GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)
Coimbatore - 641 013

Curriculum For

ELECTRICAL AND ELECTRONICS ENGINEERING

(PART TIME)

2023

Regulations

OFFICE OF CONTROLLER OF EXAMINATIONS

GOVERNMENT COLLEGE OF TECHNOLOGY

THADAGAM ROAD, COIMBATORE - 641 013

PHONE 0422 - 2433355 FAX: +91 0422 - 2433355

email: coegct@gmail.com

GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai)
Coimbatore-641013

VISION AND MISSION OF THE INSTITUTION

VISION

To emerge as a centre of excellence and eminence by imparting futuristic technical education in keeping with global standards, making our students technologically competent and ethically strong so that they can readily contribute to the rapid advancement of society and mankind

MISSION

To achieve Academic excellence through innovative teaching and learning practices

To enhance employability and entrepreneurship

To improve the research competence to address societal needs

To inculcate a culture that supports and reinforces ethical, professional behaviours for a harmonious and prosperous society

GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)

Coimbatore - 641 013

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION:

To be a premier and value based department committed to excellence in preparing students for success in Electrical Engineering and Technology professions.

MISSION:

To facilitate quality learning blended with practical engineering skills.

To prepare students to develop all round competitiveness.

To motivate Faculty and students to do impactful research on societal needs.

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE – 641 013

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - PART TIME

2023 REGULATIONS

(Candidates admitted during 2022-2023 and onwards)

FIRST SEMESTER

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
THEORY									
1	23PTE1Z1	Applied Mathematics – I (Common to CIVIL, MECH, EEE & ECE)	40	60	100	3	0	0	3
2	23PTE1Z2	Environmental Science and Engineering (Common to CIVIL, MECH, EEE & ECE)	40	60	100	3	0	0	3
3	23PTE103	Programming in C	40	60	100	3	0	0	3
4	23PTE104	Electric Circuit Theory	40	60	100	3	0	0	3
PRACTICAL									
5	23PTE105	Programming in C Laboratory	60	40	100	0	0	3	1.5
		TOTAL			500				13.5

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE – 641 013

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - PART TIME

2023 REGULATIONS

(Candidates admitted during 2022-2023 and onwards)

SECOND SEMESTER

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
THEORY									
1	23PTE2Z1	Applied Mathematics – II (Common to MECH, EEE & ECE)	40	60	100	3	0	0	3
2	23PTE202	Electronic Devices and Circuits	40	60	100	3	0	0	3
3	23PTE203	Field Theory	40	60	100	3	0	0	3
4	23PTE204	Digital Circuits	40	60	100	3	0	0	3
5	23PTE205	Electrical Machines-I	40	60	100	3	0	0	3
		TOTAL			500				15

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE – 641 013

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - PART TIME

2023 REGULATIONS

(Candidates admitted during 2023-2024 and onwards)

Third Semester

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
THEORY									
1	23PTE301	Power Generation and Utilisation	40	60	100	3	0	0	3
2	23PTE302	Transmission and Distribution	40	60	100	3	0	0	3
3	23PTE303	Electrical Machines-II	40	60	100	3	0	0	3
4	23PTE304	Electrical and Electronic Measurements	40	60	100	3	0	0	3
PRACTICAL									
5	23PTE305	Electrical Machines Laboratory	60	40	100	0	0	3	1.5
		TOTAL	**220**	**280**	**500**	**12**	**0**	**3**	**13.5**

Fourth Semester

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
THEORY									
1	23PTE401	Linear Integrated Circuits	40	60	100	3	0	0	3
2	23PTE402	Control Systems	40	60	100	3	0	0	3
3	23PTE403	Power System Analysis	40	60	100	3	0	0	3
4	23PTE404	Microprocessors, Microcontrollers and Applications	40	60	100	3	0	0	3
5	23PTE405	Energy Auditing and Management	40	60	100	3	0	0	3
		TOTAL	**200**	**300**	**500**	**15**	**0**	**0**	**15**

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE – 641 013

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - PART TIME

2023 REGULATIONS

Fifth Semester

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
THEORY									
1	23PTE501	Power Electronics	40	60	100	3	0	0	3
2	23PTE502	Power System Protection	40	60	100	3	0	0	3
3	23PTE503	Modern Control Theory	40	60	100	3	0	0	3
4	***E1***	***Elective – I***	40	60	100	3	0	0	3
PRACTICAL									
5	22PTE504	Power System Laboratory	60	40	100	0	0	3	1.5
		TOTAL	**220**	**280**	**500**	**12**	**0**	**3**	**13.5**

Sixth Semester

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
THEORY									
1	23PTE601	Special Machines and Controllers	40	60	100	3	0	0	3
2	23PTE602	Industrial Drives and Controls	40	60	100	3	0	0	3
3	23PTE603	Electric Vehicle Technology	40	60	100	3	0	0	3
4	***E2***	***Elective – II***	40	60	100	3	0	0	3
PRACTICAL									
5	23PTE604	Power Electronics and Drives Laboratory	60	40	100	0	0	3	1.5
		TOTAL	**220**	**280**	**500**	**12**	**0**	**3**	**13.5**

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE – 641 013

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - PART TIME

2023 REGULATIONS

Seventh Semester

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
THEORY									
1	23PTE701	Electrical Machine Design	40	60	100	3	0	0	3
2	23PTE702	HVDC Transmission Systems	40	60	100	3	0	0	3
3	23PTE703	Renewable Power Generation Systems	40	60	100	3	0	0	3
4	***E3***	***Elective – III***	40	60	100	3	0	0	3
5	***E4***	***Elective – IV***	40	60	100	3	0	0	3
		TOTAL	**200**	**300**	**500**	**15**	**0**	**0**	**15**

Eighth Semester

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
THEORY									
1	23PTE801	IoT for Electrical Engineering	40	60	100	3	0	0	3
2	23PTE802	Technology Management	40	60	100	3	0	0	3
3	***E5***	***Elective – V***	40	60	100	3	0	0	3
PRACTICAL									
4	23PTE803	Project Work	60	40	100	0	0	6	3
		TOTAL	**180**	**220**	**400**	**9**	**0**	**6**	**12**

TOTAL NO. OF CREDITS : 111

LIST OF ELECTIVES:

SEMESTER - V
ELECTIVE - I

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
1	23PTE5E1	Restructured Power Systems	40	60	100	3	0	0	3
2	23PTE5E2	Power Quality Engineering	40	60	100	3	0	0	3
3	23PTE5E3	Power System Stability	40	60	100	3	0	0	3
4	23PTE5E4	Power System Economics	40	60	100	3	0	0	3

SEMESTER - VI
ELECTIVE – II

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
1	23PTE6E1	Biomedical Instrumentation	40	60	100	3	0	0	3
2	23PTE6E2	Thermal Power Plant Instrumentation	40	60	100	3	0	0	3
3	23PTE6E3	Neural and Fuzzy Systems	40	60	100	3	0	0	3
4	23PTE6E4	Optimization Techniques and Applications	40	60	100	3	0	0	3

SEMESTER - VII
ELECTIVE – III

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
1	23PTE7E1	Automotive Electronics for Electrical Engineering	40	60	100	3	0	0	3
2	23PTE7E2	Logic and Distributed Control Systems	40	60	100	3	0	0	3
3	23PTE7E3	Digital Signal Processing and Processors	40	60	100	3	0	0	3
4	23PTE7E4	Principles of Virtual Instrumentation	40	60	100	3	0	0	3

SEMESTER - VII

ELECTIVE - IV

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
1	23PTE7E5	Smart Grid Technology	40	60	100	3	0	0	3
2	23PTE7E6	Energy Storage Technology	40	60	100	3	0	0	3
3	23PTE7E7	Microgrid Technology	40	60	100	3	0	0	3
4	23PTE7E8	MEMS and NEMS	40	60	100	3	0	0	3

SEMESTER - VIII
ELECTIVE - V

Sl. No.	Course Code	Course Title	Sessional Marks	Final Exam Marks	Total Marks	Credits			
						L	T	P	C
1	23PTE8E1	Intelligent Control of Electric Vehicles.	40	60	100	3	0	0	3
2	23PTE8E2	Grid Integration of Electric Vehicle	40	60	100	3	0	0	3
3	23PTE8E3	Design of Motor and Power Converters for Electric Vehicles	40	60	100	3	0	0	3
4	23PTE8E4	Electric Vehicle Architecture	40	60	100	3	0	0	3

23PTE1Z1	APPLIED MATHEMATICS - I (Common to CIVIL, MECH, EEE & ECE)	SEMESTER I

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	This course mainly deals with topics such as linear algebra, single variable calculus and numerical methods and plays an important role in the understanding of engineering science.	
UNIT – I	**LINEAR ALGEBRA**	**9 Periods**
Consistency of System of Linear Equations, Eigenvalues and eigenvectors, Diagonalization of matrices by orthogonal transformation, Cayley-Hamilton Theorem, Quadratic form to canonical forms.		
UNIT – II	**DIFFERENTIAL CALCULUS**	**9 Periods**
Radius of curvature, Centre of curvature, Circle of curvature , Evolutes of a curve, Envelopes		
UNIT – III	**INTEGRAL CALCULUS**	**9 Periods**
Evaluation of definite and improper integrals, Applications: surface area and volume of revolution (Cartesian coordinates only).		
UNIT – IV	**NUMERICAL SOLUTION OF EQUATIONS**	**9 Periods**
Algebraic and Transcendental equation: Fixed point iteration method, Bisection method, Newton-Raphson method, Simultaneous equation: Gauss elimination method, Gauss-Jordan method, Gauss Seidal method.		
UNIT – V	**NUMERICAL INTERPOLATION**	**9 Periods**
Equal interval: Newton's forward and Backward difference interpolation formulae, Gauss forward and Backward difference interpolation formulae, Unequal interval: Lagrange's interpolation, Newton's divided difference interpolation.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK

1	*VeerarajanT.,* ***Engineering Mathematics I****, Tata McGraw-Hill Education(India)Pvt. Ltd, New Delhi,2015.*
2	*P. Kandasamy, K. Thilagavathy, K. Gunavathi,* ***Numerical Methods****, S. Chand & Company, 3nd Edition, Reprint 2013.*

REFERENCES

1	*B.S.Grewal,* ***"Higher Engineering Mathematics"****, Khanna Publishers, 44th Edition, 2017.*
2	*David C.Lay,* ***"Linear Algebra and Its Application"****, Pearson Publishers, 6th Edition,2021.*
3	*Howard Anton,* ***"Elementry Linear Algebra"****, 11th Edition, Wiley Publication, 2013.*
4	*Narayanan.S and Manicavachagom Pillai. T.K. –* ***"Calculas Vol I and Vol II",*** *S.chand & Co, Sixth Edition, 2014.*
5	*S.S. Sastry,* ***"Introductory methods of numerical analysis"****, PHI, New Delhi, 5th Edition, 2015.*
6	*Ward Cheney, David Kincaid,* ***"Numerical Methods and Computing",*** *Cengage Learning, Delhi, 7th Edition 2013.*
7	*Jain R.K. and Iyengar S.R.K.,* ***"Advanced Engineering Mathematics"****, Narosa Publicaitons, Eighth Edition, 2012.*

	COURSE OUTCOMES: Upon completion of the course, the students will be able to:	**Bloom's Taxonomy Mapped**
CO1	Use the essential tool of matrices and linear algebra in a comprehensive manner.	K3
CO2	Explain the fallouts of circle of curvature, evolute and envelops that is fundamental to application of analysis to Engineering problems.	K3
CO3	Interpret the integral calculus to notions of definite and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.	K3
CO4	Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to polynomial and transcendental equations.	K3
CO5	Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations.	K3

23PTE1Z2	ENVIRONMENTAL SCIENCE AND ENGINEERING (Common to CIVIL, MECH, EEE & ECE)	SEMESTER I

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	The course is aimed at creating awareness among the students and also inseminates the critical ideas of preserving environment.	
UNIT – I	**ENVIRONMENTAL ENERGY RESOURCES**	**9 Periods**
Food-effects of modern agriculture, fertilizers, pesticides, eutrophication & biomagnifications-Energy resources: renewable resources - Hydro Energy, Solar & Wind. Non-renewable resources – Coal and Petroleum - harnessing methods.		
UNIT – II	**ECO SYSTEM AND BIODIVERSITY**	**9 Periods**
Eco system and its components - biotic and abiotic components. Biodiversity: types and values of biodiversity, hot spots of biodiversity, endangered and endemic species, conservation of biodiversity: In situ and ex situ conservation. Threats to biodiversity-destruction of habitat, habit fragmentation, hunting, over exploitation and man-wildlife conflicts. The IUCN red list categories.		
UNIT – III	**ENVIRONMENTAL POLLUTION**	**9 Periods**
Air pollution, classification of air pollutants – sources, effects and control of gaseous pollutants SO_2, NO_2, H_2S, CO, CO_2 and particulates. Water pollution - classification of water pollutants, organic and inorganic pollutants, sources, effects and control of water pollution. Noise pollution - decibel scale, sources, effects and control.		
UNIT – IV	**ENVIRONMENTAL THREATS**	**9 Periods**
Global warming-measure to check global warming - impacts of enhanced Greenhouse effect, Acid rain- effects and control of acid rain, ozone layer depletion- effects of ozone depletion, disaster management - flood, drought, earthquake and tsunami.		
UNIT – V	**SOCIAL ISSUES AND ENVIRONMENT**	**9 Periods**
Water conservation, rain water harvesting, e-waste management, Pollution Control Act, Wild life Protection Act. Population growth- exponential and logistic growth, variation in population among nations, population policy. Women and Child welfare programs. Role of information technology in human and health, COVID-19 - effects and preventive measures.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

TEXT BOOK:

1	*Sharma J.P., **"Environmental Studies"**, 4th Edition, University Science Press, New Delhi 2016.*
2	*AnubhaKaushik and C.P.Kaushik**, "Environmental Science and Engineering"**, 7th Edition, New age International Publishers, New Delhi, 2021.*

REFERENCES:

1	*A k de, **"environmental chemistry"**, eight edition, new age international publishers, 2017.*
2	*G. Tyler miller and scott e. Spoolman, **"environmental science"**, cengage learning indiapvt, ltd, delhi, 2014.*
3	*ErachBharucha, **"Textbook of Environmental Studies"**, Universities Press(I) Pvt, Ltd, Hydrabad, 2015.*
4	*Gilbert M.Masters**, "Introduction to Environmental Engineering and Science"**, 3rd Edition, Pearson Education, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recognize and understand about the various environmental energy resources and the effective utility of modern agriculture.	K2
CO2	Acquire knowledge about the interaction of biosphere with environment and conservation methods of bio diversity.	K2
CO3	Be aware of the sources of various types of pollution, their ill effects and preventive methods.	K2
CO4	Identify and take the preventive measures to control the environmental threats and effects of Global warming, Ozone depletion, Acid rain, and natural disasters.	K2
CO5	Demonstrate an idea to save water and other issues like COVID -19.	K2

23PTE103	PROGRAMMING IN C	SEMESTER I

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	1. To Familiarize with Computer and Programming fundamentals 2. To understand Data types in C and Flow control statements 3. To outline Functions, Arrays, Pointers and Strings 4. To recognize Bitwise Operators, Pre-processor Directives, Structures and Unions 5. To build Structures, Unions, List Processing, Input and Output functions.	
UNIT – I	**COMPUTER AND PROGRAMMING FUNDAMENTALS**	**9 Periods**
Computer fundamentals –Anatomy of a computer: CPU, Memory, I/O – Introduction to software – Generation and classification of programming languages – Compiling – Linking and loading a program – Translator – loader – linker – develop a program – software development – Introduction to OS –Types of OS – Algorithms – Structured programming concept.		
UNIT – II	**DATA TYPES AND FLOW OF CONTROL**	**9 Periods**
An overview of C – Programming and Preparation – Program Input /Output – Variables – Expressions, and Assignment, The use of #include, printf(), scanf() – Lexical elements, operators - The fundamental data types – Flow of control		
UNIT – III	**FUNCTIONS, ARRAYS, POINTERS AND STRINGS**	**9 Periods**
Functions and storage classes - Arrays – Pointers – Call by reference – Relationship between Arrays and Pointers – Pointer arithmetic and element size – Arrays as function argument – Dynamic memory allocation – Strings – String handing functions – Multidimensional Arrays.		
UNIT – IV	**ARRAY OF POINTERS, BITWISE OPERATORS, PREPROCESSOR DIRECTIVES**	**9 Periods**
Arrays of Pointers – Arguments to main () - Functions as Arguments – Array of Pointers to Functions - Type qualifiers.-Bitwise operators and expressions – Masks – Software tools – Packing and unpacking – Enumeration types – The preprocessor directives.		
UNIT – V	**STRUCTURES AND UNIONS, I/O AND FILE OPERATIONS**	**9 Periods**
Structures and Unions – Operator precedence and associativity – Bit fields – Accessing bits and bytes - Input and Output functions – File Processing Functions – Environment variables – Use of make and touch.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*PradipDey, ManasGhosh, "**Computer Fundamentals and Programming in C**", Second Edition, Oxford University Press, 2013.*
2	*Ashok H. Kamthane, Amit Ashok Kamthane, "**Programming in C**", Third Edition, Pearson, 2015.*

REFERENCES:

1	*Stephen G. Kochan, "**Programming in C-A complete introduction to the C programminglanguage**", Third Edition, Sams Publication, 2004.*
2	*Yashavant P. Kanetkar, "**Let Us C**", 13th edition, BPB Publications, 2013.*
3	*Brian W. Kernighan and Dennis Ritchie, "**The C Programming Language**", Second Edition, Prentice Hall Software Series, 1988.*
4	*Stephen Prata, "**C Primer Plus**", Fifth Edition, Sams Publishing, 2005.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Articulate the programming environment	K1
CO2	Write algorithm for solving the given problem statement	K2
CO3	Use right data types and flow control statements	K1
CO4	Write programs using functions, arrays, pointers and strings	K1
CO5	Use right storage classes, preprocessor directives, bitwise operators in programs	K3

23PTE104	ELECTRIC CIRCUIT THEORY	SEMESTER I

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To gain knowledge in basic concepts of circuit theory and finally be able to analyze and synthesize electric circuits	
UNIT – I	**DC AND AC CIRCUIT ANALYSIS**	**9 Periods**
Ohm's law and Kirchhoff's Laws –Form Factor and Peak Factor derivation for alternating waveforms - R, L, C series-parallel circuits - Star-delta transformation - Source transformations - Mesh and nodal methods –Power factor - Real, reactive and apparent powers.		
UNIT – II	**NETWORK THEOREMS AND POLYPHASE CIRCUITS**	**9 Periods**
Superposition theorem – Thevenin's and Norton's theorems - Maximum power transfer theorem - Reciprocity theorem. Three phase system - Interconnection of three- phase sources and loads - Balanced and unbalanced circuits - Power measurement.		
UNIT – III	**RESONANCE, COUPLED CIRCUITS AND TRANSIENTS**	**9 Periods**
Resonance in series and parallel circuits – frequency response - derivation of bandwidth - Introduction to coupled circuits – Mutual inductance – Coefficient of coupling - Dot rule - Single and double tuned circuits - Problems. Transient responseusing Laplace transforms – DC response of RL, RC, R L C circuits – Sinusoidal response of RL, RC, RLC circuits.		
UNIT – IV	**TWO PORT NETWORKS**	**9 Periods**
Two port networks - Open circuit impedance and short circuit admittance parameters – Transmission and inverse transmission parameters – Hybrid and inverse hybrid parameters- Image parameters - Application.		
UNIT – V	**FILTER DESIGN AND SYNTHESIS OF CIRCUITS**	**9 Periods**
Classification of filters - Low pass and high pass filters - Band pass and Band stop filters- Constant K and m-derived filters. Hurwitz Polynomials – Positive Real Function – Synthesis of reactive one port RL, RC networks using Foster and Cauer methods.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Sudakar A. and Shyam Mohan S.Palli* ***"Circuits and Networks (Analysis and Synthesis)"*** *Tata McGraw Hill Book Co., New Delhi, III Ed., 2017.*
2	*Charles K. Alexander, Matthew N.O. Sadiku* ***"Fundamentals of Electric Circuits"*** *McGraw Hill Book Co., 7 Ed. 2020.*

REFERENCES:

1	*Hayt W.H and Kemmerley J.E,* ***"Engineering Circuit Analysis"****, Tata McGraw Hill Book Co., V Ed., 2019.*
2	*C.P. Kuriakose* ***"Circuit Theory: Continuous and Discrete – time systems – Elements of Network Synthesis"*** *PHI, Delhi, 2018.*
3	*Gangadhar K.A.,* ***"Circuit Theory"****, Khanna Publishers, II Ed., 2019.*
4	*M.E.VanValkenburg,* ***"Network Analysis"****, PHI, Delhi, 2019.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply electric circuit laws to DC and AC circuits and solve problems	K3
CO2	Analyze complex circuits using theorems and solve three phase circuits	K4
CO3	Understand the concepts of resonance, coupled circuits and transients and solve problems	K2
CO4	understand two port networks and solve the networks using different parameters	K2
CO5	Design filter circuits and Synthesize electric networks.	K6

23PTE105	PROGRAMMING IN C LABORATORY	SEMESTER I

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	Upon completion of this course, the Students will be familiar with 1.Data types in C and Flow control statements 2. Functions, Arrays, Pointers And Strings 3. Dynamic memory allocation and command line arguments 4.Bitwise Operators, Preprocessor Directives, Structures and Unions 5. Structures, List Processing, Input and Output.

