training opportunities and an opportunity for the company or organisation to assess the performance of the student and to offer the student an employment opportunity after his/her graduation, if it deems fit.

Each student shall

1) Identify an internship program of relevance in his/her branch of engineering to undergo during summer break between 6^{th} and 7^{th} semester,
2) Get approval of the concerned HOD,
3) Undergo the industry internship program for minimum 4 weeks duration
4) Prepare their own report
5) Present in the class among fellow students and faculty members / deliver viva voce.
6) Submit the report and participation/course completion certificate.

SEMINAR ON CONTEMPORARY ENGINEERING TOPICS – I (SE EE 707)

Course Code	EE 707
Course Title	Seminar on Contemporary Engineering Topics – I
Number of Credits	L: 0, T: 0, P: 2)
Prerequisites	1
Course Category	Seminar (SE)
Number of classes	24 hours

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Identify contemporary topics in respective branch of engineering	K3
CO-2	Survey literature to understand insight of the selected topic	K4

CO-3	Develop report writing and presentation making skill	K3
CO-4	Utilize suitable aid to present the topic among audience.	K3

Course Content:-

Each student shall

1) Identify a topic of current relevance in his/her branch of engineering,
2) Get approval of the faculty concerned/HOD,
3) Collect sufficient literature on the selected topic, study it thoroughly (literature survey),
4) Prepare their own report and presentation slides and
5) Present in the class among fellow students and faculty members

TRIPURA UNIVERSITY
(A CENTRAL UNIVERITY)

CURRICULUM STRUCTURE

OF

4 YEARS

BACHELOR OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL

ENGINEERING(EE)

8th Semester

2021

8th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Program Elective-4	PEEE801/1	Power System Dynamics & Control	3	0	0	3	3	100
		PEEE801/2	Electrical and Hybrid Vehicles						
		PEEE801/3	Industrial Process Control						
2.	Program Elective-5	PEEE 802/1	HVDC transmission System	2	0	0	2	2	100
		PEEE 802/2	Electrical Energy Conservation and Auditing						
		PEEE 802/3	Line-Commutated and Active PWM Rectifiers						
3.	Open Elective-1	OEEE 803		3	0	0	3	3	100
4.	Open Elective-2	OEEE 804		2	0	0	2	2	100
5.	Project - 3	PREE 805	Project Work Final	0	0	12	12	6	200
6.	Seminar - 2	SE EE 806	Seminar on Contemporary Engineering Topics - II	0	0	2	2	1	100
7.	Online Course	SW EE 807	SWAYAM Courses#	0	0	0	0	1	100
			Total :	10	0	14	24	**18**	**800**

POWER SYSTEM DYNAMICS AND CONTROL

Course Code	PEEE-801/1
Course Title	Power System Dynamics & Control
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Power System, Electrical Machine
Course Category	Program Elective-4
Number of classes	36 hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	Understand the problem of power system stability and its impact on the system.	K2
CO-2	Apply different methods to improve stability	K3
CO-3	Apply different power system components for the study of stability	K3
CO-4	Understand the HVDC and FACTS controllers	K2
CO-5	Analyze linear dynamical systems and apply numerical integration methods	K4

Course Content:

Module 1: Introduction to Power System Operations (8 hours):

Introduction to Power System Operations: Introduction to power system stability. Power system operations and control, Stability problems in power system, Impact on Power System Operations and control, Analysis of Linear Dynamical System and Numerical Methods: Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability, Modal Analysis of Linear System, Analysis using Numerical Integration Techniques, Issues in

Modeling; Slow and Fast Transients, Stiff System.

Module 2: Modeling of Synchronous Machines and Associated Controllers (10 hours)
Modeling of Synchronous Machines and Associated Controllers: Modeling of synchronous machine: Physical Characteristics, Rotor position dependent model, D-Q Transformation, Model with Standard Parameters, Steady-State Analysis of Synchronous Machine, Short Circuit Transient Analysis of a Synchronous Machine, Synchronization of Synchronous Machine to an Infinite Bus, Modeling of Excitation and Prime Mover Systems, Physical Characteristics and Models, Excitation System Control, Automatic Voltage Regulator, Prime Mover Control Systems, Speed Governors.

