CURRICULUM AND DETAILED SYLLABI

FOR

M.TECH DEGREE PROGRAMME

IN

ELECTRICAL AND ELECTRONICS ENGINEERING

POWER CONTROL AND DRIVES

SEMESTERS I TO IV

2020 SCHEME
(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY
(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)
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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Vision and Mission of the Institution

Vision:

To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:

To transform the Youth as technically competent, ethically sound and socially committed professionals, by providing a vibrant learning ambience for the welfare of humanity.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Vision and Mission of the Department

Vision:

To be a Centre of Excellence in Electrical & Electronics Engineering Education, Research and Application of knowledge to benefit the society at large.

Mission:

To mould quality Electrical Engineers, fostering creativity and innovation to address global issues.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

M.Tech. Power Control and Drives

For the students admitted from 2020-21

Scheduling of Courses

i) Knowledge Segments and Credits

Every course of M. Tech Programme is placed in one of the seven categories as listed in Table 1 below. No semester shall have more than six lecture-based courses and two laboratory courses, and/or drawing/seminar/project courses in the curriculum.

Table 1: Credit distribution and the Knowledge Domains

Sl. No.	Category	Category Code	Number of Courses	Total Credits
1	Programme Core Courses	PCC	7	24
2	Laboratory Courses		2	2
3	Programme Elective Courses	PEC	5	15
4	Mandatory Credit Course (Research Methodology)	MCC	1	2
5	Seminar	PWS	2	4
6	Mini Project		1	2
7	Project		2	18
			Total Mandatory Credits	**67**

*Note: 67 credits have been the requirement for award of degree in all M.Tech Programmes of the College which was approved by the University.

ii) Semester-wise Credit Distribution

Semester	**I**	**II**	**III**	**IV**	**Total Credits**
Credits for Courses	22	19	14	12	**67**

SEMESTER I							
Slot	**Category Code**	**Course Number**	**Course Name**	**L**	**T**	**P**	**Credit**
A	PCC	MA0P60B	Advanced Mathematics and Optimisation Techniques	3	0	0	3
B	PCC	EE1P60A	Dynamics of Linear Systems	3	1	0	4
C	PCC	EE1P60B	Modelling of Electrical Machines	3	1	0	4
D	PCC	EE1P60C	Power Converter Circuits	3	0	0	3
E	PCC	EE1P60D	Advanced Signal Processing	3	0	0	3
S	MCC	MC0P60A	Research Methodology	0	2	0	2
U	PWS	EE1P69A	Seminar I	0	0	2	2
T	PCC	EE1P68A	Power Electronics Lab	0	0	2	1
			TOTAL	**15**	**4**	**4**	**22**

SEMESTER II							
Slot	**Category Code**	**Course Number**	**Course Name**	**L**	**T**	**P**	**Credit**
A	PCC	EE1P60E	Electric Drives	3	1	0	4
B	PCC	EE1P60F	Design Principles of Power Converters	3	0	0	3
C	PEC	EEiPXXX	Elective I	3	0	0	3
D	PEC	EEiPXXX	Elective II	3	0	0	3
E	PEC	EEiPXXX	Elective III	3	0	0	3
W	PWS	EE1P69B	Mini Project	0	0	4	2
T	PCC	EE1P68B	Drives and Simulation Lab	0	0	2	1
			TOTAL	**15**	**1**	**6**	**19**

ELECTIVE I

Slot	Category Code	Course Number	Course Name	L	T	P	Credit
C	PEC	EE1P61A	Process Control and Industrial Automation	3	0	0	3
		EE1P61B	New and Renewable Sources of Energy	3	0	0	3
		EE1P61C	Application of Power Electronics in Power Systems	3	0	0	3
		EE1P61D	Embedded Systems and Real Time Applications	3	0	0	3

ELECTIVE II

Slot	Category Code	Course Number	Course Name	L	T	P	Credit
D	PEC	EE1P62A	Flexible AC Transmission Systems	3	0	0	3
		EE1P62B	Microcontroller Applications in Power Electronics	3	0	0	3
		EE1P62C	Power Electronics for Renewable Energy Systems	3	0	0	3
		EE1P62D	Digital Simulation of Power Electronic Systems	1	2	0	3

ELECTIVE III

Slot	Category Code	Course Number	Course Name	L	T	P	Credit
E	PEC	EE1P63A	Soft Computing Techniques	3	0	0	3
		EE1P63B	Hybrid Electric Vehicles	3	0	0	3
		EE1P63C	Modern Power Converters	3	0	0	3