PRACTICALS EXERCISES ILLUSTRATING THE FOLLOWING CONCEPTS:

1. Operators , Expressions and IO formatting
2. Decision Making and Looping
3. Arrays and Strings
4. Functions and Recursion
5. Pointers
6. Dynamic Memory Allocation
7. Structures
8. Unions
9. Files
10. Command line arguments

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use appropriate data types and flow control statements	K1
CO2	Write programs using functions, arrays, pointers and strings	K3
CO3	Write programs using dynamic memory allocation	K3
CO4	Implement programs using right storage classes, preprocessor directives, bitwise operators	K2
CO5	Work with command line arguments, structures, unions and files	K3

23PTE2Z1	APPLIED MATHEMATICS - II (Common to CIVIL, MECH, EEE & ECE)	SEMESTER II

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	This course mainly deals with topics such as differential equations and numerical methods and plays an important role in the understanding of engineering science.	
UNIT – I	**ORDINARY DIFFERENTIAL EQUATIONS**	**9 Periods**
Higher order linear differential equations with constant coefficients -variable coefficients: Cauchy-Euler equation, Cauchy-Legendre equation-Method of variation of parameters-Simultaneous first order linear equations with constant coefficients.		
UNIT – II	**PARTIAL DIFFERENTIAL EQUATIONS**	**9 Periods**
Formation of partial differential equations – First order partial differential equations – Standard types and Lagrange's linear equation – Homogeneous linear partial differential of second and higher order with constant coefficients.		
UNIT – III	**NUMERICAL DIFFERENTIATION AND INTEGRATION**	**9 Periods**
Numerical Differentiation: Newton's interpolation and Lagrange's formula-Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules (single integral only).		
UNIT – IV	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**9 Periods**
Ordinary differential equations: Taylor's series method-Euler's and modified Euler's methods-Runge-Kutta method of fourth order for solving first order equations-Milne's and Adam's predicator-corrector methods		
UNIT – V	**NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS**	**9 Periods**
Partial differential equations: Finite difference solution of two dimensional Laplace equation and Poisson equation- Implicit and explicit methods for one dimensional heat equation (Bender-Schmidt and Crank-Nicholson methods)-Finite difference explicit method for one dimensional wave equation.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK

1	*Veerarajan.T,* ***"Engineering Mathematics"****, Revised Edition 2018, McGraw Hill Education (India) Private Limited*
2	*P. Kandasamy, K. Thilagavathy, K. Gunavathi,* ***"Numerical Methods"****, S. Chand & Company, 3nd Edition, Reprint 2013.*

REFERENCES

1	*B.S.Grewal,* ***"Higher Engineering Mathematics"****, Khanna Publishers, New Delhi, 44thEdition, 2018.*
2	*SrimantaPal,* ***"Numerical Methods Principles, Analyses and Algorithms"****, Oxford University Press, New Delhi, IstEdition 2009.*
3	*Raisinghania.M..D,* ***"Ordinary And Partial Differential Equations"****, 20th Edition, S. ChandPublishing,2020*
4	*S.S. Sastry,* ***"Introductory methods of numerical analysis"****, PHI, New Delhi, 5th Edition, 2015.*
5	*Ward Cheney, David Kincaid,* ***"Numerical Methods and Computing",*** *Cengage Learning, Delhi, 7th Edition 2013.*
6	*S. Larsson, V. Thomee,* ***"Partial Differential Equations with Numerical Methods"****, Springer, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Obtain the knowledge for solving higher order linear differential equation with constant and variable coefficient techniques and simultaneous differential equation.	K3
CO2	Understand the knowledge of partial differential equations (PDEs), modeling; demonstrate accurate and efficient use of Lagrange's techniques.	K3
CO3	Demonstrate and understanding of common numerical methods and how they are used to obtain approximate solutions to polynomial and transcendental equations.	K3
CO4	Construct one-step and linear multistep methods for the numerical solution of initial-value problems for ordinary differential equations.	K3
CO5	Acquire the knowledge of principles for designing numerical schemes for PDEs in particular finite difference schemes.	K3

23PTE202	ELECTRONIC DEVICES AND CIRCUITS	SEMESTER II

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To impart knowledge about various electronic devices and circuits To identify the suitability of electronic devices for real time applications.	
UNIT – I	**DIODES,SPECIAL DIODES AND APPLICATIONS**	**9 Periods**
PN diode: VI characteristics–transition and diffusion capacitance–reverse recovery time–diode models–Applications: Half-wave and Full-wave rectifiers and filters–power supply regulators–Clipping and clamping circuits–Avalanche and Zener breakdown-Zener diodes–varactor and optical diodes.		
UNIT – II	**BI-POLAR JUNCTION TRANSISTORS AND AMPLIFIERS**	**9 Periods**
BJT: Structure–operation and characteristics– as an amplifier and switch–DC operating point –base, emitter and voltage-divider bias –Miller's theorem –BJT amplifier : operation –AC equivalent circuits–CE,CC,CB configurations-multistage–RC coupled–transformer coupled–Darlington and differential amplifiers.		
UNIT – III	**FIELD-EFFECT TRANSISTORS AND BIASING**	**9 Periods**
JFET: Structure, operation and characteristics with parameters–biasing configurations –MOSFET: Structure–types (Depletion and Enhancement)–operation and characteristics–biasing configurations–VMOSFET–CMOS technology.		
UNIT – IV	**AMPLIFIER ANALYSIS AND FEEDBACK TECHNIQUES**	**9 Periods**
BJT and FET amplifiers – basics of frequency response – Low–high and total Frequency response –Power amplifiers –operation – characteristics– parameters of Class A, AB, B and C amplifiers –Operational Amplifier : inverting and non-inverting amplifiers (Quantitative) –concepts of feedbacks –Negative feedback: shunt and series feedback- Positive feedback: Wien Bridge and RC phase shift oscillators.		
UNIT – V	**OTHER SEMICONDUCTOR DEVICES**	**9 Periods**
Basic constructions, characteristics curves, parameters and applications : SCR – DIAC – TRIAC – Uni-junction Transistors - programmable Uni-junction Transistors –IGBT –photo transistors and optical couplers–New semiconductor materials –SiliconCarbide- GalliumArsenide.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*ThomasL.Floyd"**ElectronicDevices**",9th Edition.,Prentice Hall Inc.,2012*
2	*RobertBoylestad**"ElectronicDevicesandCircuitTheory"**,9th Edition, Pearson,2010*

REFERENCES:

1	*Jacob Millman,Christos C Halkias and Satyabrata JIT,"**ElectronDevicesand Circuits**",2nd Ed.,TataMcGrawHill,2008*
2	*Allen Mottershead, "**Electronic Devices and Circuits, An Introduction**", Eastern Economy Ed.,Prentice-HallofIndia,2009*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the construction and working of semiconductor devices	K2
CO2	Analyze the characteristics of the devices and their equivalent circuit models	K4
CO3	Design of electronic circuits using devices and components	K3
CO4	Explore the suitability the device for various applications	K5
CO5	Study the special semiconductor and power electronic devices	K2

23PTE203	FIELD THEORY	SEMESTER II

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To learn the concepts of static and dynamics of charges, understand electromagnetic fields and work on problem solving and application of these ideas for design	
UNIT – I	**ELECTROSTATIC POTENTIAL AND FIELD**	**9 Periods**
Types of charges - Charge distribution - Coulomb's Law - Gauss' law - their applications - Potential - Electric field intensity - Boundary Conditions - Laplace and Poisson's equations – Dielectrics – Capacitance - Electrostatic energy.		
UNIT – II	**MAGNETIC POTENTIAL AND FIELD**	**9 Periods**
Biot - Savart's law - Ampere's law - applications - Scalar and Vector magnetic potentials - Magnetic torque - Force - Boundary conditions – Energy density in magnetic field – Lifting power of electromagnet.		
UNIT – III	**ELECTRO MAGNETIC FIELDS**	**9 Periods**
Problems in divergence and curl of vector fields in various coordinates - Faraday's laws - Maxwell's equations - Current densities - Time harmonics fields.		
UNIT – IV	**ELECTROMAGNETIC WAVES**	**9 Periods**
Wave equations – Uniform plane waves in free space - Uniform plane waves in lossless dielectrics – Uniform plane waves in lossy dielectrics – Uniform plane waves in good conductor - Poynting's theorem.		
UNIT – V	**FIELD MODELING, EMI AND EMC**	**9 Periods**
Field plotting - Laplace equation in rectangular coordinates – Separation of variables - Finite difference method - Finite element method - Infinite square through with lid – Infinite square through with different potentials on four sides – Moment method – EMI and EMC – Sources – Conducted and Radiated EMI – Elimination methods.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical:0 Periods** **Total: 45 Periods**		

TEXT BOOK:

1	*John D. Kraus and Daniel A. Fleisch **"Electromagnetics with Applications"** McGrawHill International Ed., 2018.*
2	*William H.Hayt **"Engineering Electromagnetics"** McGraw Hill Book Co., 2020*

REFERENCES:

1	*AshutoshPramanik**"Electromagnetism"** Prentice Hall of India Pvt. Ltd, 2018*
2	*Gangadhar K.A., **"Field Theory",**Khanna Publishers, 2017*
3	*Joseph Edminister, **"Electromagnetics",** 2ndEd., Tata McGraw Hill Book Co., 2019*
4	*Mathew N.D Sadiku, **"Elements of Electromagnetics",** Oxford university press, Fourth Edition., 2021*
5	*Dr.Dhananjayan.P. **"Engineering Electromagnetics",** Lakshmi Publications, 2021*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the basics of electric field	K2
CO2	Ascertain the concepts of magnetic field	K3
CO3	Master the fundamentals of electromagnetic field	K3
CO4	Illustrate the knowledge gained to analyze electromagnetic waves	K3
CO5	Estimate the field parameters for a given problem based on field modeling	K4

23PTE204	DIGITAL CIRCUITS	SEMESTER II

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To learn the fundamental concepts and design techniques used in digital electronics and also to familiarize with the basics of Hardware description language in the design of digital circuits	
UNIT – I	**BOOLEAN ALGEBRA AND LOGIC GATES**	**9 Periods**
Binary Systems, Boolean Algebra and Logic gates – Boolean functions - Canonical and Standard Forms - Digital Logic gates – Integrated circuits. Gate level minimization – Map methods- NAND and NOR Implementation.		
UNIT – II	**COMBINATIONAL LOGIC**	**9 Periods**
Combinational circuits - Analysis and Design Procedure- Binary adder subtractor - Decimal adder – Binary multiplier – Magnitude comparator – Decoders – Encoders – Multiplexers.		
UNIT – III	**SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL LOGIC**	**9 Periods**
Sequential circuits- Latches – Flip flops – Analysis of Clocked Sequential Circuits – State Reduction and Assignment - Design Procedure. Asynchronous Circuits - Analysis Procedure - Circuits with Latches – Reduction of State Flow Tables – Race Free State Assignment – Hazards - Design Example.		
UNIT – IV	**REGISTERS, COUNTERS AND MEMORY**	**9 Periods**
Registers, Shift Registers, Ripple Counters, Synchronous Counters, Random Access Memory, Memory Decoding, Error Detection and Correction, Read Only Memory, Programmable Logic Array. Register Transfer Level Introduction, Algorithmic State Machines, Binary Multiplier.		
UNIT – V	**HARDWARE DESCRIPTION LANGUAGE**	**9 Periods**
Introduction to Verilog: Structure of Verilog module, Operators, data types, Styles of description- Data flow description, Implement logic gates, half adder and full adder using Verilog data flow description. Behavioral description: Structure, variable assignment statement, Verilog behavioral description of Multiplexers (2:1,4:1) and Encoders (8 to 3), Decoders (2 to 4).		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Morris Mano.M **"Digital Design"** Pearson Education, New Delhi, 6thEd., 2018.*
2	*Samir Palnitkar, **"Verilog HDL- A guide to Digital Design and Synthesis"** Pearson Education, New Delhi, 2ndEd., 2003.*

REFERENCES:

1	*Ronald J. Tocci, Neal S Widmer,Gregory L Moss, **"Digital Systems: Principles andApplications",** Prentice Hall, 12thEd., 2017*
2	*Floyd Thomas L.,**"Digital fundamentals"** Pearson Education, New Delhi, 11thEd.,2015.*
3	*Charles H.Roth**"Fundamentals of Logic Design"**7thEd.,Cl-Engineering, 2013.*
4	*Nazeih M. Botros,**"HDL Programming VHDL and Verilog "**Dreamtech press ,2009.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the fundamentals of digital electronics and logic families.	K2
CO2	Illustrate reduction of logical expressions using Boolean algebra and k-map.	K4
CO3	Use the procedures for the analysis and design of combinational circuits	K3
CO4	Analyze the design capability in synchronous and asynchronous sequential circuits	K4
CO5	Design digital logic circuits in different types of modeling using HDL	K6

23PTE205	ELECTRICAL MACHINES - I	SEMESTER II

PREREQUISITES	L	T	P	C
ENGINEERING PHYSICS – FIELD THEORY	3	0	0	3

Course Objectives	1.To obtain knowledge about energy in magnetic system 2.To understand the working principle of DC generators 3.To understand the working principle of DC motors 4.To know about the principle of operation of Transformers 5.To perform testing in various DC machines and transformers	
UNIT – I	**PRINCIPLES OF ELECTROMECHANICAL ENERGY CONVERSION**	**9 Periods**
Energy in magnetic system – Field energy and co energy - Force and torque equations- eddy currents and eddy current losses – flux distribution curve in the air gap – Singly and multiply excited magnetic field systems - mmf of distributed ac windings – Winding Inductances - Rotating Magnetic Field and mmf waves - Magnetic saturation and leakage fluxes.		
UNIT – II	**DC GENERATORS**	**9 Periods**
Constructional details and principle of operation – Armature winding -Emf equation – Types- Armature reaction: Effects - demagnetizing & cross magnetizing ampere-turns –compensating windings – interpoles; Commutation – Characteristics of DC generators - losses and efficiency -Parallel operation of dc generators- applications.		
UNIT – III	**DC MOTORS**	**9 Periods**
Constructional details and principle of operation- back emf – Types of dc motors - Torque equation losses and efficiency – power flow diagram – Electrical and mechanical characteristics of different types of motors – Starters – Speed control methods – Types of Electric braking.		
UNIT – IV	**TRANSFORMERS**	**9 Periods**
Principle of operation – Types and constructional features of single phase and three phase transformers –EMF equation - Phasor diagram – Transformers on load - Equivalent circuit – Voltage Regulation and efficiency- All day efficiency Three phase transformer connections – Scott connection – Parallel operation of three phase transformers – Inrush current phenomenon and its prevention - Auto transformers, Off-load and on-load tap changing transformer-Isolation Transformers.		
UNIT – V	**TESTING OF DC MACHINES AND TRANSFORMERS**	**9 Periods**
DC machines: Brake test, field test, Retardation test , Swinburne's test , Hopkinson's test. Transformers: Open Circuit and Short Circuit Tests-– Phasing, Identification and Polarity of transformer winding - Sumpner's test.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Nagrath J. and D. P. Kothari,* ***"Theory of Electric Machines",*** *Tata McGraw Hill, 2006*
2	*Fitzgerald A. E., C. Kingsley and S. Umans,* ***"Electric Machinery",*** *7/e, McGraw Hill, 2020*

REFERENCES:

1	*Bimbra P. S.,* ***"Electrical Machinery",*** *7/e, Khanna Publishers, 2021.*
2	*Theraja B. L.,* ***"A Textbook of Electrical Technology",****S.Chand, New Delhi. Reprint 2019.*
3	*AbhijithChakrabarti, SudiptaDebnath,* ***"Electrical Machines",*** *McGraw Hill Education, NewDelhi, 2015.*
4	*Deshpande M. V.,* ***"Electrical Machines",*** *Prentice Hall India, New Delhi, 2011.*
5	*Theodore Wilde,* ***"Electrical Machines, Drives and Power System",*** *Pearson Ed. Asia, 2001*

6	*Jacek F. Gieras,* ***"Electrical Machines: Fundamentals of Electromechanical Energy Conversion",*** *CRC press,2016*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply basic laws of electromagnetic principles for static and dynamic electric machines.	K1
CO2	Analyze the performance of electrical machines for the different level of utilization in Industries.	K4
CO3	Identify suitable machines for any specific application.	K6
CO4	Perform testing of the electrical machines.	K3
CO5	Evaluate the performance of electrical machines.	K5

23PTE301	POWER GENERATION AND UTILIZATION	SEMESTER III

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To gain knowledge on various power generation techniques, ways of proper utilization of electrical power through analysis and synthesis of electrical apparatus	
UNIT – I	**CONVENTIONAL ENERGY GENERATION**	**(9 periods)**
Different types of conventional energy sources – Prediction of load and energy requirements – Hydro electric plant – Large hydro plants – Mini Hydel schemes – Pumped storage plant – Thermal energy production – Heating value – Coal combustion mechanism – Thermal power plant – Super thermal plant – Nuclear power plant – Fast breeder reactors – Gas power plant - Co generation.		
UNIT – II	**NON - CONVENTIONAL ENERGY GENERATION**	**(9 periods)**
Solar Energy - Photo voltaic: p-n junctions - Solar cells - Solar PV systems – Standalone, Grid connected solar power system (Three Phase and Single Phase rooftop system) – merits. Wind Energy - Basic principle of wind energy conversion system, wind data and energy estimation, site selection, components of wind energy conversion system, merits and limitations- application – FuelCells – Introduction to Batteries - Study of different types of Batteries for plug in electric vehicles.		
UNIT – III	**TRACTION ENGINEERING**	**(9 periods)**
Traction mechanics – Tractive effort – Speed time curves – Power output and maximum speed – Specific energy output – Traction motors – Control of motors – Electric braking – Traction supply system – Negative boosters.		
UNIT – IV	**ILLUMINATION, HEATING AND WELDING**	**(9 periods)**
Definitions and lighting calculations – Interior and exterior illumination systems – Design of lighting schemes – Energy efficient Lighting system. Direct and indirect heating methods – Types of furnaces – Heat control – High frequency heating methods – Induction furnace – Dielectric heating – Welding and its classification – Electric arc welding – Electronic welding control.		
UNIT – V	**DOMESTIC UTILIZATION OF ELECTRICAL ENERGY**	**(9 periods)**
House wiring - working principle of air conditioning system, Induction based appliances, Online and OFF line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing system for Domestic, Industrial and Substation.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS :

1	*Soni M.L., Gupta P.V., Bhatnagar U.S "**A Course in Electric Power**" DhanpatRai and Sons, New Delhi, 2005*
2	*B.R. Gupta "**Generation of Electrical Energy**" Eurasia Publishing House (Pvt.) Ltd, 2010*

REFERENCES :

1	*Rai , G.D., "**Non Conventional sources of Energy**", Khanna Publishers , IV Ed.,2009*
2	*Taylor E.O. and VVL Rao, "**Utilization of Electric Energy**", Orient Longman, New Delhi, 200*
3	*Garg G.C., "**Utilisation of Electric Power and Electric Traction**", Khanna Publishers, New Delhi, 2004*
4	*Rajput R.K., "**Utilization of Electrical Power**", Laxmi Publications Pvt. Ltd, New Delhi, 2008*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply knowledge for electrical power generation from various resources available.	K3
CO2	Evaluate the performance of electrical apparatus through analysis and synthesis.	K4
CO3	Study the heating, welding and electrolytic processes	K2
CO4	Gain information on energy conservation	K3
CO5	Obtain knowledge on Energy auditing.	K2

23PTE302	TRANSMISSION AND DISTRIBUTION	SEMESTER III

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To acquire idea about designing of electric utility substation with respect to electrical and mechanical point of view and can assess the new plan of power system	
UNIT – I	**INTRODUCTION**	**(9 periods)**
Structure of electric power system – Different operating voltages of generation, transmission and distribution – Advantage of higher operating voltage for AC transmission. An introduction to EHV AC transmission, HVDC transmission and FACTs. Mechanical design of transmission line between towers – Sag and tension calculations using approximate equations taking into account the effect of ice and wind.		
UNIT – II	**TRANSMISSION LINE PARAMETERS**	**(9 periods)**
Parameters of resistance, inductance and capacitance calculations – Single and three phase transmission lines – Single and double circuits – Solid, stranded and bundled conductors – Symmetrical and unsymmetrical spacing – Transposition of lines – Concepts of GMR and GMD – Skin and proximity effects – Interference with neighbouring communication circuits. Corona discharge characteristics – Critical voltage and loss.		
UNIT – III	**MODELLING AND PERFORMANCE OF TRANSMISSION LINES**	**(9 periods)**
Transmission line classification – Short line, medium line and long line – Equivalent circuits – Ferranti effect – Surge impedance, attenuation constant and phase constant – Voltage regulation and transmission efficiency – Real and reactive power flow in lines – Power circle diagrams – Shunt and series compensation. An introduction to power angle diagram – Surge – Impedance loading, Loadability limits based on thermal loading; angle and voltage stability considerations.		
UNIT – IV	**INSULATORS AND CABLES**	**(9 periods)**
Classification of insulators for transmission and distribution purpose – Voltage distribution in insulator string and grading – Improvement of string efficiency. Underground cables – Constructional features of LT and HT cables – Insulation resistance, capacitance, dielectric stress and grading – Tan δ and power loss – Thermal Characteristics.		
UNIT – V	**SUBSTATION, GROUNDING SYSTEM AND DISTRIBUTION SYSTEM**	**(9 periods)**
Classification, functions and major components of substations. Bus-bar arrangements – Substation bus schemes – Single bus, double bus with double breaker, double bus with single breaker, main and transfer bus, ring bus, breaker-and-a-half with two main buses, double bus-bar with bypass isolators. Importance of earthing in a substation. Qualitative treatment to neutral grounding and earthing practices in substations. Feeders, distributors and service mains. DC distributor – 2-wire and 3-wire, radial and ring main distribution. AC distribution – Single phase and three phase 4-wire distribution.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS :

1	*Soni M.L., Gupta P.V., Bhatnagar U.S "A Course in Electric Power" Dhanpat Rai and Sons, New Delhi, 2005*
2	*S.N. Singh "Electric Power Generation, Transmission and Distribution" Prentice Hall of India Pvt.Ltd, New Delhi, 2002.*

REFERENCES :

1	*D.P.Kothari and I.J.Nagrath, "Power System Engineering", Tata McGraw Hill, Third Reprint 2008*
2	*Wadhwa C.L, "High Voltage Engineering", New Age International Pvt. Ltd., New Delhi, 3rd Ed., 2010*
3	*Mehta V.K., RohitMehta.,"Principles of Power Systems", S.Chand and Co., Fourth Revised Ed., 2008*
4	*Luces M. Fualkenberry, Walter Coffer, "Electrical Power Distribution and Transmission", Pearson Education, 1996*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the structure of power system with component features	K2
CO2	Analyze the transmission and distribution components	K3
CO3	Evaluate the performance of transmission and distribution network	K3
CO4	Design transmission and distribution network with respect to electrical and mechanical aspects	K4
CO5	Derive methods of determining the electrical parameters of the T&D network.	K3

23PTE303	ELECTRICAL MACHINES-II	SEMESTER III

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To acquire the knowledge of working principles and performance of rotating AC machinery and special machines.	
UNIT – I	**SYNCHRONOUS GENERATOR**	**(9 periods)**
Construction – Rotor types – emf equation – Synchronous reactance – Armature reaction-Voltage regulation – EMF, MMF, ZPF –Synchronizing and parallel operation – Synchronizing torque-Change of excitation and mechanical input – Two reaction theory – Determination of direct and quadrature axis synchronous reactance using slip test – Operating characteristics.		
UNIT – II	**SYNCHRONOUS MOTOR**	**(9 periods)**
Principle of operation – Torque equation – Operation on infinite bus bars - V and inverted V curves – Power input and power developed equations – Starting methods – Current loci for Constant power input, constant excitation and constant power developed - Necessity of Damper windings - Applications.		
UNIT – III	**THREE PHASE INDUCTION MOTOR**	**(9 periods)**
Construction – Principle –Rotor types - Slip – Equivalent circuit – Slip-torque characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests -Separation of no load losses – Double cage rotors – Induction generator – Synchronous induction motor. Types of starters – Rotor resistance, Autotransformer and Star-delta starters – Speed control - Voltage control, Frequency control and pole changing – Cascaded Connection-V/f control – Slip power recovery Scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.		
UNIT – IV	**SINGLE PHASE INDUCTION MOTOR AND STARTING METHOD**	**(9 periods)**
Constructional details of single phase induction motor – Double revolving field theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors - Shaded pole induction motor - Capacitor-start capacitor run induction motor.		
UNIT – V	**SPECIAL MACHINES**	**(9 periods)**
Linear induction motor - Hysteresis motor - AC series motor-Switched Reluctance Motor-Stepper motor –Permanent magnet A.C motor (BLDC and PMSM) (Qualitative treatment only)- Magnetic levitation.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS :

1	*Kothari D. P. and Nagrath I. J., "**Electric Machines**" Tata McGraw Hill, 5th Ed., 2017.*
2	*Fitzgerald A.E., Charles Kingsly C. Stephen D. Umans., "**Electric Machinery**" Tata McGrawHill, 6th Ed., 2013.*

REFERENCES :

1	*Sahdev, S. K.. "**Electrical Machines**", Cambridge University Press, United Kingdom, 2017.*
2	*Melkebeek, Jan A., "**Electrical Machines and Drives: Fundamentals and Advanced Modelling**", Springer International Publishing, Germany, 2018.*
3	*E.G. Janardanan, "**Special electrical machines**", PHI learning Private Limited, Delhi, 2014.*
4	*Ghosh, Smarajit, "**Electrical Machines**", Pearson Education India,, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the operating principle of rotating AC machines.	K2
CO2	Familiarize the characteristics of synchronous and induction machines.	K2
CO3	Apply the knowledge of Induction and Synchronous machines for specific applications	K3
CO4	Execute speed control and starting methods for various AC motors.	K3
CO5	Familiarize special electrical machines and their applications	K4

23PTE304	ELECTRICAL AND ELECTRONIC MEASUREMENTS	SEMESTER III

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To learn the construction, operation and its importance of instruments in measurements and provide practical experience to supplement the theoretical knowledge gained in the field of measurements.	
UNIT – I	**MEASUREMENTS OF ELECTRICAL QUANTITIES AND ERROR ANALYSIS**	**(9 Periods)**
Functional elements of Instruments, -Standards and calibrations - Principle of operation of permanent magnet moving coil, moving iron, dynamometer, induction, thermal and rectifier instruments - Extension of instrument ranges Limiting errors of instruments - Combination of limiting errors – Gross, systematic and random errors in measurements - Statistical analysis of errors		
UNIT – II	**MEASUREMENTS USING BRIDGES**	**(9 Periods)**
Wheatstone, Kelvin, Wein, Hay's, Maxwell, Anderson and Schering bridges - Q meter - Measurement of self and mutual inductances - Wagner earthing device - Megger.		
UNIT – III	**MEASUREMENTS OF MAGNETIC QUANTITIES AND INSTRUMENT TRANSFORMERS**	**(9 Periods)**
Flux meters – B-H curve and permeability measurements on ring and bar specimens – Iron loss measurement by magnetic squares – Instrument transformers - types and errors - Instruments for measurement of frequency and power factor - maximum demand Indicator		
UNIT – IV	**ELECTRONIC INSTRUMENTATION**	**(9 Periods)**
Sensors and Transducers – Signal Conditioning - Digital voltmeter – DMM – Digital Clamp meter - True RMS meter - Standard signal generators - Function generator - Spectrum analyzer - Power Quality analyzer- Introduction to virtual Instrumentation		
UNIT – V	**DISPLAY DEVICES AND RECORDERS**	**(9 Periods)**
Digital storage oscilloscope – Active and passive probes - Errors in measurement – calibration of probes - Seven segment display – Dot matrix, LED, LCD - Concepts of Smart meters – Net metering - Data logger.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS :

1	*Sawhney A.K.,* ***"A Course in Electrical and Electronics Measurements and Instrumentation"*** *DhanpatRai& Sons, 19th edition 2015*
2	*David A Bell,* ***"Electronic Instrumentation and Measurements"****, Third Edition, Ox for University Press, 2013*

REFERENCES:

1	*Golding E.W. and Widdis F.G.,* ***"Electrical Measurements and Measuring Instruments",*** *A.H. Wheeler & Co., Ahmedabad , 2003*
2	*A.D. Helfrick and W.D. Cooper,* ***"Modern Electronic Instrumentation and Measurement Techniques"****, Prentice Hall India Private Ltd., New Delhi, 2010*
3	*H.S. Kalsi,* ***"Electronic Instrumentation"****, Tata McGraw-Hill, New Delhi, 2010.*
4	*Jovitha Jerome* ***"Virtual Instrumentation Using LabVIEW"*** *PHI Learning Pvt. Ltd 1st Ed., 2010*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the standards, characteristics and errors of measurements	K2
CO2	Demonstrate the operation of electrical and electronics measuring instruments	K3
CO3	Identify the kind of instrument for measurement of different quantities.	K3
CO4	Test and measure electrical and electronic parameters using instruments.	K4
CO5	Analyse and calculate all the parameters related to measurements	K4

23PTE305	ELECTRICAL MACHINES LABORATORY	SEMESTER III

PREREQUISITES	L	T	P	C
NIL	0	0	3	1.5

Course Objectives	To provide hands-on training for evaluating the performance and characteristics of DC and AC Machines and to identify the suitability of its applications.

LIST OF EXPERIMENTS: **(45 Periods)**

1. Swinburne's test and Speed control of d.c. shunt motor.
2. Open circuit characteristics and load test on d.c. shunt generator.
3. Open circuit characteristics and load test on separately excited d.c. generator
4. Load test on d.c. shunt motor.
5. OC and SC tests on single phase transformers.
6. Load test on single phase transformer.
7. Sumpner's test.
8. Regulation of Alternator by EMF and MMF Methods.
9. Load test on three phase Alternator.
10. Regulation of Alternator by ZPF method.
11. V and Inverted V curves of Synchronous Motor.
12. Equivalent Circuit of three phase Induction Motor.
13. Load Test on three phase Induction Motor.

Contact Periods:
Lecture: 0 Periods **Tutorial:0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Determine the performance characteristics of different types of AC and DC Machines.	K2
CO2	Suggest suitable test for performance determination of Rotating AC and DC Machines.	K3
CO3	Analyze and evaluate the performance of rotating machines.	K5
CO4	Identify suitable speed control methods for rotating machines.	K2
CO5	Evaluate the electrical apparatus to identify the suitability for different applications.	K5

23PTE401	LINEAR INTEGRATED CIRCUITS	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To learn the concept of IC fabrication technology and applications and to design and develop real time OPAMP applications.	
UNIT – I	**IC FABRICATION AND REALIZATION**	**(9 Periods)**
IC Classification - fundamental of monolithic IC technology: epitaxial growth, masking and etching, diffusion of impurities - Realization of monolithic ICs and packaging - Fabrication of diodes, capacitance, resistance and FETs.		
UNIT – II	**OPERATIONAL AMPLIFIERS CHARACTERISTICS**	**(9 Periods)**
Functional block diagram - Ideal op-amp - Open loop and closed loop operation – CMRR - Input bias and offset currents - Input and output offset voltages - Compensation techniques - Frequency response of op-amp – Transfer characteristics - Slew rate - Bandwidth.		
UNIT – III	**APPLICATIONS OF OPERATIONAL AMPLIFIERS**	**(9 Periods)**
Inverting and Non Inverting amplifiers – Differential amplifiers - Integrator and differentiator - V/I & I/V converters - Log and Antilog Amplifiers - Active Filters – Voltage to frequency converters – Sample and Hold circuits – Instrumentation amplifiers – Comparators – Clippers - Clampers - Zero crossing detectors – Square and triangular waveform generator		
UNIT – IV	**555 TIMERS, A/D AND D/A CONVERTERS**	**(9 Periods)**
555 timer – Functional block diagram - Astable and monostable operation of 555 timer – Applications – Frequency counters – A/D converters(Flash and successive approximation types) - D/A converters(R- 2R ladder and weighted resistor types		
UNIT – V	**APPLICATION ICs**	**(9 Periods)**
Positive and negative voltage regulators (IC723) Adjustable voltage regulators (LM117/LM317) – Dual tracking regulators (78xx & 79xx Series) – Phase Locked loop (IC565)- Programmable supply – SMPS - LM 380 power amplifier - ICL 8038 function generator IC.		
Contact Periods : **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Roy Choudhry D. and Shail Jain "**Linear Integrated Circuits**" New Age international, New Delhi,4th Ed., 2017*
2	*David A.Bell"**Op-amp & Linear ICs**" Oxford, 3rd Ed., 2021*

REFERENCES:

1	*RamakantA.Gayakwad, "**OPAMPs and Linear Integrated Circuits**", Prentice Hall of India Pvt.Ltd. New Delhi, 4th Ed. 2011*
2	*Jacob Millman, Christos C.Halkias, Integrated Electronics - Analog and Digital circuits.,2017*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the fabrication of semiconductor devices and circuits	K2
CO2	Analyze working of circuits in practical conditions	K4
CO3	Identification of suitable solutions to real time problems	K2
CO4	Application of circuits for interfacing and generation of waveforms	K3
CO5	Use of general purpose circuits to specific applications and Utility of devices in regulated supply for electronic circuits	K3

23PTE402	CONTROL SYSTEMS	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To understand the different ways of system representations, to assess the system dynamics and to design appropriate controllers and compensators.	
UNIT – I	**CONTROL SYSTEM MODELING**	**(9 Periods)**
Basic Elements of Control System - Open loop and Closed loop systems - Transfer function models of linear time - invariant systems - Modelling of Electric systems, Mechanical systems - Block diagram reduction Techniques - Signal flow graph		
UNIT – II	**TIME DOMAIN ANALYSIS**	**(9 Periods)**
Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system- type number.		
UNIT – III	**FREQUENCY DOMAIN ANALYSIS**	**(9 periods)**
Relationship between time and frequency response, Bode plots, Polar plots, Nichols chart, Nyquist plot - gain and phase margin, Construction of M&N circles - Closed loop frequency response.		
UNIT – IV	**DESIGN OF FEEDBACK CONTROL SYSTEM**	**(9 Periods)**
Design specifications - Lead, Lag and Lag-lead compensators using Root Locus and Bode Plot techniques - PID controller - PR controller-Design using reaction curve and Zeigler-Nichols technique - PID control in State Feedback form.		
UNIT – V	**STATE SPACE ANALYSIS OF CONTINUOUS SYSTEMS**	**(9 Periods)**
Concepts of state variables - State space model – Decomposition of transfer function – Canonical state model – Transfer function from state model – Solution of state equations – State transition matrix –Eigen values - Eigen vectors - Concept of Controllability and Observability.		
Contact Periods: **Lecture:45 Periods Tutorial:0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	Nagarath, I.J. and Gopal, M., "Control Systems Engineering",Nagarath, I.J. and Gopal, M., New Age International Publishers, 2017.
2	S.K. Bhattacharya, "Control Systems Engineering", Sheffield Hallam University, 2017.