Module 3: Modeling of other Power System Components (8 hours):

Modeling of other Power System Components, Modeling of Transmission Lines and Loads, Transmission Line Physical Characteristics, Transmission Line Modeling, Load Models - induction machine model, Frequency and Voltage Dependence of Loads, Other Subsystems - HVDC and FACTS controllers.

Module 4: Stability Analysis (10 hours):

Stability Analysis: Angular stability analysis in Single Machine Infinite Bus System, Angular Stability in multimachine systems - Intra-plant, Local and Inter-area modes, Frequency Stability: Centre of Inertia Motion, Load Sharing: Governor droop, Single Machine Load Bus System: Voltage Stability, Introduction to Torsional Oscillations and the SSR phenomenon, Stability Analysis Tools: Transient Stability Programs, Small Signal Analysis Programs, Enhancing System Stability: Planning Measures, Stabilizing Controllers (Power System Stabilizers), Operational Measures-Preventive Control, Emergency Control.

References / Suggested Learning Resources:
1. K.R. Padiyar, “Power System Dynamics, Stability and Control, B. S. Publications, 2002.
2. P. Kundur, “Power System Stability and Control, McGraw Hill, 1995.
3. P. Sauer and M. A. Pai, “Power System Dynamics and Stability, Prentice Hall, 1997.

ELECTRICAL AND HYBRID VEHICLES

Course Code	PEEE 801/2
Course Title	Electrical and Hybrid Vehicles
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Electrical Machine-I & II, Power Electronics and Control System-I
Course Category	Program Elective-4(PE-4)
Number of classes	36 hours

Course Outcome:-

After completion of the course, students will be able to:

CO No	CO Description	K-level
PEEE801/2.1	Illustrate the models to describe hybrid vehicles and compare their performance.	K2
PEEE801/2.2	Develop the different train topologies and power flow control in electric vehicles.	K3
PEEE801/2.3	Explain the use of different types of energy storage devices used for hybrid electric vehicles.	K2
PEEE801/2.4	Interpret the different energy management strategies used in hybrid and electric vehicles.	K2

Course Content:-

Module- 1: Introduction (10 hours)

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Module- 2: Electric Trains (10 hours):

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.
Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives,
Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Module- 3: Energy Storage (8 hours):

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

Module- 4: Energy Management Strategies (8 hours):

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

References/ Suggested Learning Resources:-

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel
Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.
5. Iqbal Husain, ELECTRIC and HYBRID VEHICLES, Design Fundamentals, CRC Press,
2003.
6. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2015.

INDUSTRIAL PROCESS CONTROL

Course Code	PEEE 801/3
Course Title	Industrial Process Control
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Control System, Measurement & Instrumentation
Course Category	Program Elective-4(PE-4)
Number of classes	36 hours

Course Outcomes: After Completing this course, students will be able to

CO No	CO Description	K-level
PEEE-801/3:OC.01	Understand about the different Process Control Systems and their working principles.	K2
PEEE-801/3:OC.02	Design of Process Controllers using different methods and implementations.	K6
PEEE-801/3:OC.03	Understand about Feed-forward Control, Ratio Control, Multi-loop Control of Process and their implementations.	K2
PEEE-801/3:OC.04	Explain about Final Control elements of Process Control and Supervisory control of large Industrial Plants.	K2

Module 1: Concepts of different Type of Processes (10 Hours)

Concept of Processes, Components of Process Control, Process dynamics of different type of Industrial processes, Process Control terminologies. Modeling of Standard first order and second order type processes with examples - flow control, level control, Temperature Control, Pressure control and Humidity Control, Capacitance type process, Resistance type process, Single time constant type process, Multiple time constant type process, Interactive and non-interactive type processes. Auto/Manual modes of operation. Bump-less transfer of Processes.