SEMESTER III							
Slot	**Category Code**	**Course Number**	**Course Name**	**L**	**T**	**P**	**Credit**
A	PEC	EE1PXXX	Elective IV	3	0	0	3
B	PEC	EE1PXXX	Elective V	3	0	0	3
U	PWS	EE1P79A	Seminar II	0	0	2	2
W	PWS	EE1P79B	Project (Phase – I)	0	0	12	6
			TOTAL	**6**	**0**	**14**	**14**

ELECTIVE IV

Slot	Category Code	Course Number	Course Name	L	T	P	Credit
A	PEC	EE1P71A	Advanced Instrumentation	3	0	0	3
		EE1P71B	Digital controllers in Power Electronics	3	0	0	3
		EE1P71C	EHVAC and DC Transmission	3	0	0	3
		EE1P71D	Power System Protection	3	0	0	3

ELECTIVE V

Slot	Category Code	Course Number	Course Name	L	T	P	Credit
B	PEC	EE1P72A	Switch Mode Power Converters	3	0	0	3
		EE1P72B	Finite Element Methods for Electrical Machines	3	0	0	3
		EE1P72C	Biomedical Instrumentation	3	0	0	3

SEMESTER IV							
Slot	**Category Code**	**Course Number**	**Course Name**	**L**	**T**	**P**	**Credit**
W	PWS	EE1P79C	Project Phase – II	0	0	24	12
			TOTAL	**0**	**0**	**24**	**12**

SYLLABUS
SEMESTER I

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0P60B	ADVANCED MATHEMATICS AND OPTIMIZATION TECHNIQUES	PCC	3	0	0	3	2020

i) COURSE OBJECTIVES

1. Develop a conceptual basis for vector spaces and Linear algebra.
2. Equip the Students with a thorough understanding of various optimization techniques.

ii) COURSE OUTCOMES

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

CO 1	Apply the concepts of vector spaces and orthogonality in various applications	Apply
CO 2	Solve Linear programming Problems	Apply
CO 3	Solve Integer programming Problems	Apply
CO 4	Solve unconstrained and constrained optimization problems.	Apply

iii) SYLLABUS

Vector spaces –subspaces-Basis-null space and column space- linear Transformations - orthogonality – least square solutions - matrix factorizations.

Linear programming problems - Simplex Methods –Two phase method-Duality-Dual Simplex Method-Integer programming.

Non-linear programming (Unconstrained and constrained) Kuhn-Tucker conditions-quadratic programming - Dynamic programming.

iv) REFERENCES

1) David C. Lay, *Linear Algebra*, Pearson Education, 4th Edition 2012.
2) Kenneth Hoffman and Ray Kunze, *Linear Algebra*, Prentice-Hall, 2nd Edition.1978.
3) Seymour Lipschulz, *Linear Algebra*, Tata McGraw Hill,3rd Edition 2017,.
4) Singiresu S Rao, *Engineering Optimization Theory and Practice*, 3rd Edition 2010.
5) K.V. Mittal and C. Mohan, *Optimization Methods in Operations Research and System Analysis*, New Age International Publishers,3rd Edition,2016.
6) Hamdy A. Taha, *Operations Research an Introduction*, PHI, 9th Edition, 2011.

v) COURSE PLAN

Module	Contents	No. of hours
I	Vector spaces and subspaces, null space and column space of a matrix; linearly independent sets and bases; Coordinate systems; dimension of a vector space; rank; change of basis; linear transformations–properties-kernel and range-computing kernel and range of a linear transformation.	8
II	Inner product, length and orthogonality; orthogonal sets; orthogonal projections; Gram Schmidt process; least square solutions - QR factorization; Singular value decomposition.	8
III	Linear Programming Problems-Simplex Methods – two phase simplex method – Duality - Dual simplex method. Integer linear programming; Graphical representation - Gomory's cutting plane method.	7
IV	Unconstrained non-linear Optimization - Steepest descent method, Conjugate Gradient method, Powell's method, Hooke-Jeeves method, Davidon-Fletcher-Powell method.	8
V	Constrained non-linear programming - Complex method - Cutting plane method - method of feasible directions - Kuhn-Tucker conditions.	7
VI	Quadratic programming - Dynamic programming - Examples - solution of dynamic programming problems using calculus method.	7
	Total hours	45

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P60A	DYNAMICS OF LINEAR SYSTEMS	PCC	3	1	0	4	2020

i) COURSE OBJECTIVES

The course will provide knowledge of linear system modelling, analysis and design so as to obtain the ability to apply the same to engineering problems in a global perspective. The students will be able to carry out controller design to achieve stability of systems. Also, it will provide knowledge to design observers and controllers for linear systems so as to be able to implement the methodology for practical control systems.