REFERENCES:

1	*Nise, Norman S., "**Control systems engineering**", Wiley, 2020.*
2	*B.C. Kuo&FaridGolnaraghi, "**Automatic Control System**", McGraw Hill, 2018.*
3	*S. Salivahanan, "**Control Systems Engineering**", Pearson, India, 2015.*
4	*Manke, B. S, "**Control System Design**", Mercury Learning & Information, 2017.*
5	*K. Ogata, "**Modern Control Engineering**", 5th edition, PHI, 2012*.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	**Model** linear-time-invariant systems using transfer function and state space forms.	K3
CO2	**Compare** various feedback control strategies.	K2
CO3	**Analyze** the system stability in time-domain and frequency domain.	K4
CO4	**Apply and Design** different types of compensators for time-domain and frequency domain specifications.	K5
CO5	**Evaluate** the system stability using the state space model.	K5

23PTE403	POWER SYSTEM ANALYSIS	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To model and analyze the electric power network under normal and abnormal operating conditions for the design of protective and control apparatuses through the analysis results	
UNIT – I	**POWER SYSTEM MODELLING**	**(9 Periods)**
Need for system planning and operational studies – Basic components of a power system - Single line diagram – Per phase and per unit analysis – Generator – Transformer – Transmission line and load representation for different power system studies - Primitive network – Construction of Y-bus using inspection and singular transformation methods .		
UNIT – II	**POWER FLOW ANALYSIS**	**(9 Periods)**
Importance of power flow analysis in planning and operation of power systems – Statement of power flow problem – Classification of buses – Development of power flow model in complex variables form – Iterative solution using Gauss-Seidel method – Q-limit check for voltage controlled buses – Power flow model in polar form – Iterative solution using Newton - Raphson method, Fast Decoupled Method for LFA.		
UNIT – III	**ANALYSIS OF BALANCED FAULTS**	**(9 Periods)**
Importance of short circuit analysis – Assumptions in fault analysis – Analysis using Thevenin's theorem – Z-bus-Building algorithm - Fault analysis using Z-bus – Computations of short circuit capacity, post fault voltages and currents.		
UNIT – IV	**ANALYSIS OF UNBALANCED FAULTS**	**(9 Periods)**
Introduction to symmetrical components – Sequence impedances – Sequence circuits of synchronous machine, transformer and transmission lines – Sequence networks - analysis of single line to ground, line to line and double line to ground faults using Thevenin's theorem and Z-bus.		
UNIT – V	**STABILITY ANALYSIS**	**(9 Periods)**
Importance of stability analysis in power system planning and operation – Classification of power system stability – Rotor angle and voltage stability – Single Machine Infinite Bus (SMIB) system: Swing Equation – Equal area criterion – Determination of critical clearing angle and time – Solution of swing equation by Modified Euler method and Runge - Kutta fourth order method.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan "Electrical Power Systems-Analysis, Security and Deregulation" PHI Learning Private Limited, New Delhi, 2012
2	Nagrath I.J. and Kothari D.P "Modern Power System Analysis" Tata MC Graw Hill, Publishing Co. Ltd., New Delhi, 3rd Edition 2011

REFERENCES :

1	John J Grainger and William D Stevenson J R "Power System Analysis" Tata MC Graw Hill, 6th Reprint, 2007
2	Wadhwa C.L, "Electrical Power Systems", Wiley Eastern Ltd., New Delhi, 2009.
3	Olle. I. Elgerd, "Electric Energy Systems Theory – An Introduction", Tata McGraw Hill Publishing Company Limited, New Delhi, Second Edition, 2012.
4	HadiSaadat, "Power System Analysis", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Model the power system under steady state operating conditions.	K6
CO2	Illustrate numerical methods to solve the power flow problem.	K2
CO3	Analyze the system under fault conditions.	K4
CO4	Examine the transient behavior of the power system under fault conditions.	K4
CO5	Evaluate the power system network for stable operation.	K5

23PTE404	MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	Tolearn the basic concepts of microprocessor and microcontroller hardware and assembly language programming and to demonstrate interfacing techniques and applications.	
UNIT – I	**8085 AND ARM ARCHITECTURE**	**(9 Periods)**
Architecture and Addressing modes of 8085 processors - Instruction set of 8085 - ARM architecture – ARM organization and implementation – The ARM instruction set - Basic ARM Assembly language program.		
UNIT – II	**PIC18 MICROCONTROLLER FRAMEWORK**	**(9 Periods)**
Architecture - Instruction set - Memory organizations - Register file structure - CPU registers - Addressing modes - Assembly language programming.		
UNIT – III	**REAL TIME CONTROL**	**(9 Periods)**
Timers – Prescaler and generating a large time delay- Timer 0,1,2,3 and Counter programming – PWM Generation - Interrupts-Interrupt Service Routine-Sources of interrupts – Programming timer interrupts, external hardware interrupts, serial communication interrupt – Interrupt priority.		
UNIT – IV	**PERIPHERALS OF PIC MICROCONTROLLER**	**(9 Periods)**
ADC characteristics- ADC programming in PIC – DAC interfacing – Sensor interfacing and signal conditioning – Basics of serial communication – PIC connection to RS232 – Serial port programming		
UNIT – V	**ARM AND MICROCONTROLLER APPLICATIONS**	**(9 Periods)**
MICROCONTROLLER APPLICATIONS: LEDs, push buttons, relays and latch connection - Keyboard interfacing-interfacing 7 segment displays – LCD interfacing - ADC/DAC Interfacing - Measurement applications - Automation and control applications. **ARM APPLICATIONS** : Smart phones, Set top boxes , digital television, digital cameras.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey, "**PIC Microcontroller and Embedded Systems – Using Assembly and C for PIC18**", Pearson International 2nd Edition, 2021.*
2	*SteaveFurber,**"ARM system – on – chip architecture",**Addison Wesley, 2nd Edition,2001*

REFERENCES:

1	*Ramesh. S. Gaonkar, "**Microprocessor Architecture, Programming and Applications of 8085**", Penram International Pvt. Ltd., 2004*
2	*Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. M CKinlay "**The 8051 Microcontroller and Embedded Systems**", Second Ed., Pearson Education 2009*
3	*Deshmhmukh L M, "**Microcontrollers (Theory and applications)**", Tata McGraw-Hill Publishing Co. Ltd, New Delhi, 2008*
4	*Vijayendran.V, "**Fundamentals of Microprocessor-8085: Architecture, Programming & Interface**", Vijay Nicole Pvt. Ltd, 2004*
5	*John Crisp, "**Introduction to Microprocessors and Microcontrollers**", Newnes publications (Imprint of Elsevier), 2nd Ed., 2004*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explore the architecture of 8085, ARM and PIC microcontrollers.	K2
CO2	Illustrate the File Registers, Memory and employ assembly language programming	K2
CO3	Create interface between digital system and input/output devices	K2
CO4	Design and develop microcontroller based real-time applications	K3
CO5	Design and Develop skill in simple program writing for 8085, ARM and PIC microcontroller-based control applications	K3

23PTE405	ENERGY AUDITING AND MANAGEMENT	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To comprehend energy management schemes and perform economic analysis and energy conservation in electrical and thermal systems	
UNIT – I	**BASICS OF ENERGY AUDIT AND MANAGEMENT**	**(9 Periods)**
Energy Security - Salient Features of Energy Conservation Act 2022 - Objectives of Energy Management - Energy Audit - Need - Types - Methodology - Audit Report - Instruments for Audit - BEE regulations.		
UNIT – II	**ACTION PLANNING AND MONITORING**	**(9 Periods)**
Energy Action Planning - Energy Cell - EnergyAuditor - Energy Manager - Eligibility - Roles and responsibilities - EnMS ISO (50001:2011) - Project management: Steps in detail. – Energy monitoring and interpretation of variances for remedial actions. Environmental concerns: UNFCC – Kyoto protocol – COP – CDM – PCF – Sustainable development.		
UNIT – III	**ENERGY ASSESSMENT OF THERMAL UTILITIES**	**(9 Periods)**
Boilers - Types - Performance Evaluation of Boilers–Energy Conservation Opportunity – Furnaces - Types – Fuel economy measures in furnaces - Cogeneration: Principle – Classification – Influencing Factors and technical parameters. Waste heat recovery: Classification – application – benefits - Different heat recovery devices		
UNIT – IV	**ENERGY ASSESSMENT OF ELECTRICAL UTILITIES**	**(9 Periods)**
Electricity Billing – Estimation and minimization of technical losses in distribution system - Motor efficiency and tests – Energy efficient motors – Effects of rewinding - VFD - Lighting System: Choice of lighting - Types and features – recommended luminance levels – Lighting design for interiors - energy saving opportunities - Case studies - ECBC.		
UNIT – V	**ENERGY ASSESSMENT IN UTILITY SYSTEMS**	**(9 Periods)**
Financial analysis techniques, ROI, Risk and sensitivity analysis - Payback period – methods – factors affecting analysis. Performance assessment of HVAC System - Pumps - Motors and variable speed drives - Measurements, Procedure – Evaluation.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	Murphy W.R. and G.Mckay Butter worth , "*Energy Management*", Heinemann Publications, 2019.
2	Paul o' Callaghan, "*Energy Management*", Mc-Graw Hill Book Company – 1 st edition; 2018

REFERENCES :

1	John.C.Andreas, "*Energy Efficient Electric Motors*", Marcel Dekker Inc Ltd – 2 nd edition; 2018
2	W.C.Turner, "*Energy Management Handbook*", John Wiley and Sons, Fifth edition, 2019
3	Albert Thumann, Terry Niehus and William J Younger, "*Handbook of Energy Audits*", Taylor & Francis, 2018
4	www.em-ea.org/gbook1.asp

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Observe energy audit and the document audit report	K2
CO2	Demonstrate energy management actions and develop the understanding of implementation	K3
CO3	Examine the operation of thermal utilities	K4
CO4	Plan the operation of electrical utilities	K4
CO5	Evaluatefinancial analysis and assess different utility systems.	K5

23PTE501	POWER ELECTRONICS	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To learn about the operation of different types of power semiconductor devices and circuits and identify the more efficient circuit for specific applications.	
UNIT – I	**POWER SEMICONDUCTOR DEVICES**	**(9 Periods)**
Basic structure and switching characteristics of Power diode - Power transistor - SCR- TRIAC – GTO - MOSFET and IGBT- Ratings of SCR - Series Parallel operation of SCR - di/dt and dv/dt protection - Gate driving circuits - Introduction to wide bandgap devices.		
UNIT –II	**CONTROLLED RECTIFIERS**	**(9 Periods)**
Operation and analysis of 1Φ half and fully controlled rectifiers with R- RL and RLE load (Fully controlled and Half controlled) and analysis of rectifiers - Operation of 3Φ Half and Fully controlled Rectifier with R and RL loads - Operation of Vienna Rectifiers-Effect of source impedance in 1Φ and 3Φ Full converters - 1Φ and 3Φ Dual Converters.		
UNIT – III	**DC CHOPPERS**	**(9 Periods)**
Classification and operation of different types of choppers - Control strategies – Forced commutation-Operation of voltage, current and load commutated choppers - Cuk and SEPIC converters - SMPS.		
UNIT – IV	**INVERTERS**	**(9 Periods)**
Types of inverters - Operation of 1Φ - 3Φ bridge inverters (120 and 180 degree modes) – Current Source Inverter - 1Φ ASCSI, 1Φ and 3Φ PWM inverters – types of PWM (single pulse, multiple pulse and sine PWM) - Modulation Index-Fourier analysis of PWM inverter output voltage. Introduction to Multilevel inverter – Types – Operation – Applications.		
UNIT – V	**AC VOLTAGE CONTROLLERS**	**(9 Periods)**
Types of control (Phase and Integrated cycle control) - Operation of 1Φ voltage regulator with R- RL loads - Operation of 3Φ AC voltage controller with R load - 1Φ step up and step down cyclo converters - Concept of matrix converter		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Muhammad H. Rashid "**Power Electronics - Circuits- Devices and Applications**" Prentice Hall of India- New Delhi- Fourth Ed.- 2014*
2	*Ned Mohan "**Power Electronics-Converter Applications and Design Wiley**", 3rd Ed., Reprint 2009.*
3	*Dr. P.S.Bhimbra "**Power Electronics**" Khanna Publishers, 5th Ed., Reprint 2014*

REFERENCES :

1	*Singh. M.D and Khanchandani. K.B "**Power Electronics**" Tata McGraw Hill Publishing Co. Ltd,New Delhi- 3rd Reprint 2012*
2	*Dubey- G.K., Doradla.S.R., Joshi.A., Sinha.R.M.K- "**Thyristorised Power Controllers**"- New Age International Publishers Ltd.-1st Ed., Reprint 2012*
3	*VedamSubramaniam- "**Power Electronics**"- New Age International (P) Publishers Ltd. - 2nd Ed., Reprint, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge about fundamental concepts and techniques used in power electronics.	K2
CO2	Illustrate and compare performance of various power semiconductor devices and switching circuits	K3
CO3	Demonstrate the operation of power electronic converters.	K2
CO4	Select suitable devices by assessing the circuits for various applications.	K4
CO5	Analyze and evaluate the performance of a power electronic circuit.	K5

23PTE502	POWER SYSTEM PROTECTION	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	Achieve mastery in the principles and applications of protective relays, including types, components, construction, operational principles, protection schemes, and performance considerations.	
UNIT – I	**PROTECTIVE RELAYS**	**(9 Periods)**
Electromagnetic relays – Basic requirements of relays – Primary and backup protection – Construction details of – Attracted armature, Balanced beam, Inductor type and differential relays – Universal torque equation – Characteristics of over current, Direction and distance relays, Static relays – Advantages and disadvantages – Definite time, Inverse and IDMT static relays – Comparators – Amplitude and phase comparators. Microprocessor based relays – Advantages and disadvantages – Block diagram for over current (Definite, Inverse and IDMT) and Distance relays and their flowcharts.		
UNIT – II	**PROTECTION OF GENERATORS AND TRANSFORMERS**	**(9 Periods)**
Protection of generators against stator faults, Rotor faults and abnormal conditions. Restricted earth fault and inter-turn fault protection. Numerical problems on percentage winding unprotected. Protection of transformers: Percentage differential protection, Numerical problem on design of CT ratio, Buchholz relay protection, Numerical Problems.		
UNIT – III	**PROTECTION OF FEEDERS AND LINES**	**(9 Periods)**
Protection of feeder (Radial and ring main) using over current relays. Protection of transmission line – 3 zone protection using distance relays. Carrier current protection. Protection of bus bars.		
UNIT – IV	**CIRCUIT BREAKERS**	**(9 Periods)**
Elementary principles of arc interruption, Recovery, Restriking voltage and recovery voltage – Restriking phenomenon, Average and max. RRRV, Numerical problems – Current chopping and resistance switching – CB ratings and specifications: Types and numerical problems – Auto reclosures, Description and operation of Minimum oil circuit breakers, Air blast circuit breakers, Vacuum and SF_6 circuit breakers.		
UNIT – V	**OVERVOLTAGE PROTECTION IN POWER SYSTEMS**	**(9 Periods)**
Overvoltages in power systems – Protection against lightning overvoltages – Valve type and Zinc-Oxide lightning arresters – Insulation coordination – BIL - SIL.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	Y. G. Paithankar, S. R. Bhide, "Fundamentals of Power System Protection", PHI Learning, 2010
2	Badri Ram & D N Vishwakarma, "Power system protection and switch gear", Tata McGraw Hill Education, 2011.

REFERENCES:

1	BhaveshBhalja, Maheshwari,, NileshChothani , "Protection and Switchgear", OUP India, 2011
2	Ravindra P. Singh, "Switchgear and Power System Protection", Prentice Hall of India, 2009
3	A. S. Ingole, "Switchgear and protection" Umesh publication, 2006
4	B. Ravindranath and M. Chander, "Power system protection and switchgear", New age International (P) Ltd., 2003
5	C. Christopoulos and A. Wright, "Electrical power system protection", Springer International edition, 2010

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Discuss the performance of protective relays, components of protection schemes and relay terminology	K2
CO2	Illustrate various protection schemes, construction, operating principle for the protection of power system apparatuses like generators, motors, transformer and bus bar.	K2
CO3	Examine the construction, working of distance relays, the effects of various parameters on the performance of distance relays.	K4
CO4	Summarize the construction and operation of different types of circuit breakers and compare their performances against requirements.	K2
CO5	Analyze causes of overvoltages and Evaluate its protection schemes	K5

23PTE503	MODERN CONTROL THEORY	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To explain the concepts of basic and modern control systems for the real-time analysis and design of control systems, toanalyzenon-linear systems and the concept of stability for nonlinear systems and their categorization.	
UNIT – I	**SAMPLED-DATA SYSTEMS AND Z -TRANSFORM**	**(9 Periods)**
Sampled data theory – Sampling process – Sampling theorem – Signal reconstruction – Sample and hold circuits – Z Transform – Theorems on Z Transforms – Inverse Z Transforms. Pulse transfer function - Response of sampled data system to step and ramp inputs - Steady state error – Stability studies - Jury's test and bilinear transformation.		
UNIT – II	**STATE SPACE ANALYSIS OF DISCRETE SYSTEMS**	**(9 Periods)**
State variables – Canonical forms – Diagonalization – Solutions of state equations – Controllability and observability – Effect of sampling time on controllability – Pole placement by state feedback – Linear observer design – First-order and second-order problems.		
UNIT – III	**NON -LINEAR SYSTEMS**	**(9 Periods)**
Introduction – Non-Linear Systems – Types of Non-Linearities – Saturation – Dead-Zone – Backlash– Jump Phenomenon etc., Linearization of nonlinear systems, Singular Points and its types– Describing function–describing function of different types of nonlinear elements, – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, Stability analysis of nonlinear systems based on phase-plane method.		
UNIT – IV	**LYAPUNOV STABILITY ANALYSIS**	**(9 Periods)**
Stability in the sense of Lyapunov, Lyapunov's stability, and Lypanov's instability theorems – Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.		
UNIT – V	**OPTIMAL CONTROL**	**(9 Periods)**
Introduction to Optimal Control, statement of the optimal control problem, general introduction to the principle of optimality, discrete time linear quadratic problem, optimal state feedback solution. Formation of optimal control problems- Hamiltonian formulation-solution of optimal control problems- Evaluation of Riccati equation State and output Regulator problems.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*M. Gopal, "**Modern Control System Theory**" , New Age International Private Limited, 2014.*
2	*Dorf, Richard C and Bishop, Robert H, "**Modern Control Systems**" , Pearson, Brazil, 2017.*

REFERENCES:

1	*K. Ogata, "**Modern Control Engineering**", 5th edition, PHI, 2012.*
2	*XiangjieLiu,"**Systems Control Theory**",DeGruyter, China Science Publishing & Media Ltd, 2018*
3	*Varmah, K. R, "**Modern Control Theory**", CBS Publishers & Distributors, India, 2020.*
4	*Kirk, Donald E, "**Optimal Control Theory: An Introduction**", Dover Publications, United States, 2012.*
5	*Jacquot, Raymond G, "**Modern Digital Control Systems**", CRC Press, United States, 2019.*
6	*Paraskevopoulos, P.N, "**Modern Control Engineering**", CRC Press, United Kingdom, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Realize the discrete systems and mathematical modelling.	K2
CO2	Examine the properties of nonlinear systems.	K2
CO3	Analyze the stability of nonlinear systems	K4
CO4	Design and Evaluate the optimal controller.	K5
CO5	Apply advanced control strategies to practical engineering problems.	K3

23PTE504	POWER SYSTEM LABORATORY	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	0	0	3	1.5

Course Objectives	Attain expertise in employing digital techniques to address power system operational and control challenges, vital for planning and assessing standard power network configurations.