Module 2: Design and Implementation of Controllers for Process Control Systems (12 Hours)

Controller Implementation : Implementations of Proportional and Integral Control, their Saturation, Characteristics of P, PI, PD, and PID controllers for Process Control Systems, Provision for anti-integral windup and anti-derivative kick. Tuning of P, PI, PID Controllers using Process reaction Curve of Industrial Processes, Cohen-Coon method, Ziegler-Nichol's tuning method for implementation of PI, PD, and PID Controllers, Design of controllers with auto-tuning method employing relay feedback, Frequency domain design for Controllers. Flow Loop control design Using Caldwell's and Sundaresan's Methods.

Module 3: Advanced Process Control employing Ratio, feed-forward and Multi-loop(8 Hours.)

Structure & Implementations of Feed-forward control, Ratio Control, Multi-loop and Cascade control with examples-their Transfer functions, advantages & disadvantages and their modifications. Interaction and decoupling, Non-linear effects in plants and controllers. Boiler Drum Level Control-different techniques.

Module 4: Final Control elements and sequential & Supervisory Control (10 Hours)

Final control elements in process control loop. Type of Actuators: Pneumatic, Electrical, Hydraulic. Positioners. Pneumatic to electrical Signal and. electrical to pneumatic signal converters. Control valves: Classifications & Characteristics of Control Valves, single stem and double stem sliding valves, Valve sizing technique. Concepts of Modulating and Sequential Control. Structure of Modulating Control loops. Supervisory control: Objectives and Implementation in Process Control.

References/ Suggested Learning Resources:-

1. Smith & Corripio, Principles and Practice of Automatic Process Control.
2. Eckman, Automatic Process Control.
3. Shinskey, Process Control Systems.
4. Process Systems Analysis and Control - Coughanowr & Koppel
5. Anand, M.M.S., Electronic Instruments & Instrumentation techniques, PHI, 2004
6. D. Patranabish, Industrial Instrumentation, PHI
7. Krishna Kanth, Computer based Industrial Control, PHI, 2005
8. SeborG-Edgar-Doyle, Process Dynamics and Control, John wiley, 2011
9. C. D. Johnson, Process Control Instrumentation Technology, PHI, 2004
10. Surekha Bhanot, Process Control Principal and Applications, PHI, 2008.
11. Stephanopoulous, Chemical Process Control, PHI, 1984

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HVDC TRANSMISSION SYSTEMS

Course Code	PEEE 802/1
Course Title	HVDC Transmission Systems
Number of Credits	02 (2L:0T:0P)
Prerequisites	Basic circuit laws, Power system I, Power Electronics
Course Category	Program Elective (PC)
Number of classes	26

Course Outcomes:

After Completing this course, students will be able to		K-Level
CO -1	Understand the advantages of dc transmission over ac transmission.	K2
CO -2	Understand the operation of Line Commutated Converters and Voltage Source Converters.	K2
CO-3	Understand the control strategies used in HVDC transmission system.	K2
CO -4	Understand the improvement of power system stability using an HVDC system.	K2

Course Content:

Module 1: dc Transmission Technology (6 hours)

Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Description of DC transmission system: types of DC link, converter station. Planning for HVDC transmission. Modern trends in HVDC Technology. Operating problems of HVDC transmission.

Module 2: Analysis of Line Commutated and Voltage Source Converters (7 hours)

Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter.

Module 3: Control of HVDC Converters: (7 hours)

Principles of Link Control in a LCC HVdc system. Control Hierarchy, Firing Angle Controls– Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Reactive Power Control. Principles of Link Control in a VSC HVdc system. Telecommunication requirements

Module 4: MTDC Links and Stability Enhancement using HVDC Control (6 hours)

Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTdc systems using LCCs. MTdc systems using VSCs. Protection of MTDC Systems. Potential Applications MTDC Systems. Basic Concepts: Power System stability- Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links.

Text/References:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011.
2. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
3. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley-Interscience, 1971.