ii) COURSE OUTCOMES:

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

CO 1	Design a suitable compensator to meet the required specifications.	Analyse
CO 2	Design and tune PID controllers for a given system.	Analyse
CO 3	Analyse the system performance using state space techniques.	Apply
CO 4	Design a controller and observer for a given system and evaluate its performance.	Analyse
CO 5	Realize a MIMO system and evaluate its controllability and observability.	Apply

iii) SYLLABUS

Design of feedback control systems- Review of compensator design using Root locus and Bode plots- PID controllers

State Space Analysis Design- Linear state variable feedback for SISO systems-

State Space Analysis Design formulae for feedback gain-Transfer function approach-controllable and uncontrollable modes - regulator problems,

Observers - Asymptotic observers for state measurement-implementation of the observer-full order and reduced order observers combined observer–controller

MIMO systems - Introduction-controllability-observability- different companion forms for MIMO systems.

iv) REFERENCES

1) Richard C. Dorf and Robert H. Bishop, *Modern Control Systems*, Pearson Education, Limited, 12th Edition, 2013.
2) Gene K. Franklin and J. David Powell, *Feedback Control of Dynamic Systems*, Pearson Education, 8th Edition, 2018.
3) Gopal M., *Control Systems-Principles and Design*, Tata McGraw-Hill, 4th Edition, 2012.

4) Nagrath J. J. and Gopal M., *Control System Engineering*, New Age International Pvt Ltd, 6th Edition, 2018.
5) Thomas Kailath, *Linear System*, Prentice Hall Inc., Eaglewood Cliffs, NJ, 1998.
6) Harold Klee and Randal Allen, S*imulation of Dynamic Systems with MATLAB and Simulink*, CRC Press, 3rd Edition, 2018.
7) Chen C. T., *Linear System Theory and Design*, New York, Oxford university press, 4th Edition, 2014.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Design of Controllers & Compensators:** Design of feedback control systems- Approaches to system design compensators– performance measures- cascade compensation networks phase lead and lag compensator design using both Root locus and Bode plots.	**10**
II	**PID controllers**: Effect of proportional, integral and derivative gains on system performance- PID tuning-integral windup and solutions. Computer Simulation of a typical power converter control using PID	**10**
III	**State Space Analysis:** State Space Analysis and Design- Analysis of stabilization by pole cancellation- reachability and constructability - Stabilizability - controllability - observability-Analysis of stabilization by output feedback-Transfer function approach - state feedback and zeros of the transfer function.	**10**
IV	**State Feedback Controllers:** Linear state variable feedback for SISO systems, -modal controllability formulae for feedback gain-Ackermann's formula feedback gains in terms of Eigen values - Mayne- Murdoch formula - non controllable realizations and stabilizability - controllable and uncontrollable modes - regulator problems Computer Simulation of speed control of a DC/AC motor using Feedback controllers.	**10**
V	**Observers:** Asymptotic observers for state measurement-open loop observer-closed loop observer-formulae for observer gain –implementation of the observer - full order and reduced order observers – separation principle - combined observer –controller.	**10**
VI	**MIMO systems:** Design using polynomial equations - Direct analysis of the Diophantine equation. MIMO systems: Introduction, controllability, observability, different companion forms for MIMO systems.	**10**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P60B	MODELLING OF ELECTRICAL MACHINES	PCC	3	1	0	4	2020

i) COURSE OBJECTIVES:

This course is introduced to analyse the electrical machine behaviour based on the voltage and torque equations of the machine and its transformation using different methods. This course also provides the concept of generalized machine theory and its application in DC machines, synchronous machine, single phase and three phase Induction motor. This course also imparts knowledge about the analysis of transient and steady state behaviour of rotating electrical machines.

ii) COURSE OUTCOMES

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

CO 1	Develop the basic two pole model representation of electrical machines.	Apply
CO 2	Develop the linear transformation equations of rotating electrical machines incorporating the concept of power invariance.	Apply
CO 3	Analyse the steady state behaviour of different types of rotating electrical machines by applying linear transformations.	Analyse
CO 4	Analyse the transient behaviour of different types of rotating electrical machines by applying linear transformations.	Analyse

iii) SYLLABUS

Unified approach to the analysis of electrical machine performance - basic two pole model of rotating machines- per unit system

Primitive machine - transformer and rotational voltages in the armature voltage and torque equations resistance, inductance and torque matrix.