LIST OF EXPERIMENTS: **(45 Periods)**

1. Computation of Parameters and Modeling of Transmission Lines
2. Formation of Bus Admittance and Impedance Matrices
3. Load Flow Analysis Using Gauss-Seidel Method
4. Load Flow Analysis Using Newton- Raphson and Fast-Decoupled Methods
5. Symmetrical and Asymmetrical Fault Analysis
6. Transient and Small Signal Stability Analysis: Single-Machine Infinite Bus System
7. Transient Stability Analysis of Multi-machine Power Systems
8. Load – Frequency Dynamics of Single- Area and Two-Area Power Systems
9. Economic Dispatch in Power Systems
10. Unit Commitment in Power Systems
11. Study of various protection schemes for Generator and Transformer protection
12. Voltage Control using passive compensation technique
13. Automatic Voltage Regulator
14. Characteristic study of Solar Photovoltaic Array
15. Characteristic study of Wind Power Generation System
16. Study of Power Quality Problems

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Demonstrate the Power System Analysis, Control, Operation and Protection problems virtually through simulation and hardware setup.	K2
CO2	Apply the concepts described in various power system theories to actual situations.	K3
CO3	Analyze ideas learnt through various power system concepts in designing and planning a new one.	K4
CO4	Evaluate the existing power system for its reliable operation.	K5
CO5	Propose modern technologies for the enhanced operation of power systems.	K6

23PTE601	SPECIAL MACHINES AND CONTROLLERS	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To grasp the principle of working of special electrical machines and to cater the knowledge to real world applications.	
UNIT – I	**STEPPING MOTORS**	**(9 Periods)**
Constructional features – Principle of operation – Modes of excitation – Torque production in Variable Reluctance (VR) stepping motor – Dynamic characteristics – Drive systems and circuit for open loop control– Closed loop control of stepping motor		
UNIT – II	**SWITCHED RELUCTANCE MOTORS**	**(9 Periods)**
Constructional features – Principle of operation – Torque equation – Power controllers – Characteristics and control : Speed control-current control- Sensor less operation of SRM – Current sensing- rotor position measurement and estimation methods- sensor less rotor position estimation-inductance based estimation - Microprocessor based controller.		
UNIT – III	**SYNCHRONOUS RELUCTANCE MOTORS**	**(9 Periods)**
Constructional features –Types –Axial and radial air gap motors –Phasor diagram – Characteristic and Control - Vernier motor - Applications		
UNIT – IV	**PERMANENT MAGNET BRUSHLESS DC MOTORS**	**(9 Periods)**
Commutation in DC motors – Difference between mechanical and electronic commutators – Hall sensors – Optical sensors – Multiphase Brushless motor – Square wave permanent magnet brushless motor drives – Torque and emf equation – Torque and Speed characteristics – Microprocessor based controller.		
UNIT – V	**PERMANENT MAGNET SYNCHRONOUS MOTORS**	**(9 Periods)**
Constructional features - Principle of operation – EMF, power input and torque expressions – Phasor diagram – Power controllers – Torque and Speed characteristics –Current and Speed control - Self control – Vector control – Current control schemes.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	R. Krishnan - Switched Reluctance Motor Drives Modeling, Simulation, Analysis, Design, and Applications -CRC Press 2017
2	T.Kenjo, ' Stepping motors and their microprocessor controls', Oxford University press, New Delhi, Dekker 2009

REFERENCES :

1	.T.J.E. Miller, 'Brushless magnet and Reluctance motor drives', Clarendon press, London, 1989
2	Ramu Krishnan - Permanent Magnet Synchronous and Brushless DC Motor Drives -CRC Press, Marcel Applications -CRC Press 2009
3	Bilgin, Berker Emadi, Ali Jiang, James Weisheng - Switched reluctance motor drives: fundamentals to applications-CRC 2019.
4	Jacek F. Gieras, Dr. Rong-Jie Wang, Professor Maarten J. Kamper - Axial Flux Permanent Magnet Brushless Machines-Springer Netherlands 2008

COURSE OUTCOMES: Upon completion of the course, the students will be able to:	Bloom's Taxonomy Mapped

CO1	Describe the constructional features,principle of operation and the types of special electrical machines	K2
CO2	Compute the Torque and EMF equations of the special electrical machines	K3
CO3	Interpret the static and dynamic characteristics of the special electrical machines	K3
CO4	Examine various converter circuits for special electrical machines	K3
CO5	Develop different controllers for special electrical machines.	K4

23PTE602	INDUSTRIAL DRIVES AND CONTROLS	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To learn the concepts of electrical drives and their applications in carrying out modern industrial processes and to expose modern drives for energy conservation.	
UNIT – I	**SPEED CONTROL OF DC MOTORS**	**(9 Periods)**
Concept of Electric Drive – Classification of Electric Drives – Torque calculation, sizing of motor, different types of load torque, Speed/Torque characteristics -Heating and cooling of drives-Braking methods – Methods of speed control – Ward Leonard drives –Semi, Full converter fed DC drives – Single, Two and Four quadrant operations –Dual converter fed DC drives.		
UNIT – II	**DIGITAL CONTROL OF DC MOTORS**	**(9 Periods)**
Digital technique in speed control of DC motors – Advantages – Limitations – Closed loop control of DC drives – Analog, Digital and Hybrid speed control – control of DC motor using microprocessor.		
UNIT – III	**SPEED CONTROL OF AC MOTORS**	**(9 Periods)**
Speed control of AC motors – complete Speed / Torque characteristics – Braking methods. AC - AC controller fed AC drives, Inverter fed AC drives, Frequency control, V/F control of induction and synchronous motor - Self control, Margin angle control and power factor control.		
UNIT – IV	**ROTOR SIDE CONTROL OF INDUCTION MOTOR**	**(9 Periods)**
Rotor side control of Slip ring Induction motor with thyristor chopper – Static control of Rotor resistance – Slip-Energy recovery scheme – Static Scherbius and Kramer systems – Speed control using microprocessor.		
UNIT – V	**INDUSTRIAL APPLICATIONS**	**(9 Periods)**
Choice of selection of motors – Electric drive applications – Steel rolling mills – Cement mills – Paper mills – Textile mills – Sugar mills – Coal mines – Machine Tools- E mobility		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Dubey G.K **"Fundamentals of Electrical Drives"**, Narosa Publishing House, New Delhi, 2nd Ed. 2002.*
2	*Sen, P.C., **"Thyristor DC Drives"**, Krieger Publishing Company 1991.*

REFERENCES :

1	*VedamSubramaniam, **"Electrical Drives and Applications"**, Tata McGraw Hill, New Delhi, 2nd Edition 2010.*
2	*Murphy J.M.D., **"Thyristor Control of AC Motors"**, Pergamon Press, NewYork, 1973.*
3	*Krishnan R., **"Electric Motor and Drives: Modeling, Analysis and Control**", Pearson Education, New Delhi, 2001.*
4	*Pillai S.K., **"A First Course on Electrical Drives"**, Wiley Eastern Ltd., Bombay, 2nd Ed. 2007*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Illustrate the role of power electronics in modern drives.	K2
CO2	Design the digital controller for drives.	K4
CO3	Demonstrate the speed control techniques for AC drives	K3
CO4	Categorize drive for particular applications considering the present and future needs of industries.	K4
CO5	Apply microprocessors in control of electric drives	K3

23PTE603	ELECTRIC VEHICLE TECHNOLOGY	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	Understand electric propulsion unit configuration, integrate vehicle dynamics into design, explore EV battery usage, study electrical machines/controllers, and analyze EV energy management.	
UNIT – I	**OVERVIEW OF ELECTRIC VEHICLES**	**(9 Periods)**
Electric Vehicle Introduction, The Drive Torque, Power, Speed and Energy, Energy Source, Vehicle Auxiliary, Petrol pumps and Charging stations, Introduction to Electric Vehicles in India. Vehicle Subsystems: EV Power-train, Storage for EVs, Fundamentals of EV Battery Pack design, EV Motors and Controllers: Fundamentals and Design, Vehicle Accessories		
UNIT – II	**VEHICLE DYNAMICS**	**(9 Periods)**
Forces acting when a vehicle move, Aerodynamic drag, Rolling Resistance and Uphill Resistance, Power and torque to accelerate, Concept of drive cycle, Drive Cycles and Energy used per km		
UNIT – III	**MOTORS AND CONTROLLERS**	**(9 Periods)**
Fundamentals and Design, Power and Efficiency, Torque Production, Speed and Back EMF, The d-q Equivalent circuit, Field-oriented Control, Three phase AC, Thermal Design, Engineering Considerations.		
UNIT – IV	**BATTERIES FOR EV**	**(9 Periods)**
Battery Charging and Swapping - Introduction to Battery Parameters, Batteries in Future, Li-Ion Battery Cells, SoH and SoC estimation and Self Discharge, Battery Pack Development, Computation of Effective cost of battery, Charging Batteries, Fundamentals of Battery Pack Design, Electrical Design of Battery Pack, Mechanical Design of Battery Pack, Thermal Design of Battery Pack.		
UNIT – V	**EV CHARGER**	**(9 Periods)**
Charger Parameters and Types - Slow, Fast chargers and Swapping,Swapping - Standardization and on board chargers, Public chargers, Public charger economics in Indian Context, Bulk Chargers, Swapping stations and data analytics, Management of EV Infrastructure - BMS Design and Embedded System, Cell Testing & Characterization.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012.
2	Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013.

REFERENCES :

1	Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems" Boca Raton, CRC Press, 2003.
2	Husain, I. "Electric and Hybrid Vehicles" Boca Raton, CRC Press, 2010.
3	Tariq Muneer and Irene IllescasGarcía, "The automobile, In Electric Vehicles: Prospects and Challenges", Elsevier, 2017
4	MehrdadEhsani, Yimin Gao, Stefano Longo, KambizEbrahimi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC Press, 2018

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Comprehend the Electrical Vehicle configuration	K2
CO2	Identify the electric vehicle components to develop updated technologies	K6
CO3	Analyze the components for the performance improvements of complete EV System	K4
CO4	Design suitable drives and control for the operation of EV by applying concepts studied	K6
CO5	Evaluate the Vehicle performance in terms of vehicle dynamics, loss & economic considerations	K5

23PTE604	POWER ELECTRONICS AND DRIVES LABORATORY	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	0	0	3	1.5

Course Objectives	To design, evaluate and analyze the performance of power electronic converters circuits and drives.

List of Experiments: **(45 Periods)**

1.V-I characteristics of SCR and TRIAC
2. V-I characteristics of MOSFET and IGBT
3. Triggering circuits for SCR,MOSFET and IGBT
4. Single phase half controlled rectifier
5. Single phase fully controlled bridge rectifier
6. Buck, Boost and Buck-Boost converter
7. Single phase PWM inverter
8. Series inverter
9. Single phase voltage control using SCR and TRIAC
10. Speed control of chopper fed separately excited DC drive
11.V/f speed control of the three-phase Induction Motor
12. Speed control of BLDC Motor
13. Speed control of Switched Reluctance Motor

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Total: 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyze the characteristics of power semiconductor devices	K4
CO2	Build and test various power electronic converters	K5
CO3	Design of control techniques and circuits for power converters	K6
CO4	Determine the performance of solid state drives	K3
CO5	Calculate the performance of special machines drives	K3

23PTE701	ELECTRICAL MACHINE DESIGN	SEMESTER VII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To impart knowledge on designing static and Rotating machines based upon fundamental theories.	
UNIT – I	**FUNDAMENTALS OF ELECTRICAL MACHINE DESIGN**	**(9 Periods)**
Major considerations in Electrical Machine Design - Electrical Engineering Materials - Space factor - Choice of Specific Electrical and Magnetic loadings- Concept of magnetic circuit- MMF calculation for various types of electrical machines - Thermal considerations - Heat flow - Temperature rise and Insulating Materials - Rating of machines - IE3,IE4,NEMA Standard specifications.		
UNIT – II	**DESIGN OF DC MACHINES**	**(9 Periods)**
Output Equations - Main Dimensions - Choice of Specific Electric and Magnetic Loading - Magnetic Circuits Calculations - Carter's Coefficient - Net length of Iron - Selection of number of poles - Design of Armature, commutator, air gap, field poles, field coil and brushes - Performance prediction using design values		
UNIT – III	**DESIGN OF TRANSFORMERS**	**(9 Periods)**
Output Equations - Main Dimensions - kVA output for single and three phase transformers - Window space factor - Design of core, yoke and winding - Overall dimensions - Operating characteristics - No load current - Temperature rise in Transformers - Design of Tank and cooling tubes of transformers-Introduction to Resin type and Oil less Transformer.		
UNIT – IV	**DESIGN OF INDUCTION MOTORS**	**(9 Periods)**
Output equation of Induction motor - Main dimensions - Design of stator - Choice of Average flux density- Length of air gap- Rules for selecting rotor slots of squirrel cage machines- Design of rotor bars, slots and end rings - Design of wound rotor - Magnetic leakage calculations - Leakage reactance of poly phase machines - Magnetizing current - Short circuit current - Operating characteristics - Losses and Efficiency.		
UNIT – V	**DESIGN OF SYNCHRONOUS MACHINES**	**(9 Periods)**
Output equations - Choice of Electrical and Magnetic Loading - Design of salient pole machines - Short circuit ratio - Shape of pole face - Armature design - Estimation of air gap length - Design of rotor and damper winding - Determination of full load field mmf - Design of field winding - Design of turbo alternators - Rotor design.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Pyrhonen, Juha, et al. , "**Design of Rotating Electrical Machines**", Wiley, United Kingdom, 2013.*
2	*Sawhney A.K, "**A course in Electrical Machine Design**", Dhanpat Raj & Co, 2016*

REFERENCES:

1	*Gray, Alexander, "**Electrical Machine Design: The Design and Specification of Direct and Alternating Current Machinery"**, N.p., Creative Media Partners, LLC, 2018.*
2	*Lipo, Thomas A. "**Introduction to AC Machine Design**", Wiley, United Kingdom, 2017.*
3	*Vishnu Murthy, K M. "**Computer Aided Design of Electrical Machines**", BS Publications, India, 2015.*
4	*V Rajini, V.S Nagarajan, "**Electrical Machine Design**", Pearson, 2017.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	**Illustrate the basics** of design considerations for rotating and static electrical machines.	K2
CO2	**Design** DC machines as per requirements.	K3
CO3	**Create** Transformers as per requirements.	K2
CO4	**Develop** Induction machines as per requirements.	K5
CO5	**Formulate** and analyze synchronous machines.	K4

23PTE702	HVDC TRANSMISSION SYSTEMS	SEMESTER VII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To familiarize with the HVDC transmission system and its control	
UNIT – I	**GENERAL ASPECTS OF HVDC SYSTEM**	**(9 Periods)**
Introduction - Comparison between AC and DC transmissions - DC links - DC cables and line insulators - Comparison between ac and dc cables - Important HVDC projects - Components of a HVDC system.		
UNIT – II	**CONVERTER CIRCUITS AND ANALYSIS**	**(9 Periods)**
Three Phase bridge converter using SCRs - Operating principles - Waveforms - Gate control and overlap – Voltage, current and power factor relations – Commutating resistance – Inversion – Equivalent circuits – Analysis and charts only for overlap less than 60º - Simple problems		
UNIT – III	**CONVERTER CONTROL**	**(9 Periods)**
Principle of control – Control characteristics – Constant minimum firing angle control – Constant current control – Constant extinction angle control – Tap changer control – Power and frequency control – Stability control – Starting and stopping of DC link- Power control		
UNIT – IV	**FAULTS AND PROTECTION**	**(9 Periods)**
Bypass valve – SCR valves malfunctions – Over voltage and current oscillations – DC circuit breakers – DC lightning arrestors – Simple problems.		
UNIT – V	**HARMONICS, FILTERS AND GROUND RETURN**	**(9 Periods)**
Characteristic and uncharacteristic harmonics – Harmonic ac and dc filters – Interference with communication systems – Ground return – land, shore and sea electrodes – Cathodic protection – DC corona.		
Contact Period: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	Kimbark E.W "Direct Current Transmission" Vol I, Wiley – Interscience, New york, Reprint 2016.
2	Padiyar K.R "HVDC Transmission Systems" New Age International Pvt. Ltd, 2016.

REFERENCES:

1	Adamson and Hingorani H.G., "High Voltage DC Power Transmission", Garaway Ltd. England Reprint 2014
2	WadhwaC.L.,"Electrical Power Systems", New Age International Pvt. Ltd, New Delhi, 2018.
3	Arillaga J., "High Voltage Direct Current Transmission", Peter Peregrinus, London, Reprint 2015
4	V.K.Sood, HVDC and FACTS controllers–Applications of Static Converters in Power System, Kluwer Academic Publishers, 2018.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyze HVDC system and enumerate its merits	K4
CO2	Appraise and analyze different converter circuits	K4
CO3	Apply converter control for power flow	K3
CO4	Select suitable protection method for various converter faults	K2
CO5	Illustrate about harmonic filtering in HVDC systems	K3

23PTE703	RENEWABLE POWER GENERATION SYSTEMS	SEMESTER VII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To understand energy scenarios, energy sources and their utilization, society's present needs and future energy demands, the principles of renewable energy conversion systems	
UNIT – I	**ENERGY SCENARIO**	**(9 Periods)**
Principles of renewable energy; energy and sustainable development, fundamentals and social implications. worldwide renewable energy availability, renewable energy availability in India, brief descriptions on solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy, oil shale. Introduction to Internet of energy (IOE).		
UNIT – II	**SOLAR ENERGY**	**(9 Periods)**
Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Solar radiation Measurements- Pyrheliometers, Pyrometer, Sunshine Recorder. Solar Thermal systems: Flat plate collector; Solar distillation; Solar pond electric power plant. Solar electric power generation- Principle of Solar cell, Photovoltaic system for electric power generation, advantages, Disadvantages and applications of solar photovoltaic system.		
UNIT – III	**WIND AND BIOMASS ENERGY**	**(9 Periods)**
Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, Basic components of wind energy conversion system (WECS); Classification of WECS- Horizontal axis- single, double and multi blade system. Vertical axis- Savonius and Darrieus types. Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies -fixed dome; Urban waste to energy conversion; Biomass gasification (Downdraft).		
UNIT – IV	**TIDAL AND OCEAN THERMAL ENERGY**	**(9 Periods)**
Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages and limitations. Ocean Thermal Energy Conversion: Principle of working, OTEC power stations in the world, problems associated with OTEC.		
UNIT – V	**GREEN ENERGY**	**(9 Periods)**
Introduction, Fuel cells: Classification of fuel cells – H_2; Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problem associated with hydrogen energy.		
Contact Periods: (Times New Roman, Size 11, BOLD, Sentence case) **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	Nonconventional Energy sources, G D Rai, Khanna Publication, Fourth Edition, 2009
2	Boyle, "Renewable Energy – Power For A Sustainable Future", Oxford, 2012

REFERENCES :

1	S Rao,B.B. Parulekhar, "Energy Technology 3/e: Nonconventional, Renewable and Conventional", Khanna Publishers, 1994
2	G. N. Tiwari,"Solar Energy - Fundamentals, Design, Modelling and Applications", 2002
3	Gilbert M. Masters, "Renewable and Efficient Electric Power Systems" Wiley,2005
4	ShobhNath Singh, "Non-Convention Energy Resources", Pearson, 2018

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the environmental aspects of renewable energy resources in comparison with various conventional energy systems, their prospects and limitations.	K2
CO2	Summarize the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, electric power generation.	K2
CO3	Apply the conversion principles of wind and tidal energy for the production of electric power generation	K3
CO4	Apply the concept of biomass energy resources and green energy for developing sustainable electric power generation set-up	K3
CO5	Analyze the basic knowledge of ocean thermal energy conversion and hydrogen energy and hence design & evaluate the power generation system	K4

23PTE801	IoT FOR ELECTRICAL ENGINEERING	SEMESTER VIII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To outline Smart Objects and IoT Architectures and functional stacks, various IOT-related protocols, build simple IoT Systems using Arduino and Raspberry Pi, data analytics and cloud in the context of IoT to apply IoT infrastructure for Electrical Power Industry	
UNIT – I	**FUNDAMENTALS OF IoT**	**(9 Periods)**
Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects.		
UNIT – II	**IoT PROTOCOLS**	**(9 Periods)**
IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT		
UNIT – III	**DESIGN AND DEVELOPMENT**	**(9 Periods)**
Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.		
UNIT – IV	**DATA ANALYTICS AND SUPPORTING SERVICES**	**(9 Periods)**
Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG.		
UNIT – V	**IoT in ELECTRICAL POWER INDUSTRY**	**(9 Periods)**
IoT in the Electrical Power Industry – SCADA, Smart Grids, Power transmission line state monitoring, Effective Power Conservation, Smart Metering, Advanced Metering Infrastructure, Building Automation, Connected Public Lighting, Smart Grid, Smart Inverters, Remote control operation of energy consuming devices		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, —IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017
2	DrKamleshLakhwani, Dr Hemant Kumar Gianey, Joseph Kofi Wireko, Kamal Kant Hiran, “Internet of Things – Principles, Paradigms and Applications of IoT” BPB Publications, 2020

REFERENCES:

1	VlasiosTsiatsis, Stamatis Karnouskos, Jan Holler, David Boyle, Catherine Mulligan, "Internet of Things – Technologies and Applications for a New Age of Intelligence", Elsevier Science, 2018
2	Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols‖, Wiley, 2012
3	Jan Ho¨ ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
4	Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011. https://www.arduino.cc/ https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet
5	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things‖, Springer, 2011
6	ArshdeepBahga, Vijay Madisetti, —Internet of Things – A hands-on approach‖, Universities Press, 2015

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concept of IoT.	K2
CO2	Analyze various protocols for IoT	K4
CO3	Design and develop a PoC of an IoT system using Raspberry Pi/Arduino	K6
CO4	Apply data analytics and use cloud offerings related to IoT	K3
CO5	Identify and evaluate the application of IoT to the Electric Power Industry	K5

23PTE802	TECHNOLOGY MANAGEMENT	SEMESTER VIII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To outlineIntricacies of technology selection and to learn the Role of technology in today's business	
UNIT – I	**INTRODUCTION**	**(9 Periods)**
Evolution, growth of technology, role and significance of technology management, forms of technology – process, product technology, impact of technology on society and business, technology and competition.		
UNIT – II	**TECHNOLOGY FORECASTING**	**(9 Periods)**
Technology forecasting, characteristics, principles, process, forecasting methods and techniques.		
UNIT – III	**ACQUISITION OF NEW TECHNOLOGY**	**(9 Periods)**
Alternative for acquiring new technology, reasons to obtain new technology, management of acquired technology, measures of scale and mechanisms for acquiring technologies. Technology transfer-models, modes of transfer, dimensions of technology transfer, features of technology package- routes of technology transfer.		
UNIT – IV	**HUMAN ASPECTS OF TECHNOLOGY MANAGEMENT**	**(9 Periods)**
Integration of people and technology, factors considered in technology management – organizational, psychological, organizational structure and technology –technological change and industrial relations.		
UNIT – V	**SOCIAL ASPECTS OF TECHNOLOGY MANAGEMENT**	**(9 Periods)**
Technology assessment and environmental impact analysis(EIA)-EIA-process, scope, issues in report preparation, elements of environmental problem, case study on social impact of technology.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Sanjiva Shankar Dubey,* ***"Technology and Innovation Management",*** *PHI Learning Private Ltd., 2017.*
2	*Gerard H. Gaynor,* ***"Hand Book Technology of Management"****, McGraw Hill professional, 2009.*

REFERENCES:

1	*Khalil, T, "****Management of technology: The Key to competitiveness and wealth creation****" Tata McGraw Hill, Delhi, 2013.*
2	*Ralph Katz****, "The human side of Managing Technological Innovation: A Collection of Readings",*** *2nd Edition Oxford University Press, 2003*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Learn to manage ideas and knowledge in a technology-based organization.	K2
CO2	Equipped with skills needed to implement technology policies and strategies.	K4
CO3	Formulate technology policies and strategies for businesses.	K4
CO4	Appropriately choose the new technologies.	K3
CO5	Ability to foresee future technological requirements.	K3

23PTE5E1	RESTRUCTURED POWER SYSTEMS	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To obtain knowledge about Indian power markets and deregulation	
UNIT – I	**INTRODUCTION TO RESTRUCTURING OF POWER INDUSTRY**	**(9 Periods)**

Introduction-Reasons for restructuring / deregulation of power industry-Understanding the restructuring process - Entities involved-The levels of competition-The market place mechanisms-Sector-wise-issues involved in deregulation-objectives of deregulation of various power systems across the world. Fundamentals of Economics -Consumer behavior-Supplier behavior- Market equilibrium, Short-run - Long-run costs, Various costs of production, Relationship between short-run - long-run average costs-Perfectly competitive market- Policies of restructured environment.