ELECTRICAL ENERGY CONVERSATION AND AUDITING

Course Code	PEEE 802/2
Course Title	Electrical Energy Conservation and Auditing
Number of Credits	2 (L: 2; T: 0; P: 0)
Prerequisites	Power System
Course Category	Program Elective-2
Number of Classes	26

Course Outcome: After Completion of this course students will able to

CO Number	CO Description	K-level
CO-1	Understand different energy resources, energy consumptions, emission & pollution.	K2
CO-2	Explain energy Audit System.	K2
CO-3	Categorize different energy Systems.	K4
CO-4	Understand different types of energy storage & conservation System.	K2

Module-I Energy Resources and Generation of Power (8 hours)

Energy Resources in general, present scenario, Energy consumption and acts, Environmental aspects of Thermal, Nuclear and hydroelectric power generations, types of emission from various sectors, co-relation between emission & pollution. Kyoto protocol, and carbon credit etc.

Module-II Energy Audit (6 hours)

Energy audit: primary and detail auditing. Energy management: Demand side management (DSM) and Supply side management(SSM), Supply side management through energy price control, Smart Grid – functions, features and technologies. The role of Reactive power management. Distributed generation (DG) and Microgrids:-features of distributed generations, technical issues of DG connection at distribution voltage level. Composition of Microgrid.

Module-III Renewable Energy Resources and Generation of Power (6 hours)

Renewable energy resources: Solar- solar thermal, solar PV, wind energy- prospects and status in national and global context, principles of wind energy conversion, wind monitoring system, VAWT and HAWT, selection of site for WTGS. Geothermal, Tidal, Bio-energy- Biomass and bio gas with gasifiers etc. Fuel cell. Mini and micro hydel power plant, micro turbine.

Module-IV Energy Storage and Conservation (6 hours)

Energy storage and conservation:- Types and methods of energy storage, Energy storage setups like Chemical, Thermal, Magnetic, fly wheel storage etc. Energy conservation – Concept of cogeneration, combined heat and power (CHP).

Reference / Text Books:

1. Energy Management Handbook (6th ed. 2007) – by Wayne C. Turner & Steve Doty, the Fairmont Press, Inc.
2. Guide to energy management, 6th Ed., - by Barney L. Capehart, Wayne CTurner, William J. Kennedy, The Fairmont Press, Inc.
3. Power Station Engineering and Economics – Skortzki, B. G. A. and Vopat W. A. McGraw Hill, NewYork.
4. Solar Energy Engg - Sayigh A. A. M - Academic Press.
5. Demand Side Management planning - Gelling C W et al. Fairmount Press, Lilbum, U S A.
6. Generation of Electrical Energy – B. R. Gupta, Eurasia Publishing House (Pvt) Ltd.

LINE-COMMUTATED AND ACTIVE PWM RECTIFIERS

Course Code	PEEE 802/3
Course Title	Line-Commutated and Active PWM Rectifiers

Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Power Electronics
Course Category	Program Elective-5(PE-5)
Number of classes	24 hours

Course Outcome:-

After completion of the course, students will be able to:

CO No.	CO Description	K-level
PEEE802/3.1	Analyze the controlled rectifier circuits.	K4
PEEE802/3.2	Explain in basic operation and compare the performance of various power semiconductor devices and switching circuits.	K2
PEEE802/3.3	Illustrate the operation of line-commutated rectifiers - 6 pulse and multi-pulse configurations.	K2
PEEE802/3.4	Explain the operation of PWM rectifiers - operation in rectification and regeneration modes and lagging, leading and unity power factor mode.	K2

Course Content:-

Module- 1: Diode rectifiers and Thyristor rectifiers with passive filtering (6 hours):

Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C
and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous
conduction, input current wave shape. Half-wave thyristor rectifier with RL and RC loads; 1-phase thyristor rectifier with L and LC filter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current wave shape.

Module- 2: Multi-Pulse converter (6 hours)

Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis,
commutation overlap, notches during commutation.

Module- 3: Single-phase ac-dc single-switch boost converter (6 hours)

Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure.

Module- 4: Ac-dc bidirectional boost converter (6 hours)

Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.