Transformations - passive linear transformation in machines- Park's transformation-invariance of power.

DC Machines- Application of generalized theory to separately excited, shunt and series machines- Steady state and transient analysis, transfer functions.

Synchronous Machines- synchronous machine reactance and time constants-Primitive machine model of synchronous machine with damper windings on both axes- Balanced steady state analysis-power angle curves-Transient analysis.

Induction Machines- Primitive machine representation- Steady State Operation-Equivalent circuit. Double cage rotor representation- Single phase induction motor-Voltage and Torque equations.

iv) (a) TEXT BOOKS

1) Bhimbra P. S., *Generalized Theory of Electrical Machines*, 6th Edition Khanna Publishers, Delhi 2017.
2) Charles V. Johnes, *Unified Theory of Electrical Machines*, New York, Plenum Press,1985.

3) Bernad Adkins, Ronald G Harley, *General theory of ac machines*, London, Springer Publications,2013.
4) Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, *Analysis of Electrical Machines and Drive Systems*, John Wiley & Sons,2013.

(b) REFERENCES

1) Charles Concordia, *Synchronous Machines - Theory and Performance*, John Wiley and Sons Incorporate, New York, 1988.
2) Alexander S Langsdorf, *Theory of Alternating Current Machinery*, Tata McGraw Hill, 2nd revised Edition, 2001.
3) Say M. G., *Introduction to Unified Theory of Electrical Machine*, Pitman Publishing, 1978.
4) NPTEL: http://nptel.ac.in/courses/108106023/

v) COURSE PLAN

Module	Contents	No. of hours
I	**Unified approach to the analysis of electrical machine performance-** Essentials of rotating electrical machines - conventions - Basic two pole model of rotating machines- Primitive machine - DC compound and shunt machines with interpoles, single phase series machine, three phase induction machine- per unit system - Transformer and Rotational voltages in the armature- Voltage and Torque equations resistance, inductance and torque matrix.	10
II	**Transformations** - Passive linear transformation in machines, power invariance, Transformation from a displaced brush axis-Transformation from three phase to two phase and from rotating axes to stationary axes-Physical concept of Park's transformation- Restrictions of the Generalized theory of machines, Numerical Problems.	10
III	**DC Machines**: Application of generalized theory to separately excited, shunt, series and compound machines. Expression for Rotational Mutual Inductance-Steady state and transient analysis, transfer functions of separately excited DC generator on no load and loaded conditions. Sudden short circuit of separately excited generator, sudden application of inertia load to separately excited DC motor. Numerical Problems	11
IV	**Synchronous Machines**: Synchronous machine Parameters-Expression for armature self-Inductance, armature mutual Inductance, Synchronous reactance and time constants-Primitive machine model of synchronous machine without damper windings. Phasor diagram of Synchronous motor and Synchronous generator-balanced steady state analysis-Active and reactive power. power angle curves for Salient pole and Cylindrical rotor machine, Steady state stability limit Curve for different excitations, Transient analysis- sudden three phase short circuit at generator terminals Numerical Problems.	12
V	**Induction Machines:** Primitive machine representation Transformation-Torque equation, Steady state Analysis-Equivalent circuit, Torque slip	9

	characteristics -Double cage rotor representation- Equivalent circuit. Comparison between single cage and double cage Induction motor. Numerical Problems.	
VI	**Single phase induction motor-** Double Revolving Field Theory- equivalent circuit- Voltage and Torque equations- Cross field theory -Steady state Analysis, Comparison between single phase and poly phase Induction motor.	**8**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P60C	POWER CONVERTER CIRCUITS	PCC	3	0	0	3	2020

i) COURSE OBJECTIVES:

This course aims to impart the knowledge of power semiconductor devices and their applications and it also aims to analyse and design various power electronic converters.

ii) COURSE OUTCOMES

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

CO 1	Compare the different types of switches used in power electronic circuits.	Understand
CO 2	Analyse the operation and performance parameters of uncontrolled rectifiers.	Analyse
CO 3	Analyse the operation and performance parameters of controlled rectifiers.	Analyse
CO 4	Analyse the working of various DC-DC Converters.	Analyse
CO 5	Analyse the performance of Inverters and various modulation techniques.	Analyse

iii) SYLLABUS

Power electronic switches-Switching constraints- Characteristics-Losses; Switch model; Uncontrolled Rectifier; Single Phase- Three Phase- Filters- Line Current Distortion-Total Harmonic Distortion- Displacement Power Factor- Power Factor.

Controlled Rectifiers: single phase- Three phase- Semi-converter- Inversion mode of operation.