UNIT – II	MARKET MODELS AND TRANSMISSION CONGESTION MANAGEMENT	(9 Periods)

Market models based on contractual arrangements-Comparison of various market models-Electricity vis-à-vis other commodity - Four pillars of market design.- Market architecture-Definition of congestion-transfer capability limitation-Importance of congestion management in deregulated environment-features of congestion management schemes-Classification of congestion management methods-Calculation of ATC - Definition of various terms-ATC calculation using PTDF -LODF based on DC model-Calculation of ATC using AC model- Non-market methods- Market based methods- Nodal pricing- Inter-zonal- Intra-zonal congestion management-Price area congestion management- Capacity alleviation method.

UNIT – III	LOCATIONAL MARGINAL PRICES AND FINANCIAL TRANSMISSION RIGHTS	(9 Periods)

Mathematical preliminaries- Fundamentals of locational marginal pricing-Lossless DCOPF model for LMP calculation-Loss compensated DCOPF model for LMP calculation- ACOPF model for LMP calculation-Financial Transmission Rights-Risk Hedging Functionality Of financial Transmission Right-Simultaneous feasibility test -revenue adequacy-FTR issuance process-Treatment of revenue shortfall-Secondary trading of FTRs-Flow Gate rights-FTR -market power-FTR -merchant transmission investment.

UNIT – IV	ANCILLARY SERVICES AND TRANSMISSION PRICING	(9 Periods)

Introduction to ancillary services-Types of ancillary services-Classification of ancillary services, Load-generation balancing related services-Voltage control - reactive power support services-Black start capability service-Co-optimization of energy -reserve services, International comparison-Pricing of transmission network usage -loss allocation - transmission pricing-Principles of transmission pricing-Classification of transmission pricing method-Rolled-in transmission pricing methods- Marginal transmission pricing paradigm-Composite pricing paradigm-Merits -de-merits of different paradigms-Debated issues in transmission pricing- loss allocation-Classification of loss allocation methods -comparison.

UNIT – V	POWER MARKETS AND REFORMS IN INDIAN POWER SECTOR	(9 Periods)
Attributes of a perfectly competitive market-The firm's supply decision under perfect competition-Imperfect competition-Market power-Financial markets associated with electricity markets-optimal bidding by a generator company-Optimal bidding methods- Reforms in Indian power sector:Framework of Indian power sector-Reform initiatives during 1990-1995-Availability Based Tariff (ABT)-The Electricity Act 2003- Open Access issues-Powerexchange-Reforms in near future.		
Contact Periods: **Lecture:45 Periods Tutorial: 0Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	Kankar Bhattacharya, Jaap E. Daadler, Math H.J Bollen, "Operation of restructured power systems" , Kluwer Academic Pub., 2001.
2	Loi Lei Lai, "Power system Restructuring and Deregulation", John Wiley & sons, 2001

REFERENCES :

1	Sally Hunt, "Making competition work in electricity", John Wiley & Sons, Inc., 2002.
2	Shahidehpour M and Alomoush M, "Restructuring Electrical Power Systems", Marcel Decker Inc., 2001.
3	Daniel S. Kirschen and GoranStrbac, "Fundamentals of Power System Economics", John Wiley &SonsLtd., 2004.
4	Steven Stoft, " Power System Economics", Wiley – IEEE Press, 2002.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the new dimensions associated with the power systems with techno-commercial issues	K2
CO2	Apply various solutions for the commercial problems through study of fundamentals of micro economics	K3
CO3	Design power markets and market architectural aspects as per the restructuring of power system	K4
CO4	Identify operational challenges and manage the same with optimum solution	K5
CO5	Suggest reform practices in developing countries with special focus on Indian power system	K6

23PTE5E2	POWER QUALITY ENGINEERING	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To analyze the power quality issues in power systems and provide practical engineering solutions to mitigate the PQ problems	
UNIT – I	**INTRODUCTION TO POWER QUALITY PROBLEM**	**(9 Periods)**
Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non-linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.		
UNIT – II	**ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM**	**(9 Periods)**
Single phase linear and non-linear loads – single phase sinusoidal, non-sinusoidal source - supplying linear and nonlinear loads – three phase balanced system – three phase unbalanced system – three phase unbalanced and distorted source supplying nonlinear loads – concept of power factor – three phase- three wire – three phase - four wire system.		
UNIT – III	**MITIGATION OF POWER SYSTEM HARMONICS**	**(9 Periods)**
Introduction - Principle of Harmonic Filters – Series-Tuned Filters – Double Band-Pass Filters – damped Filters – Detuned Filters – Active Filters – Power Converters – Harmonic Filter Design – Tuned Filter – Second-Order Damped Filter – Impedance Plots for Filter Banks – Impedance Plots for a Three-Branch 33 kV Filter.		
UNIT – IV	**DSTATCOM**	**(9 Periods)**
Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced –Realization and control of DSTATCOM – DSTATCOM in Voltage control mode.		
UNIT – V	**SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM**	**(9 Periods)**
Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – Voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.		
Contact Periods: **Lecture: _45_ Periods Tutorial: _0__Periods Practical: _0_Periods Total: _45_ Periods**		

TEXT BOOK :

1	*Arindam Ghosh and GeradLedwich* ***"Power Quality Enhancement Using Custom Power Devices"****, Springer Publishers, First Edition,2009*
2	*George J. Wakileh,* ***"Power System Harmonics – Fundamentals, Analysis and Filter Design"****, Springer – Verlag Berlin Heidelberg, New York, 2019.*

REFERENCES :

1	*G.T.Heydt,* ***"Electric Power Quality"****, Stars in a Circle Publications, Second Edition, 2011.*
2	*R.C.Duggan* ***"Electric Power Systems Quality"****, Tata MC Graw Hill Publishers, Third Edition, 2012.*
3	*Arrillga****"Power System Harmonics"****, John Wiely and Sons, 2003 2nd Edition.*
4	*Derek A.Paice****"Power Electronic Converter Harmonics"*** *IEEE Press, 1995, Wiley – IEEE Press 1999, 18th Edition.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Illustrate the importance of power quality and differentiate various power quality issues	K2
CO2	Explain the various concepts related with linear / nonlinear loads and single phase / three phase sinusoidal, non-sinusoidal sources.	K2
CO3	Identify the sources of harmonics and choose the methods for controlling the harmonic distortion	K3
CO4	Analyze load compensation with DSTATCOM	K4
CO5	Illustrate the role of DVR, SAFs UPQC in power distribution systems	K2

23PTE5E3	POWER SYSTEM STABILITY	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To disclose the concept of transient and steady state stability, instability in power systems through the approaches of the steady state stability analysis and the transient stability analysis	
UNIT – I	**CONCEPT OF STABILITY**	**(9 Periods)**
Stability of power system – Simple two machine stability problems – Mechanical Analogy of powertransmission systems – Importance of stability to system operation and design – Effect of instability– Representation of power system components – Stability studies on network analysis		
UNIT – II	**STEADY STATE STABILITY ANALYSIS**	**(9 Periods)**
Introduction – Significance of steady state stability – Power limit of transmission system – Two machine system with negligible losses – Clarke diagram for two machine system with negligible losses – Power angle characteristic and steady state stability limit of salient pole synchronous machines– Two machine system with losses – Clarke diagram for two machine systems with resistance – Steady state stability with automatic voltage regulators.		
UNIT – III	**TRANSIENT STABILITY ANALYSIS - I**	**(9 Periods)**
General background - Swing equation for synchronous machine – Numerical solutions of Swing Equation – Multi machine stability – Factors affecting transient stability		
UNIT – IV	**TRANSIENT STABILITY ANALYSIS - II**	**(9 Periods)**
Concepts of equal area criterion – Application of equal area criterion to stability studies under faultconditions – Determination of critical clearing angle – Reduction of a power system to a single equivalent machine connected to infinite bus – Equivalent power angle curve of two finite machines – Graphical integral method of swing curve determination.		
UNIT – V	**EXCITATION SYSTEM AND ITS EFFECT ON STABILITY**	**(9 Periods)**
Introduction – Definition of terms – Quick response excitation systems – Compounding the excitation of generators – Modern trend in excitation systems – Voltage regulator capability to improve transient stability – Super-excitation for stability – Two axis excitation control – High initial response excitation systems – Exciter response - Determination by graphical integration – Point by point method of calculation.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	Gangadhar K.A "Power System Analysis and Stability" Khanna Publishers, New Delhi, 6th reprint 2004
2	Kimbark, "POWER SYSTEMS STABILITY", Volume - I,II,III, Wiley India Pvt. Limited 2007

REFERENCES :

1	P. Kundur, "Power System Stability and Control", Tata Mc Graw Hill, 3rd reprint, 2007.
2	M.A.Pai,K.Sengupta and K. R.Padiyar, Tata- McGraw hills."Small Signal Analysis of Power System", Alpha Science International, 2004
3	Paul M.Anderson and A.A. Fouad, "Power system Control and stability" IEEE Press, 2003.
4	Abdelhay A. Sallam, Om P. Malik, "Power System Stability - Modelling, Analysis and Control", Institution of Engineering and Technology, 2015

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Illustrate the modeling of a power system suitable for performing stability analysis.	K1
CO2	Analyze the stability of simple power systems using Analytical and graphical approaches.	K4
CO3	Apply computer simulation tools for stability analysis of large power systems.	K3
CO4	Apply and Evaluate control methods for tuning the turbine of voltage controllers in power system.	K5
CO5	Design and Evaluate the power system for stable operation.	K6

23PTE5E4	POWER SYSTEM ECONOMICS	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To impart knowledge on the economic principles underlying the operation and planning of the electricity systems including concepts of electricity markets and competition in electricity generation and supply and the opening of the transmission and distribution systems to third party access.	
UNIT – I	**POWER MARKET**	**(9 Periods)**
Structure and operation:- Objective of market operation, Electricity market models-Power market types-Market power-Key components in market operation. Demand - supply, Demand analysis – Theory,elasticity of demand, Demand forecasting –Types, techniques. Costs: Short run – Long run - Relationship between short run -long run costs, perfect competition – Monopoly-Monopolistic - Oligopolistic, Determination of market price, Price discrimination		
UNIT – II	**ELECTRICITY PRICE**	**(9 Periods)**
Price volatility-ancillary services in electricity power market-automatic generation control -its pricing, Generation assets valuation- risk analysis. -Introduction, VAR for Generation Asset Valuation, Generation Capacity Valuation.		
UNIT – III	**TRANSMISSION CONGESTION MANAGEMENT AND PRICING**	**(9 Periods)**
Transmission cost allocation methods- Local Marginal Price- Financial Transmission Right - Congestion Management- Role of Flexible AC Transmission System devices in competitive power market-Available Transfer Capability-Distributed Generation in restructured markets.		
UNIT – IV	**REACTIVE POWER MARKET MANAGEMENT**	**(9 Periods)**
Reactive power requirements under steady state voltage stability -dynamic voltage stability, reactive power requirements to cover transient voltage stability-System losses - loss reduction methods- Power tariffs - Market Forces shaping of reactive power- reactive power requirement of the utilities.		
UNIT – V	**RELIABILITY ANALYSIS OF GENERATION SYSTEM**	**(9 Periods)**
Characteristic operation of power plants - Choice of power plants - Hydro, Thermal - Nuclear - Size of plant – Input / Output curves. Economic Planning - Generation system - Cost analysis - Capacity cost -Production cost - Plant cost - Timing of unit additions - System cost analysis.Load forecasting -system reliability : Load forecasting - Generation system reliability - Co-ordination methods - Economic operation of power systems - Simple problems.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	Kirchmayer E. K "Economic Operation of Power Systems" John Wiley and sons, New Delhi, vol.1,2, 2009
2	Elgerd O.I "Electric Energy System Theory an Introduction" Tata McGraw Hill, New Delhi, 2008

REFERENCES : -

1	Turner,Wayne.C., "Energy Management" Hand Book.,2nd Edition, 2018
2	RR Barathwal- Professor IIT Kanpur ."Industrial Economics-an Introductory text book", New Age International,2007
3	S.K.Jain,"Applied economics for Engineers and Managers", Vikas Publishing House, 1997
4	D.M.Tagare, " Series on Electrical Power Capacitors Reactive Power Management", Madhav Electricals, Pune, Tata McGraw Hill Publishing Company Ltd.

COURSE OUTCOMES: - Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Elaborate the principles of power system economics	K2
CO2	Apply market/managerial economic aspects	K3
CO3	Illustrate the social efficiency concepts.	K2
CO4	Analyze power systems with application of economics considerations	K5
CO5	Assess electric power system for socio-economic standpoint	K5

23PTE6E1	BIOMEDICAL INSTRUMENTATION	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To understand the basics of human physiology and learn the operating principle of necessary Instrumentation associated with it	
UNIT – I	**PHYSIOLOGY**	**(9 periods)**
Cell and its structure – Resting and action potential – Propagation of action potentials – The heart and cardiovascular system - Electrophysiology of cardiovascular system – Physiology of the respiratory system – Nervous system - Central nervous system and Peripheral nervous system – Electrode theory – Bio-potential electrodes - Transducers for biomedical applications.		
UNIT – II	**ELECTRO PHYSIOLOGICAL MEASUREMENT**	**(9 periods)**
ECG – Vector cardiographs – EEG – EMG – ERG – EOG – Lead system and recording methods – Typical waveforms. Electrical safety in medical environment, shock hazards– leakage current- Instruments to protect against electrical hazards.		
UNIT – III	**NON- ELECTRICAL PARAMETER MEASUREMENTS**	**(9 periods)**
Measurement of blood pressure, blood flow and cardiac output – Plethysmography – Measurement of heart sounds – Gas analysers – Blood gas analysers – Oximeters.		
UNIT – IV	**MEDICAL IMAGING AND TELEMETRY**	**(9 periods)**
X-ray machine – Echocardiography – Computer tomography – MRI – Diagnostic ultrasound – PET – SPECT – Electrical impedance tomography – Thermograph – Biotelemetry.		
UNIT – V	**ASSISTING AND THERAPEUTIC DEVICE**	**(9 periods)**
Pacemakers – Defibrillators – Ventilator – Anaesthesia machine – Nerve and muscle stimulator – Heart lung machine – Kidney machine – Audiometers – Diathermy –Endoscopes – Lasers in biomedicine.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS :

1	*Leslie Cromwell "**Biomedical Instrumentation and Measurement**" PHI, New Delhi, 2007.*
2	*Khandpur. R.S "**Handbook of Biomedical Instrumentation**" 2nd edition, Tata McGraw Hill, 2011.*

REFERENCES :

1	*Joseph J Carr and John M.Brown,* ***"Introduction to Biomedical Equipment Technology"****, John Wiley and sons, New York, 4th edition, 2012*
2	*John G. Webster,* ***"Medical Instrumentation Application and Design"****, John Wiley and sons,New York, 2009.*
3	*Ed. Joseph D. Bronzino****"The Biomedical Engineering Handbook"*** *Third Edition, BocaRaton, CRC Press LLC, 2014.*
4	*M.Arumugam,* ***"Bio-Medical Instrumentation"****, Anuradha Agencies, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Determine the physical foundations of biological systems	K3
CO2	Realize the various electro physiological measurements in the human body.	K2
CO3	Acquire knowledge on the measurement of non-electrical parameters in the human body.	K2
CO4	Analyze the various medical imaging techniques and their applications.	K3
CO5	Apply the concepts on the working of medical assisting and therapy equipment	K3

23PTE6E2	THERMAL POWER PLANT INSTRUMENTATION	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To impart knowledge on the process variables, measurements and control loops used in thermal power plants.	
UNIT – I	**METHODS OF POWER GENERATION**	**(9 Periods)**
Methods of Power Generation: Hydro, Thermal, Nuclear, Solar and Wind – Importance of Instrumentation in Power Generation – Basic Building Block for all Types of Power Generation Plants - Details of Boiler Processes – P and I Diagram of Boiler - Cogeneration.		
UNIT – II	**MEASUREMENTS IN POWER PLANTS**	**(9 Periods)**
Measurement of Feed Water Flow, Air Flow, Steam Flow and Coal Flow – Drum Level Measurement – Temperature Measurement- Steam Pressure Measurement.		
UNIT – III	**ANALYZERS IN POWER PLANTS**	**(9 Periods)**
Analysis of Impurities in Feed Water and Steam - Oxygen Analyzer - Dissolved Oxygen Analyzer - Chromatography - pH Meter - Fuel Analyzer - Flue Gas Analyzer – Pollution Monitoring Instruments.		
UNIT – IV	**CONTROL LOOPS IN BOILER**	**(9 Periods)**
Combustion Control: Air/Fuel Ratio Control, Furnace Draft Control - Drum Level Control - Main Steam and Reheat Steam Temperature Control - Superheater Control - Attemperator – Deaerator Control - Interlocks in Boiler Operation - Distributed Control System in Power Plants.		
UNIT – V	**TURBINE AND ITS CONTROL**	**(9 Periods)**
Types of Steam Turbines: Impulse and Reaction Turbines – Compounding – Turbine Governing System– – Free Governor Mode Operation – Turbine Run up System – Turbine Speed and Vibration Measurement - Speed Control - Automatic Load Frequency Control – Safety Control System - Turbo Alternator lubrication and Cooling System.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	***Sam Dukelow, "Control of Boilers", Instrument Society of America, 2nd Edition, 1991.***
2	*Krishnaswamy, K. and Ponnibala.M, "**Power Plant Instrumentation**", PHI Learning Pvt. Ltd., New Delhi, 2nd Edition, 2014*