References/ Suggested Learning Resources:-

1. G. De, "Principles of Thyristorised Converters", Oxford & IBH Publishing Co, 1988.
2. J.G. Kassakian, M. F. Schlecht and G. C. Verghese, "Principles of Power Electronics", AddisonWesley,1991.
3. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
4. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
5. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2001.

PROJECT WORK FINAL

Course Code	PR EE 805
Course Title	Project Work Final
Number of Credits	6 (L: 0, T: 0, P: 12)
Prerequisites	Nil
Course Category	Project (PR)
Number of classes	130 hours

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Demonstrate a sound technical knowledge of their selected project topic	K2
CO-2	Develop the skill of working in a Team	K3

CO-3	Design engineering solutions to complex problems utilizing a systematic approach	K6
CO-4	Design the solution of an engineering project involving latest tools and techniques	K6
CO-5	Develop the skill of effective communication with engineers and the community at large in written an oral forms	K3
CO-6	Demonstrate the knowledge, skills and attitudes of a professional engineer	K2

Course Content:-

The project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Develop sound knowledge about the domain of the project work.
2) Perform detailed study about various components of a project.
3) Learn to be an important member of a team for successful execution of a project work.
4) Study about methodologies and professional way of documentation and communication related to project work.
5) Develop idea about problem formulation, finding the solution of a complex engineering problem.
6) Develop project report as per the suggested format to communicate the findings of the project work.
7) Acquire the skill of effective oral communication to the fellow engineers and people in the society at large.
8) Develop knowledge of how to organize, scope, plan, do and act within a project thesis.
9) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
10) Demonstrate the implementation of a project work.

Seminar on Contemporary Engineering Topics – II

Course Code	SE EE 806
Course Title	Seminar on Contemporary Engineering Topics – II
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Seminar (SE)
Number of classes	24 Hours

Course Outcome:-

CO Number	CO Description	K-level
CO-1	Identify contemporary topics in respective branch of engineering	K3
CO-2	Survey literature to understand insight of the selected topic	K4
CO-3	Develop report writing and presentation making skill	K3
CO-4	Present the topic so prepared among audience using suitable aid	K3

Course Content:-

Each student shall:

1) Identify a topic of current relevance in his/her branch of engineering,
2) Get approval of the faculty concerned/HOD,
3) Collect sufficient literature on the selected topic, study it thoroughly (literature survey),
4) Prepare their own report and presentation slides and
5) Present in the class among fellow students and faculty members.

SWAYAM Courses

Course Code	SW EE 807
Course Title	SWAYAM Courses
Number of Credits	1 (L: 0, T: 0, P: 0)
Prerequisites	Nil
Course Category	Online Course (SW)
Number of classes	-

Courses Outcome:-

CO Number	CO Description	K-level
CO-1	Make use of digital learning platform to enhance knowledge and skill beyond the prescribed curriculum structure	K3
CO-2	Take part in proctored examination system to prepare oneself for similar future challenges	K4
CO-3	Utilize the opportunity to learn from best faculty in the countryfor professional development	K3
CO-4	Develop the skill of lifelong self-learning and become future ready	K3

Courses Content:-

SWAYAM (Study Webs of Active-learning for Young Aspiring Minds); India Chapter of Massive Open Online Courses. SWAYAM is an indigenous developed IT platform, initiated by Government of India, which is instrumental for self-actualization providing opportunities for a life-long learning. Learner can choose from hundreds of courses, virtually every course that is taught at the university/college/school level and these shall be offered by best of the teachers in India and elsewhere. Student having registered a course, having submitting the Assignments as per requirements of the course, shall at the end of each course, be assessed through a proctored examination. A student having successfully completed the course shall get a Certificate.

Each student has to undergo and qualify at least two relevant SWAYAM or equivalent courses (to be certified by concerned HOD) with certification during the entire course of B. Tech. program. The Head of the departments will approve the relevancy of a SWAYAM or equivalent course for respective branch of engineering.

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PROGRAM OUTCOMES (POs) AS PER NATIONAL BOARD OF ACCREDITATION (NBA)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.