DC –DC converter-Buck Converter- Boost converter- Buck- Boost converter- Cuk Converter.

Switched Mode Power Converter- Isolation & Protection- Flyback -Forward- Push Pull converters; Half Bridge converter; Full Bridge converter.

Voltage Source Inverters- Single Phase- Three Phase; PWM Techniques; Harmonic Elimination; Current Source Inverter; Multilevel Inverter.

iv) REFERENCES

1) Rashid M. H., *Power Electronics – Circuits, Devices and Applications*, Prentice Hall of India, New Delhi, 4th Edition, 2014.
2) Ned Mohan, Tore M. Undeland and William P. Robbins, *Power Electronics: Converters, Applications, and Design*, Wiley India, 3rd Edition, 2018.
3) Umanand L., *Power Electronics: Essentials and Applications*, Wiley, 2009.
4) Singh M. D. and Khanchandani K. B., *Power Electronics*, Tata McGraw Hills, Publishing Company Limited ,2006.

5) Daniel W. Hart, *Introduction to Power Electronics*, Prentice Hall, 1997.
6) William Shepherd and Li Zhang, *Power Converter Circuits*, Marcel Dekker, 2004.
7) Dubey G. K., Doradla S. R. and Sinha R. M. K., *Thyristorised Power Controllers*, New Age International Publications, 2005.
8) Joseph Vithayathil, *Power Electronics: Principles and Applications*, McGraw-Hill, 2010.

v) COURSE PLAN

Module	Contents	No. of hours
I	Power Electronic Elements: The ideal switch, Characteristics of ideal switches, two-quadrant and four-quadrant switches-Switching constraints in power electronic circuits. Losses in practical switches: Model of MOSFET for evaluating conduction and switching losses.	**7**
II	Uncontrolled rectifiers: Single phase - Analysis with R load and RL load, Analysis with capacitive filter Fourier Analysis of repetitive waveforms, Line current Distortion, Total Harmonic Distortion, Displacement Power Factor, Power Factor. Line voltage distortion.	**7**
III	Controlled Rectifiers: Single phase, Three phase - fully controlled and semi controlled- Performance Analysis with R, RL, RLE loads, Voltage conversion ratio, Total Harmonic Distortion, Displacement Power Factor, Effect of source impedance, Inversion mode of operation.	**8**
IV	DC-DC Converters: Steady state analysis and design of DC to DC converters. Buck, Boost, Buck Boost, cuk -Control methods of DC to DC converters- duty ratio control, Voltage conversion ratios of different topologies, Current ripple and voltage ripple calculations.	**8**
V	Block diagram of Switched Mode Power Supply - Requirements of isolation and protection. Isolated DC-DC converter topologies: Fly-back and forward converters, Push-pull converter, Half bridge and full bridge topologies, Steady state analysis - Voltage conversion ratios.	**7**
VI	Inverters: Performance analysis of single-phase voltage source inverter, Three Phase Inverters - PWM Techniques - Analysis of single pulse, multiple pulse modulation and sinusoidal pulse modulation, various harmonic elimination techniques. Current source inverters, Concept of multi-level inverters. Types of multilevel inverters.	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P60D	ADVANCED SIGNAL PROCESSING	PCC	3	0	0	3	2020

i) COURSE OBJECTIVES:

This course is designed with the analysis, study, interpretation and manipulation of signals. The signals may be audio, image, video ECG EEG signals captured by communication receivers, seismic signals. Signal processing techniques are finding important applications in wide areas of technology ranging from wired and wireless communication to multimedia processing to medical diagnosis to earth quake prediction.

ii) COURSE OUTCOMES:

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

CO 1	Classify and process signals in the discrete domain.	Understand
CO 2	Illustrate the discrete Fourier transform (DFT) and Fast Fourier transform (FFT) of a sequence.	Apply
CO 3	Design filters to suit specific requirements for specific applications.	Apply
CO 4	Analyse finite word length effects and time-frequency distribution.	Analyse
CO 5	Demonstrate the working of multi-rate signal processing.	Understand
CO 6	Explain the application of multi-rate signal processing and different DSP processors.	Understand

iii) SYLLABUS

Discrete time signals and Systems: Review of DTS, LTI systems, linear convolution and its properties, Z transform and Inverse Z- transform

Discrete Fourier Transform and Fast Fourier Transform: Discrete Fourier series, Discrete time sequences, Discrete Fourier Transform (DFT), properties, linear convolution using DFT, Efficient computation of DFT, Fast Fourier Transform (FFT).