REFERENCES

1	*Liptak B.G, "**Instrumentation in Process Industries**", Chilton Book Company, 2005.*
2	*Jain R.K, "**Mechanical and Industrial Measurements**", Khanna Publishers, New Delhi, 11th Edition, 1999.*
3	*Gill.A.B, "**Power Plant performance**", Butterworth and Co (Publishers) Ltd, 2003.*
4	*David Lindsley, "**Boiler Control Systems**", Mc-Graw Hill, 1991.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the different methods of generating power	K2
CO2	Select suitable instruments for various process measurements in power plants	K2
CO3	Describe the operation of different analysers used in power plants	K2
CO4	Analyze the control strategies implemented in different stages of power plant	K3
CO5	Elaborate on the types of turbines, their related measurements and control	K2

23PTE6E3	NEURAL AND FUZZY SYSTEMS	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To apply the intelligent human characters such as generalization, learning and vagueness in artificial intelligent systems for the betterment of Engineering	
UNIT – I	**INTRODUCTION TO NEURAL NETWORKS**	**(9 Periods)**
Introduction – Biological and Artificial neural networks - Learning rules – Training - ADALINE - MADALINE – BAM – Discrete Hopfield networks.		
UNIT – II	**ARTIFICIAL NEURAL NETWORKS**	**(9 Periods)**
Theory, Architecture and Applications of Back propagation network – Counter propagation network – Kohenen's Self Organising Maps.		
UNIT – III	**INTRODUCTION TO FUZZY LOGIC**	**(9 Periods)**
Fuzzy sets and membership – Chance Vs ambiguity – Classical sets – Fuzzy sets – Fuzzy relations –Tolerance and Equivalence relations – Value assignments.		
UNIT – IV	**FUZZIFICATION AND DEFUZZIFICATION**	**(9 Periods)**
Fuzzification – Membership value assignments – Fuzzy to Crisp conversions - Lambda – Cuts for Fuzzy sets and relations – Defuzzification methods		
UNIT – V	**FUZZY ARITHMETIC, NUMBERS, VECTORS AND EXTENSION PRINCIPLE**	**(9 Periods)**
Extension principle – Fuzzy numbers – Interval analysis in arithmetic – Approximate methods of extension: Vertex method, DSW algorithm, Restricted DSW algorithm – Fuzzy vectors – Classical predicate logic – Approximate reasoning – Fuzzy tautologies, contradictions, Equivalence and Logical proofs.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	***LaureneFausett "Fundamentals of Neural Networks" Prentice Hall, New Jersey, 2004***
2	*S.Rajasekaran, G.A.VijayalakshmiPai"**Neural Networks, Fuzzy Logic and Evolutionary Algorithm: Synthesis and Applications"** PHI Learning Pvt. Ltd., 2017*

REFERENCES :

1	Robert .J.Schalkoff,"**Artificial Neural Networks**", McGraw Hill, Singapore, 2011
2	*Driankov D., Helledorn H., M.Reinframe, "**An Introduction to fuzzy control**", Narosa Publishing Co., New Delhi, 1996*
3	*Kosko.B, "**Neural Network and fuzzy systems**"- Prentice Hall of India Pvt. Ltd., New Delhi, 2007*
4	*Fakhreddine O. Karray and Clarence De Silva., **"Soft Computing and Intelligent Systems Design, Theory, Tools and Applications",** Pearson Education, India, 2009*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explore the methods of training of Artificial Intelligent systems	K2
CO2	Able to implement human intelligent concepts in AI.	K3
CO3	Methods to formulate the input and to evaluate the output of the AI systems.	K4
CO4	Learning the different architectures and able to differentiate them	K3
CO5	Select suitable AI technique for engineering applications	K3

23PTE6E4	OPTIMIZATION TECHNIQUES AND APPLICATIONS	SEMESTER : VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To formulate the mathematical models, Engineering design methodology and perform quantitative analysis of managerial problems in industries.	
UNIT – I	**LINEAR PROGRAMMING**	**(9 Periods)**
Introduction – formulation of linear programming model-Graphical solution–solving LPP using a simplex algorithm – Revised Simplex Method.		
UNIT – II	**ADVANCEDLINEAR PROGRAMMING**	**(9 Periods)**
Duality theory- Dual simplex method – Sensitivity analysis–-Transportation problems–Assignment problems - Travelling sales man problem -Data envelopment analysis.		
UNIT – III	**NONLINEAR PROGRAMMING**	**(9 Periods)**
Classification of Non-Linear programming – Lagrange multiplier method – Karush – Kuhn Tucker conditions–Reduced gradient algorithms–Quadratic programming method – Penalty and Barrier method.		
UNIT – IV	**INTERIOR POINT METHODS**	**(9 Periods)**
Karmarkar's algorithm–Projection Scaling method–Dual affine algorithm–Primal affine algorithm Barrier algorithm.		
UNIT – V	**DYNAMIC PROGRAMMING**	**(9 Periods)**
Formulation of Multi-stage decision problem–Characteristics–Concept of sub-optimization and the principle of optimality–Formulation of Dynamic programming–Backward and Forward recursion– Computational procedure–Conversion of final value problem into Initial value problem.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical:0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*G. Sreenivasan, "**Operations Research: Principles and Applications**", PHI,2017*
2	*Hillier and Lieberman "**Introduction to Operations Research**", TMH, 2017*

REFERENCES :

1	*R.Panneerselvam, "**Operations Research**", PHI, 2016*
2	*HamdyATaha, "**Operations Research –An Introduction**", Prentice Hall India, 2016.*
3	*Philips, Ravindran and Solberg, "**Operations Research**", John Wiley, 2007.*
4	*Ronald L.Rardin, "**Optimization in Operation Research**" Pearson Education Pvt. Ltd. New Delhi, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the basic concepts of optimization techniques.	K2
CO2	Illustrate the basics and advancements in Linear programming techniques	K2
CO3	Observe the significance of non-linear programming techniques and suitable techniques to solve real world problem	K2
CO4	Compute the solutions foroptimisation problems using interior point methods.	K3
CO5	Develop dynamic programming problems and evaluate its solution methods	K5

23PTE7E1	AUTOMOTIVE ELECTRONICS FOR ELECTRICAL ENGINEERING

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To explore the role of electronic systems, in-vehicle networking and comfort/safety in automotive control applications.	
UNIT – I	**FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS**	**(9 Periods)**
Evolution of electronics in automobiles, emission laws, introduction to Euro standards, equivalent Bharat standards, Charging systems: Working and design of charging circuit, alternators, requirements of starting system, starter motors and starter circuits.		
UNIT – II	**IGNITION AND INJECTION SYSTEMS**	**(9 Periods)**
Ignition systems: Ignition fundamentals, Electronic Ignition system, programmed ignition, distribution less ignition, direct ignition, spark plugs, Electronic fuel control, basics of combustion, engine fuelling and exhaust emission, electronic control of carburetion, petrol fuel injection, diesel fuel injection.		
UNIT – III	**SENSORS AND ACTUATORS**	**(9 Periods)**
Working principle and characteristics of airflow rate, engine crankshaft angular position, hall effect, throttle angle, temperature, exhaust gas oxygen sensors. Fuel injector, exhaust gas recirculation actuators, stepper motor actuator and vacuum operated actuator.		
UNIT – IV	**ENGINE CONTROL SYSTEM**	**(9 Periods)**
Control modes for fuel control, engine control subsystems, ignition control methodologies, different ECUs used in engine management. Vehicle networks: CAN standard. Diagnostic systems in modern automobiles		
UNIT – V	**CHASSIS AND SAFETY SYSTEMS**	**(9 Periods)**
Traction control system, cruise control system, electronic control of automatic transmission, antilock braking system, electronic suspension system, working of airbag, centralized door locking system, climate control of cars.		
Contact Periods: **Lecture:45 Periods Tutorial:0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Tom Denton, "**Automobile Electrical and Electronic Systems**", Arnold Publishers, fifth Edition 2017.*
2	*William B Ribbens, "**Understanding Automotive Electronics**", Eighth Edition, Newness Publishers, 2017*

REFERENCES :

1	*V A W Hillier "**Fundamentals of Automotive Electronics**", OUP Oxford, Second Edition 2012.*
2	*Ronald K Jurgen, "**Automotive Electronic Handbook**", McGraw Hill, Second Edition, 1999.*
3	*Robert Bosch, "**Automotive Electrics and Automotive Electronics**", Springer, Fifth Edition,2014.*
4	*Bogdan M. Wilamowski, J. David Irwin "**The Industrial Electronics Handbook**", CRC Press ,second edition,2011*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Perceive the electronics involved in automotive systems	K2
CO2	Outline the fundamentals involved in ignition systems	K2
CO3	Choose appropriate sensors for automobiles based on applications	K3
CO4	Implement simple and safe control systems in automobiles	K5
CO5	Analyze the safety issues that occur in automotive systems	K4

23PTE7E2	LOGIC AND DISTRIBUTED CONTROL SYSTEMS

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To study the fundamentals of PLC, exploring the intermediate and advanced functions, design and analysis of DCS with communication standards.	
UNIT – I	**BASICS OF PROGRAMMABLE LOGIC CONTROLLER**	**(9 Periods)**
Definition – Overview of PLC systems – Input and output modules – Power supplies – Isolators – General PLC programming procedures – Programming on-off outputs – Auxiliary commands and functions – Creating ladder diagrams from process control descriptions – Register basics – Timer functions – Counter functions		
UNIT – II	**PLC INTERMEDIATE AND ADVANCED FUNCTIONS**	**(9 Periods)**
Arithmetic functions – Number comparison functions – Skip and MCR functions – Data move systems – PLC advanced intermediate functions – Utilizing digital bits – Sequencer functions – Matrix functions – Alternate programming languages – Analog PLC operation – Networking of PLC – PID control of continuous processes – PLC installation – Troubleshooting and maintenance – Controlling a Robot		
UNIT – III	**INTERFACE AND BACKPLANE BUS STANDARDS**	**(9 Periods)**
Field bus: Introduction – Concept – International field bus standards – HART protocol: Method of operation – Structure – Operating conditions – Applications – Foundation Field bus - Profibus.		
UNIT – IV	**DISTRIBUTED CONTROL SYSTEMS OPERATION**	**(9 Periods)**
Evolution of DCS – Building blocks – Detailed descriptions and functions of field control units – Process – Interfacing issues - Operator stations– Data highways – Redundancy concepts.		
UNIT – V	**COMMUNICATION IN DCS**	**(9 Periods)**
DCS – Supervisory computer tasks and configuration – System Integration with PLC and computers - Special requirement of networks used for control – Protocols – Link access mechanisms – Manufacturers automation protocols – Case studies in DCS.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXTBOOK:

1	*John. W. Webb and Ronald A. Reis* ***"Programmable Logic Controllers–Principles and Applications"*** *4th Ed, Prentice Hall Inc., New Jersey, 5thEd. 2002.*
2	*Frank D. Petruzella* ***"Programmable Logic Controllers"*** *Tata McGraw Hill Book Company Book, third Ed. 2010.*

REFERENCES:

1	*Krishna Kant,* ***"Computer-based Industrial Control"****, Prentice Hall of India, 10th Printing 2009.*
2	*Curtis D. Johnson,* ***"Process control Instrumentation Technology"****, 8th Ed. Pearson Education 2006.*
3	*Bela. G. Lipkak,* ***"Process software and digital networks – vol 3"****, CRC press,4th edition ,2012.*
4	*Lukcas M.P* ***"Distributed Control Systems"*** *Van Nostrand Reinhold Company, New York, 1986.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain different Bus Standards	K2
CO2	Identify Network, Protocol and link mechanism required for a given control application	K2
CO3	Develop ladder diagrams for basic control applications using PLC	K3
CO4	Implement various advanced functions and controllers using PLC	K3
CO5	Construct distributed process controller using PLC	K3

23PTE7E3	DIGITAL SIGNAL PROCESSING AND PROCESSORS

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To emphasize intuitive understanding of the concepts of Digital Signal Processing, design FIR and IIR Filters, insist knowledge on DSP processors for practical applications.	
UNIT – I	**DISCRETE TIME LINEAR SYSTEMS**	**(9 Periods)**
Discrete Linear systems – Time invariance –Causality, Stability, Difference Equations-Transfer functions of linear discrete systems – Impulse, step and frequency response – Linear and circular convolution- Recursive and non-recursive filters – Digital filter realization – Direct, Canonic, Cascade, Parallel and ladder realizations.		
UNIT – II	**TRANSFORMATIONS IN DSP**	**(9 Periods)**
Discrete Fourier Transform – Properties – IDFT- Convolution: Linear and Circular-Fast Fourier Transform: Introduction to Radix- 2 FFT – Properties – Decimation in time – Decimation in frequency – Computation of IDFT using DFT.		
UNIT – III	**IIR DIGITAL FILTERS**	**(9 Periods)**
Approximation of analog filters – Butterworth -Chebyshev – Properties of IIR filter – IIR filter design-Bilinear transformation and Impulse invariance method – Digital transformation.		
UNIT – IV	**FIR DIGITAL FILTERS**	**(9 Periods)**
Characteristics of FIR filter - Frequency response of linear phase FIR filter - Design of FIR filter – Fourier series method–Window function- Rectangular, Kaiser and Bartlett window methods.		
UNIT – V	**DIGITAL SIGNAL PROCESSOR**	**(9 Periods)**
dsPIC30F4011 – Architecture - MCU and DSP features - Hardware DMA - Interrupt Controller - Digital I/O, On-chip Flash, Data EE and RAM - Peripherals - Timers, Communication Modules Motor Control Peripherals - Capture/Compare/PWM, Analog-to-Digital Converters		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	B.Venkataramani, M.Bhaskar, ***"Digital Signal Processors – Architecture, Programming and Applications"***, Tata McGraw Hill, Revised Edition, 2017.
2	C. Ramesh BabuDurai, ***"Digital Signal Processing"***, Tata McGraw Hill, Reprint, 2018.

REFERENCES :

1	John.G.Proakis, Dimitrias.G. and Manolakis. "DSP Principles Algorithms and Applications", Prentice Hall of India – Fourth Edition, 2014
2	Emmanuel C.Ifeachor, University of Plymouth. Barrie.W.Jervis, Sheffield Hallam University, "Digital Signal Processing. A Practical Approach", Pearson Education, II Edition, 2015.
3	SanjitK.Mitra, "Digital Signal Processing: A computer Based approach" Tata Mc Graw Hill, Fourth Edition, 2014
4	FarzadNekoogar, Gene moriarty. "Digital Control Using Digital Signal Processing" P.H. International Inc. New Jersey.2012.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Classify the digital signals and systems and perform filter realizations.	K2
CO2	Develop the ability to execute various transformations for DSP	K3
CO3	Design digital IIR filters	K3
CO4	Design digital FIR filters	K3
CO5	Explain the DSP processor and analyze it for practical applications	K4

23PTE7E4	PRINCIPLES OF VIRTUAL INSTRUMENTATION

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To understand the Virtual instrumentation concepts for measurements and control.	
UNIT – I	**OVERVIEW OF VIRTUAL INSTRUMENTATION**	**(9 Periods)**
Introduction - Block diagram and architecture of a virtual instrument - Conventional Instruments versus Virtual Instruments – Data flow techniques, graphical programming in data flow, comparison with conventional programming		
UNIT – II	**PROGRAMMING TECHNIQUES**	**(9 Periods)**
Front panel - Block diagram - VIs - Sub-VIs - Simple examples - Looping: For loop, while loop - Shift registers - case and sequence; structures, formula nodes. Arrays - Clusters, charts and graphs - Local and global variables - Property node, string and file I/O. publishing measurement data on the web		
UNIT – III	**DATA ACQUISITION**	**(9 Periods)**
DAQ – Components - Buffers - Triggering - Analog I/O - Digital I/O - Counters and timers - DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements		
UNIT – IV	**INSTRUMENT CONTROL**	**(9 Periods)**
VI Chassis requirements. Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, compact RIO - Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office - Industrial applications, VISA and IVI		
UNIT – V	**APPLICATION OF VIRTUAL INSTRUMENTATION**	**(9 Periods)**
VI toolsets, Distributed I/O modules Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Sanjay Gupta and Joseph John "**Virtual Instrumentation using LabVIEW**" Tata McGraw-Hill, Second Ed. 2017*
2	*Jovitha Jerome "**Virtual Instrumentation Using LabVIEW**" PHI Learning Pvt. Ltd 1st Ed., 2010*

REFERENCES :

1	*Lisa K Wells and Jeffrey Travis, "**Labview for everyone**", Prentice Hall, 3rd Ed. 2009*
2	*BehzadEhsani**, "Data Acquisition Using LabVIEW",Ingram short title,**2016***
3	*Gary Johnson, Richard Jennings "**Lab view graphical programming**", Tata McGraw Hill, 2011*
4	Stephen Philip Tubbs**, "LabVIEW for Electrical Engineers and Technologists",** 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concepts of virtual instrumentation	K2
CO2	Constructasimple measurement system using LABVIEW programs	K3
CO3	Demonstrate the program in LabVIEW for system monitoring, processing and controllingoperations	K4
CO4	Examine the interfacing and programming using related hardware	K4
CO5	Develop real-time applications using LabVIEW	K6

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23PTE7E5	SMART GRID TECHNOLOGY

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To provide a comprehensive understanding of Smart Grid Technology, including its components, functions, applications and implications for Energy Management and Distribution.	
UNIT – I	**BASICS OF POWER SYSTEMS**	**(9 Periods)**
Basics of Power Systems: Load and Generation - Power Flow Analysis- Economic Dispatch and Unit Commitment Problems. Smart Grid: Definition – Applications- Government and Industry-Standardization		
UNIT – II	**SMART GRID COMMUNICATIONS**	**(9 Periods)**
Two-way Digital Communications Paradigm - Network Architectures - IP-based Systems - Power Line Communications - Advanced Metering Infrastructure		
UNIT – III	**WIDE AREA MEASUREMENT**	**(9 Periods)**
Sensor Networks - Phasor Measurement Units- Communications Infrastructure- Fault Detection andSelf-Healing Systems -Applications and Challenges		
UNIT – IV	**SECURITY AND PRIVACY**	**(9 Periods)**
Cyber Security Challenges in Smart Grid - Load Altering Attacks- False Data Injection Attacks-Defense Mechanisms - Privacy Challenges- Cyber Security Standards		
UNIT – V	**ECONOMICS AND MARKET OPERATIONS**	**(9 Periods)**
Introduction, Reasons for restructuring / deregulation of power industry, Understanding the restructuring process - Entities involved. The market place mechanisms-Energy and Reserve Markets- Market Power - Generation Firms- Locational Marginal Prices- Financial TransmissionRights		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*JanakaEkanayake, Nick Jenkins, KithsiriLiyanage "***Smart Grid Technologies and applications"** *John Wiley Publishers Ltd., 2012.*
2	*P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan "***Electrical Power Systems- Analysis, Security and Deregulation"** *PHI Learning Private Limited, New Delhi, 2012.*

REFERENCES :

1	*Lars T. Berger, Krzysztof Iniewski "***Smart Grid applications, Communications and Security***" John Wiley Publishers Ltd., 2012.*
2	*Yang Xiao,* **"Communication and Networking in Smart Grids",** *CRC Press Taylor and Francis Group, 2012.*
3	*Caitlin G. Elsworth,* **"The Smart Grid and Electric Power Transmission"***, Nova Science Publishers Inc, August 2010*
4	*Lars T. Berger, Krzysztof Iniewski "***Smart Grid applications, Communications and Security***" John Wiley Publishers Ltd., 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recollect the fundamentals of conventional power systems and learn the concept of smart grid	K1
CO2	Interpret the role of communication Technologies in a smart grid	K2
CO3	Apply the state-of-the-art measurement and protection techniques for reliable grid	K3
CO4	Utilize the techniques for ensuring safety and security of the smart grid	K3
CO5	Analyze the economical aspects of the smart grids	K4

23PTE7E6	ENERGY STORAGE TECHNOLOGY

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To explore the fundamentals, technologies and applications of energy storage system.	
UNIT – I	**HISTORICAL PERSPECTIVE OF ENERGY STORAGE SYSTEM**	**(9 Periods)**
Storage Needs - Variations in Supply and energy demand Interruptions in Energy Supply- Transmission Congestion - Demand for Portable Energy-Demand and scale requirements - Environmental and sustainability issues.		
UNIT – II	**CLASSIFICATION OF STORAGE SYSTEM**	**(9 Periods)**
Introduction: Energy and Energy Transformations, Potential energy (pumped hydro, compressed air, springs)- Kinetic energy (mechanical flywheels)- Thermal energy without phase change passive (adobe) and active (water)-Thermal energy with phase change (ice, molten salts, steam)- Chemical energy (hydrogen, methane, gasoline, coal, oil)- Electrochemical energy (batteries, fuel cells)- Electrostatic energy (capacitors), Electromagnetic energy (superconducting magnets)- Different Types of Energy Storage Systems.		
UNIT – III	**PERFORMANCE FACTORS OF ENERGY STORAGE SYSTEMS**	**(9 Periods)**
Energy capture rate and efficiency- Discharge rate and efficiency- Dispatch ability and load flowing characteristics, scale flexibility, durability – Cycle lifetime, mass and safety – Risks of fire, explosion, toxicity- Ease of materials, recycling and recovery- Environmental consideration and recycling , Merits and demerits of different types of Storage. Comparison of Storage Technologies- Technology options- Performance factors and metrics- Efficiency of Energy Systems- Energy Recovery		
UNIT – IV	**BATTERY AND THERMAL ENERGY STORAGE SYSTEMS**	**(9 Periods)**
Battery Storage System: Lead Acid and Lithium- Chemistry of Battery Operation, Power storage calculations, Charging patterns, Battery Management systems -Areas of Application of Energy Storage: Waste heat recovery- Solar energy storage- Greenhouse heating-Power plant applications-Drying and heating for process industries, energy storage in automotive applications in hybrid and electric vehicles.		
UNIT – V	**HYDROGEN FUEL CELLS AND FLOW BATTERIES**	**(9 Periods)**
Hydrogen Economy and Generation Techniques, Storage of Hydrogen, Energy generation - Super capacitors: properties, power calculations – Operation and Design methods - Hybrid Energy Storage: Managing peak and Continuous power needs, Hybrid energy storage: battery and supercapacitor combination, need, operation and Merits; Flow Battery operation- Applications: Storage for Hybrid Electric Vehicles-Regenerative Power-capturing methods.		
Contact Period: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*DetlefStolten,* **"Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications"***, Wiley, 2014.*
2	*Jiujun Zhang, Lei Zhang,Hansan Liu, Andy Sun, Ru-Shi Liu***, "Electrochemical Technologies",** 2012.