Filter Design Techniques: Design of Discrete-Time IIR filters from Continuous-Time filters, bilinear transformation technique, Impulse invariance method, step invariance method. FIR filter design, Fourier series method, Window function technique, A Comparison of IIR and FIR Digital Filters.

Finite Word Length Effects and Time frequency analysis, Effects of coefficient on Quantization, Quantization in Sampling, Discrete Fourier Transform Computations, Time frequency distribution, Short time Fourier Transform, Wigner distribution, An introduction to multi component signal analysis- Wavelet transform.

Multi rate signal processing: Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multi stage implementation of sampling rate conversion, Filter design and efficient implementation for sampling rate conversion.

Application of Multi rate signal processing & Processors: Phase shifters – Interfacing of digital systems with different sampling rates - Sub band coding- Oversampled A/D and D/A converter, Commercial DSP devices, TMS C240 processor and ADSP 2181 processor.

iv) REFERENCES

1) Glenn Zelniker, Fred J. Taylor, *Advanced Digital Signal Processing – Theory and Applications*, CRC Press, 1993.
2) Oppenheim A.V. and Schafer, *Discrete Time Signal Processing*, Prentice Hall, 2nd Edition, 1998.
3) John G. Proakis and D.G. Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, Prentice Hall International Inc, 4th Edition, 2012.
4) Emmanuel C. Ifeacher, Barrie. W. Jervis, *DSP – A Practical Approach*, Pearson Education, 2nd Edition, 2001.
5) Lawrence R.Rabiner and Bernard Gold, *Theory and Application of Digital Signal Processing*, 2nd Edition, 2015.
6) Douglas F. Elliott, *Handbook of Digital Signal Processing- Engineering Application*, Academic Press, 2nd Edition, 2013.
7) Leon Cohen, *Time Frequency Analysis*, Prentice Hall, 1995.
8) Vaidyanathan P. P., *Multirate systems and Filter Banks*, Prentice Hall, 1993.
9) Avatar Singh and Srinivasan S., *Digital Signal Processing: Implementation using DSP Microprocessors with Examples from TMS320C54XX'*, Thomson Brooks/Cole, 2004.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Discrete time signals & Systems:** Review of DTS, stability & causality, frequency domain representation, LTI systems, linear convolution and its properties. Z transform-properties-system characterization in Z-domain, Inverse Z- transform.	**7**
II	**Discrete Fourier Transform & Fast Fourier Transform:** Representation of Periodic Sequences: Discrete Fourier Series, Properties Discrete time sequences, Discrete Fourier Transform (DFT), properties, linear convolution using DFT, Efficient computation of DFT, Fast Fourier Transform (FFT), Decimation in time and frequency algorithm.	**8**
III	**Filter Design Techniques:** Classification of filter design, Design of Discrete-Time IIR filters from Continuous-Time filters, Block diagram representation of FIR & IIR filters, Bilinear transformation technique, Impulse invariance method, Step invariance method. FIR filters design, Fourier series method, Window function technique, A Comparison of IIR and FIR Digital Filters.	**8**
IV	**Finite Word Length Effects & Time frequency analysis**: Effects of coefficient on Quantization, Quantization in Sampling, Discrete Fourier Transform Computations, the need for time frequency analysis, Time	**8**

	frequency distribution, Short time Fourier Transform, Wigner distribution. An introduction to multi component signal analysis- Wavelet transform.	
V	**Multi rate signal processing:** Mathematical description of sampling rate conversion - Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multi stage implementation of sampling rate conversion, Filter design and efficient implementation for sampling rate conversion- direct form FIR structures, Polyphase filter structures.	**7**
VI	**Application of Multi rate signal processing & Processors:** Phase shifters – Interfacing of digital systems with different sampling rates - Sub band coding- Oversampled A/D and D/A converter, Commercial DSP devices, TMS C240 processor and ADSP 2181 processor, Architecture, Addressing modes, Program control, Instructions.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MC0P60A	RESEARCH METHODOLOGY	MCC	0	2	0	2	2020

i) COURSE OBJECTIVES:

Goal of this course is to prepare the student to do the M. Tech project work with a research bias. The student will be able to formulate a viable research problem, do a critical analysis of publications in the area of research, and identify the appropriate research methodology. The student will be able to write a technical paper based on the project findings.

ii) COURSE OUTCOMES:

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

CO 1	Explain research ethics	Understand
CO 2	Explain Citation, Impact factor and Plagiarism.	Understand
CO 3	Explain the need for IPR in fostering research work, leading to creation of improved products, thus helping in economic growth and social benefits.	Understand
CO 4	Explain research problem formulation.	Apply
CO 5	Analyse research related information	Apply
CO 6	Write a technical paper	Understand

iii) SYLLABUS

Introduction to Research Methodology- Meaning of research, types of research, research problem- scope-objectives, data collection and analysis, literature review.

Ethical issues- Research ethics, Plagiarism, Effective technical writing.

Developing a Research Proposal, Format of research proposal-presentation-assessment by a review committee.

Copy right-royalty-Intellectual property rights and patent law, Patents, Designs, Process of Patenting and Development, Procedure for grant of patents.

Scope of Patent rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications. Administration of Patent system- Biological systems-Computer software.

iv) REFERENCES:

1) Stuart Melville and Wayne Goddard, *Research Methodology: An Introduction for Science & Engineering Students*, Lansdowne [South Africa] : Juta, 1996.
2) Wayne Goddard and Stuart Melville, *Research Methodology: An Introduction*, 2nd edition, Lansdowne [South Africa]: Juta, 2001.

3) Ranjit Kumar, *Research Methodology: A Step by Step Guide for beginners*, 3rd Edition, SAGE Publications Ltd; 2011.
4) Halbert, *Resisting Intellectual Property*, Taylor & Francis Ltd, 2007.
5) Mayall, *Industrial Design*, McGraw Hill, 1992.
6) Niebel, *Product Design*, McGraw Hill, 1974.
7) Asimov, *Introduction to Design*, Prentice Hall, 1962.
8) Robert P. Merges, Peter S. Menell, Mark A. Lemley, *Intellectual Property in New Technological Age*, 2016.
9) Ramappa T., *Intellectual Property Rights Under WTO*, S. Chand, 2008.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Research Methodology: Motivation towards research, Types of research. Professional ethics: Ethical issues -ethical committees. Copy right - royalty - Intellectual property rights and patent law - Reproduction of published material - Plagiarism. New developments in IPR of Biological Systems, Computer Software etc. Citation and acknowledgement, Impact factor. Identifying major conferences and important journals in the concerned area.	**6**
II	Defining and formulating the research problem -Literature Survey, Choose two papers in the area and analyse to understand how the authors have undertaken literature review, identified the research gaps, developed the objectives, formulated their problem and developed a hypothesis.	**5**
III	Research design and methods: Analyse the chosen papers to understand formulation of research methods, both analytical and experimental methods.	**4**
IV	Data Collection and analysis: Analyse the chosen papers and study the methods of data collection, data processing, analysis strategies, and tools used for analyzing the data.	**5**
V	Technical writing - Structure and components, contents of a typical technical paper, difference between abstract and conclusion, layout, illustrations and tables, bibliography, referencing and footnotes-	**5**
VI	Identification of a simple research problem – Literature survey - Research design - Methodology –paper writing based on a hypothetical result.	**5**
	Total hours	**30**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P69A	SEMINAR I	PWS	0	0	2	2	2020

i) COURSE OBJECTIVES

The goal of this course is to make students to:

1. Identify the current trends in the specific stream.
2. Collect recent publications related to the identified topics.
3. Prepare a comprehensive report based on literature survey.
4. Deliver presentation based on the preparations.
5. Improve the writing and presentation skills.

ii) APPROACH

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

iii) COURSE OUTCOMES

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

CO 1	Attain good exposure in the recent topics relevant to the specified stream.	Analyse
CO 2	Develop good communication and presentation skills.	Apply
CO 3	Explore domains of interest so as to pursue thesis.	Analyse

iv) CONTINUOUS INTERNAL EVALUATION PATTERN

Distribution of marks for the seminar shall be as follows.

Report : 30 Marks

Presentation : 40 Marks

Ability to answer questions on the topic : 30 Marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P68A	POWER ELECTRONICS LAB	PCC	0	0	2	1	2020

i) COURSE OBJECTIVES

The main objective of the course is to expose the students to hands on triggering circuit, DC-DC converter circuits, Inverters, PWM generation and computer simulation of various Converter circuits.