REFERENCES :

1	*Francois Beguin and ElzbietaFrackowiak,* **"Super capacitors"***, Wiley, 2015.*
2	*Doughty Liaw, Narayan and Srinivasan,* **"Batteries for Renewable Energy Storage"***, The Electrochemical Society, New Jersy, 2016.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge on the evolution and technologies of energy storage systems	K2
CO2	Summarize the basics of different energy storage mechanisms.	K2
CO3	Evaluate the performance factors of energy storage systems.	K5
CO4	Identify the field of applications for renewable energy systems.	K4
CO5	Explore the possibilities of hybrid energy storage techniques and applications.	K3

23PTE7E7	MICROGRID TECHNOLOGY

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To study the theory of distributed generations, operation, control and protection of microgrids	
UNIT – I	**DISTRIBUTED GENERATION**	**(9 Periods)**
Renewable sources in distributed generation – Current scenario in India – DG:Siting and sizing - Optimal placement of DG sources in distribution systems-Standards for interconnecting Distributed resources to electric power systems: IEEE 1547		
UNIT – II	**DISTRIBUTED GENERATION IN MICROGRID**	**(9 Periods)**
Solar Photovoltaic system : Types of Solar cells - characteristics of solar PV module -MPPT techniques - Wind power generation:Power available in wind- Classification - wind generators-MPPT techniques. Fuel cells: types- working principle of hydrogen fuel cells –applications.		
UNIT – III	**GRID INTEGRATION OF DGs AND ENERGY STORAGE SYSTEMS**	**(9 Periods)**
Grid integration and stand alone operation of DG– Energy storage system: need for energy storage in Microgrid- working and characteristics of Batteries, ultra-capacitors and flywheels energy storage systems-Life Cycle Assessment		
UNIT – IV	**OPERATION OF MICROGRID**	**(9 Periods)**
Microgrids :Concept and Structure-Operation Modes: Grid connected and stand alone operation -power electronic converter topologies: DC-DC converters- Grid connected converter-Hierarchical Microgrid Control: Local,secondary and Global and Droop Control -Structure and operation of AC,DC and hybrid microgrids -		
UNIT – V	**PROTECTION AND COMMUNICATION IN MICROGRID**	**(9 Periods)**
Protection of microgrids - Power quality issues in microgrids- Stability issues in microgrids - Introduction to interconnection of microgrids and Centralized and Decentralized Energy Management -Communication: objectives and requirements - Local,Field,Wide,Neighbourhood, Home area networks - Wireless communication :ZigBee,Wireless local area network and Z-wave -Protocols:IEC 61850 and Modbus		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	***G.D. Rai, "Non Conventional energy Sources", Khanna Publications , New Delhi ,Sixth Edition ,2017***
2	***N.M.Tabatabaei, E.Kabalci and N.Bizon,"MicrogridArchitectures,Control and Protection Methods"Springer,2020.***
3	***Bevrani.H,Francois.B and Ise.T, "Microgrid Dynamics and Control",JohnWiley& Sons, Inc,2017***

REFERENCES :

1	*Loi Lei Lai, Tze Fun Chan,* **"Distributed Generation- Induction and Permanent Magnet Generators"***, IEEE Press, John Wiley & Sons, Ltd., England. 2007.*
2	*John Twidell and Tony Weir,* **"Renewable Energy Resources"***, Taylor and Francis Publications, Fourth edition 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge on the concept of distributed generation in a power system	K2
CO2	Gain comprehension ofvarious distributed energy Resources	K2
CO3	Evaluate the technical impacts of DG's in power systems and energy storage technologies.	K5
CO4	Understand theconcepts and modeling of DC and AC microgrids	K2
CO5	Analyze the modes of operation and performance of micro grids	K4

23PTE7E8	MEMS AND NEMS

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To introduce the concepts of micro and nanoelectromechanical devices. To learn the fabrication process of MEMS for the design of MEMS devices	
UNIT – I	**INTRODUCTION TO MEMS AND NEMS**	**(9 Periods)**
Introduction to Design of MEMS and NEMS, Overview of Nano and Microelectromechanical Systems, Applications of Micro and Nanoelectromechanical systems, Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals.		
UNIT – II	**MEMS FABRICATION TECHNOLOGIES**	**(9 Periods)**
Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, Sputtering Etching techniques, Micromachining: Bulk Micromachining, Surface Micromachining, LIGA.		
UNIT – III	**MICROSENSORS**	**(9 Periods)**
MEMS Sensors: Design of Acoustic wave sensors, Vibratory gyroscope, Capacitive Pressure sensors, Case study: Piezoelectric energy harvester		
UNIT – IV	**MICRO ACTUATORS**	**(9 Periods)**
Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces, Case Study:RF Switch.		
UNIT – V	**NANODEVICES**	**(9 Periods)**
Atomic Structures and Quantum Mechanics, Schrodinger Equation, ZnOnanorods based NEMS device: Gas sensor.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Sergey Edward Lyshevski, "**MEMS and NEMS: Systems, Devices, and Structure"** CRC Press, 2002, (ebook 2018)*
2	*Chang Liu "**Foundations of MEMS**" Prentice Hall, 2012*

REFERENCES :

1	*Tai Ran Hsu, "**MEMS and Microsystems Design and Manufacture**", TMH, VII Reprint, 2012*
2	*Marc Madou "**Fundamental of Microfabrication**" CRC Press,3rd Ed, 2011*
3	*Gad-El-Hak, **"MEMS Handbook,"** CRC Press, 2005.*
4	*NitaigourPremchandMahalik, "**MEMS**",TMH, I Reprint, 2009*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Illustrate the basics of micro/nanoelectromechanical systems	K2
CO2	Recognize the material properties of MEMS performance	K2
CO3	Demonstrate the MEMS fabrication process	K3
CO4	Develop models and simulate sensors and actuators	K5
CO5	Recall the foundation of nanodevices	K1

23PTE8E1	INTELLIGENT CONTROL OF ELECTRIC VEHICLES	SEMESTER VIII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To design and derive the mathematical model of a BLDC motor and its characteristics and to learn the different control schemes for BLDC motor and implement in Fuzzy/FPGA.	
UNIT – I	**ANALYSIS OF BLDC MOTOR**	**(9 Periods)**
Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations. Characteristic Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients.		
UNIT – II	**CONTROLLERS FOR BLDC MOTOR**	**(9 Periods)**
Introduction -PID Control Principle, Anti-windup Controller, Intelligent Controller - Fuzzy Logic- Control applied to BLDC motor		
UNIT – III	**FPGA ARCHITECTURE**	**(9 Periods)**
Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7.		
UNIT – IV	**FPGA PROGRAMMING**	**(9 Periods)**
VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs : arithmetic, sorting, PWM generation, Speed detection, Speed Control.		
UNIT – V	**REAL TIME IMPLEMENTATION**	**(9 Periods)**
Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of BLDC motor using FPGA- Introduction to Battery Management System in EV.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

TEXT BOOK:

1	*John G. Hayes, G. Abas Goodarzi,* ***Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles****, Wiley 1st Edition 2018.*
2	*JayaramBhasker,* ***VHDL Primer****, (3rd Edition), Prentice Hall, 1 st Edition 2015.*

REFERENCES :

1	*Iqbal Hussain, "****Electric and Hybrid Vehicles: Design Fundamentals, Third Edition****" CRC Press, Taylor & Francis Group, 2021, 1 st Edition.*
2	*Chang-liang, "****Permanent Magnet Brushless DC Motor Drives and Controls****", Wiley 2012, 1 st Edition.*
3	*M.N. Cirstea, A. Dinu, J.G. Khor,M. McCormick, "****Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications****", 1 st Edition, 2002.*
4	*Wei Liu, "****Hybrid Electric Vehicle System Modeling and Control****", Wiley 2017, 2nd Edition*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the mathematical model of a BLDC motor and discuss its characteristics	K2
CO2	Demonstrate the different controller actions applied to the BLDC motor.	K3
CO3	Review the basics of fuzzy logic systems.	K2
CO4	Develop the control of EVs through VHDL coding.	K3
CO5	Devise fuzzy logic control scheme for BLDC motor using FPGA in real-time.	K4

23PTE8E2	GRID INTEGRATION OF ELECTRIC VEHICLES

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To impart the concepts of EV & V2G on the smart grid renewable energy systems and to study the challenges and issues in grid integration.	
UNIT – I	**STATUS OF V2G**	**(9 Periods)**
Defining V2G - History and Development of V2G. Incorporating V2G to the EV, Auditing and Metering , V2G in Practice , V2G, Power Markets and Applications . Electricity Markets and V2G Suitability , Long-Term Storage, Renewable Energy, and Other Grid Applications , Beyond the Grid: Other Concepts Related to V2G.		
UNIT – II	**BENEFITS AND CHALLENGES OF V2G**	**(9 Periods)**
Benefits of V2G, Technical Benefits: Storage Superiority and Grid Efficiency, Economic Benefits: EV Owners and Societal Savings, Environment and Health Benefits: Sustainability in Electricity and Transport, Other Benefits.		
UNIT – III	**CHALLENGES TO V2G**	**(9 Periods)**
Technical Challenges-Battery Degradation, Charger Efficiency, Aggregation and Communication, V2G in a Digital Society. The Economic and Business Challenges to V2G - Evaluating V2G Costs and Revenues , EV Costs and Benefits , Adding V2G Costs and Benefits , Additional V2G Costs , The Evolving Nature of V2G Costs and Benefits. Regulatory and Political Challenges to V2G , V2G and Regulatory Frameworks , Market Design Challenges. Other V2G Regulatory and Legal Challenges		
UNIT – IV	**IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS**	**(9 Periods)**
Introduction - Types of Electric Vehicles - Motor Vehicle Ownership and EV Migration - Impact of Estimated EVs on Electrical Network - Impact on Drivers and the Smart Grid - Standardization and Plug-and-Play - IEC 61850 Communication Standard and IEC 61850-7-420 Extension.		
UNIT – V	**GRID INTEGRATION AND MANAGEMENT OF EVS**	**(9 Periods)**
Introduction-M2M in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles - M2M communication with scheduling.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

TEXT BOOK:

1	Advanced Electric Drive Vehicles, Ali Emadi, CRC Press 2017, 1st Edition.
2	Plug In Electric Vehicles in Smart Grids, Charging Strategies, SumedhaRajakaruna ,FarhadShahnia and Arindam Ghosh,Springer,2015, 1st Edition

REFERENCES :

1	ICT for Electric Vehicle Integration with the Smart Grid, NandKishor 1; Jesus Fraile-Ardanuy, IET 2020, 1st Edition..
2	Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain, IET 2015, 1st Edition.
3	Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehicleto-Grid A Sociotechnical Transition Beyond Electric Mobility, 2019, 1st Edition.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concepts related with V2G.	K2
CO2	Study the grid connection of 3 phase Q inverter	K1
CO3	Explain technical, economics. business, regulatory & political challenges related with V2G	K3
CO4	Demonstrate the impact of EV and V2G on smart grid and renewable energy system	K4
CO5	Explain the concept of grid integration and management of EVs.	K5

23PTE8E3	DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES				
PREREQUISITES		**L**	**T**	**P**	**C**
NIL		**3**	**0**	**0**	**3**
Course Objectives	To expose the types of different power converters, motors and controllers and their functions for Electric Vehicle.				
UNIT – I	**POWER CONVERSION CIRCUITS**				**(9 Periods)**
Non-Isolated Power Converters: Half-Bridge Buck-Boost Bidirectional Converter, Buck Converter, Boost Converter - Inductor Sizing - Capacitor Sizing - Isolated Power Converters: Forward Converter - Sizing the Transformer - Full-Bridge Converter - Resonant Power Conversion - Desirable Converter Characteristics for Inductive Charging - Three-Phase Inverters - Modulation Schemes.					
UNIT – II	**DC MOTOR DRIVES**				**(9 Periods)**
DC Machines: speed torque characteristics - power, losses and efficiency – starting and speed control methods – regenerative braking – closed loop speed control – design criteria of DC motor drives for EVs – Application of DC motor drives in EVs. PMBLDC Motor - operation – speed torque characteristics – speed control techniques – inverters requirements - closed loop control - outer rotor PMBLDC motor drive - Design criteria of PMBLDC - Application of PMBLDC drives in EVs.					
UNIT – III	**INDUCTION MOTOR DRIVES**				**(9 Periods)**
Operation - speed torque characteristics – starting methods - speed control and braking techniques – inverters for induction motor – PWM techniques – closed loop speed/torque control – Field Oriented Control (FOC) – Direct Torque Control (DTC) - design criteria of induction motor drives for EVs.					
UNIT – IV	**PERMANENT MAGNET SYNCHRONOUS MOTOR AND SWITCHED RELUCTANCE MOTOR DRIVES**				**(9 Periods)**
Permanent Magnet Synchronous Motor (PMSM) – operation – speed torque characteristics – speed control techniques – inverters requirements - closed loop control – Planetary geared PMSM drive - Design criteria of PMSM drives for EVs. Switched Reluctance Motor (SRM) - Geometry structure - principle of operation – converter topologies for SRM – closed loop control – torque ripple reduction techniques - Design criteria of SRM drives for EVs.					
UNIT – V	**CONTROL OF ELECTRIC DRIVE**				**(9 Periods)**
Introduction - Feedback Controller Design Approach - Modeling the Electromechanical System -Mechanical System -PM DC Machine - DC-DC Power Converter - PI Controller - Designing Torque Loop Compensation - Determining Compensator Gain Coefficients for Torque Loop - Designing Speed Control Loop Compensation - Determining Compensator Gain Coefficients for Speed Loop - Acceleration of Battery Electric Vehicle (BEV) using PM DC Machine.					
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: Periods Total: 45 Periods**					

TEXT BOOK:

1	*Chau K.T., **"Electric Vehicle Machines and Drives: Design, Analysis and Application"**, Wiley – IEEE Press, 2015.*
2	*John G. Hayes, G. Abas Goodarzi, **"Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles"** John Wiley & Sons Ltd., 1st edition, 2018.*

REFERENCES:

1	*Iqbal Hussain, **"Electric and Hybrid Vehicles: Design Fundamentals, Second Edition"** CRC Press, Taylor & Francis Group, Third Edition 2021.*
2	*Bimal K Bose, **"Modern Power Electronics and AC drives"**, Pearson Education, 1st Edition, 2015.*
3	*Krishnan R., **"Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design and Applications"**, CRC Press, 2001.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Illustrate various types of converter/inverter circuits and closed loop operation.	K2
CO2	Demonstratethe working principles, performance and speed - torque characteristics of various types of electrical machines.	K3
CO3	Compare various starting, braking methods and speed control techniques of electrical machines.	K4
CO4	Evaluate various control techniques for electrical drives.	K5
CO5	Use an appropriate electric machine for electric vehicle application.	K3

23PTE8E4	ELECTRIC VEHICLE ARCHITECTURE	SEMESTER VIII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To explore and learn about the architecture,various components and control strategies of electric vehicles.	
UNIT – I	**VEHICLE MECHANICS**	**(9 Periods)**
Vehicle mechanics: Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tyre –Road mechanics, Propulsion System Design.		
UNIT – II	**VEHICLE ARCHITECTURE AND SIZING**	**(9 Periods)**
History- and Evolution of Electric Vehicle -Series, Parallel and Series parallel Architecture, Micro and Mild architectures - Mountain Bike - Motorcycle- Electric Cars and Heavy Duty-EVs. - Details and Specifications.		
UNIT – III	**POWER COMPONENTS AND BRAKES**	**(9 Periods)**
Powertrain Component sizing :Gears, Clutches, Differential, Transmission and Vehicle Brakes - EV Powertrain sizing-HEV Powertrain sizing- Example.		
UNIT – IV	**HYBRID VEHICLE CONTROL STRATEGY**	**(9 Periods)**
Vehicle supervisory controller-Mode selection strategy: Mechanical Power-split hybrid modes,series-parallel hybrid modes- Modal Control strategies: series,parallel,series-parallel,Energy Storage system and regenerative control strategies		
UNIT – V	**PLUG-IN HYBRID ELECTRIC VEHICLE**	**(9 Periods)**
Introduction-Comparison with Electrical and Hybrid Electric Vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Iqbal Husain "***Electric and Hybrid vehicles :Design Fundamentals",***second edition, CRC press,2011.*
2	*MehrdadEhsani, YiminGao, Sebastian E. Gay, Ali Emadi*, **"Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design**", *CRC Press, 2018.*

REFERENCES

1	*Wei Liu "***Hybrid Electric Vehicle System Modeling and Control",***Second Edition ,Wiley, 2017*
2	*Chris Mi,M. AbulMasrur* "**Hybrid Electric Vehicles Principles and Applications with Practical Perspectives" ,***Second Edition,Wiley,2018.*
3	*Nil Patel, Akash Kumar Bhoi,SanjeevikumarPadmanaban, Jens Bo Holm-Nielsen* "**Electric Vehicles: Modern Technologies and Trends**", *Springer,2020.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Extendknowledge on history and evaluation of Electric Vehicles	K2
CO2	Illustratethe scientific concepts related to Electric Vehicles	K2
CO3	Summarize the various components in Electric Vehicles	K2
CO4	Evaluate the control strategies of Electric Vehicles	K5
CO5	Demonstrate the fundamental operating mechanism of a hybrid Electric Vehicle	K3