ii) COURSE OUTCOMES

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

CO 1	Design and simulate various power converter circuits.	Analyse
CO 2	Analyse and design gate drive circuit and PWM generator.	Analyse
CO 3	Analyse the circuit of power converters using computer simulation software.	Analyse

iii) LIST OF EXPERIMENTS

1. DC-DC Choppers using self-commutating Devices.
   a) Buck Converter
   b) Boost converter
2. AC-AC voltage regulators
   a) Lamp load
   b) Motor load
3. Practical converter design considerations - gate and base drive circuits
4. Generation of sine-PWM using analog circuits
5. Push pull inverter.
6. Computer simulations of Single-phase uncontrolled converter, Semi converters and Full converters
   a) R load
   b) RL load
   c) RLE load
7. Computer simulations of three phase uncontrolled converter, Semi converters and Full converters
   a) R load
   b) RL load
   c) RLE load
8. Computer simulation of DC-DC regulator

iv) REFERENCES

1) Rashid M H, *Power Electronics – Circuits, Devices and Applications*, Prentice Hall of India, New Delhi, 4th Edition, 2014.
2) Ned Mohan, Tore M. Undeland, William P. Robbins, *Power Electronics: Converters, Applications, and Design*, 3rd Edition ,2002.

v) COURSE PLAN

Expt. No.	Contents	No.of hours
1	DC-DC Choppers using self-commutating Devices. a) Buck Converter b) Boost converter a) Design and set-up Buck and Boost DC-DC converter. b) Plot the waveforms of triggering circuit and power circuit.	**4**
2	AC-AC voltage regulators a) Lamp load b) Motor load a) Design and set-up an AC voltage controller using lamp load & motor load. b) Plot the different waveforms by varying the triggering angle.	**3**
3	Practical converter design considerations - gate and base drive circuits a) Design, set-up and observe the waveforms of gate trigger circuit for Power MOSFET. b) Design, set-up and observe the waveforms of gate trigger circuit for Power BJT.	**4**
4	Generation of sine-PWM using analog circuits a) Design and set-up Sine triangle pulse width modulation circuits using OPAMP. b) Plot the waveforms and observe the change in output for different modulation index.	**4**
5	Push pull inverter. a) Design and set-up push pull inverter circuit using TL 494. b) Plot the trigger pulse and output waveforms.	**3**
6	MATLAB simulations of Single-phase uncontrolled converter, Semi converters and Full converters a) R load b) RL load c) RLE (motor) load. a) Simulate single phase rectifier circuits in MATLAB. b) Observe the waveforms and performance with R, RL, & RLE load.	**4**
7	MATLAB simulations of three phase uncontrolled converter, Semi converters and Full converters a) R load b) RL load c) RLE (motor) load a) Simulate three phase rectifier circuits in MATLAB. b) Observe the waveforms and performance with R, RL & RLE load.	**4**
8	MATLAB simulation of DC-DC regulator a) Simulate Buck or Boost DC-DC converters. b) Observe the waveforms and performance for various duty cycle.	**4**
	Total Hours	**30**

SEMESTER II

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P60E	ELECTRIC DRIVES	PCC	3	1	0	4	2020

i) COURSE OBJECTIVES:

Goal of this course is to impart knowledge about electric drive system mechanics, converters and development of new drive control strategies such as field oriented / vector control, DTC, SVPWM etc. for the control and operation of DC and AC motor drives.

ii) COURSE OUTCOMES:

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

CO1	Describe the concept of electric drives and multi quadrant drive operation.	Understand
CO2	Analyse the different DC motor drives and control strategies using various Power Converters.	Analyse
CO3	Select the various speed control methods for Induction Motor Drives.	Apply
CO4	Apply the concepts of space vector modulation, vector control and DTC for Induction motor speed control.	Apply
CO5	Explain VSI and CSI fed synchronous motor drives.	Understand
CO6	Apply the control schemes for BLDC motor drives.	Apply

iii) SYLLABUS

Review of introductory concepts of drives- Block Diagram of Drive, Speed torque characteristic of load, Multi-quadrant operation of Drives, Stability of drive systems, Closed loop speed control of DC motor drives.

DC motor drives and its Operational Strategies- Transfer functions of controlled rectifiers and choppers, Four quadrant operation of dc drives with Dual converter, Four quadrant operation of dc-dc converter fed drives.

Induction Motor Drives: Steady state equivalent circuit of 3-phase Induction motor— Speed control techniques of induction motor, Slip power recovery schemes

AC Drives and its Operational Strategies - Space Vector Model of Induction motor, Basic transformations in reference frame theory- Field Orientation Principle- Vector control-FOC, DTC.

Synchronous motor drives – VSI fed synchronous motor drives – V/f control and vector control, CSI fed synchronous motor drives, Vector control of Permanent Magnet Brushless DC Motors.

iv) REFERENCES

1) Dubey G. K., *Fundamentals of Electrical Drives*, CRC Press, 2002.
2) Bimal K. Bose, *Modern Power Electronics and AC drives*, Pearson Education, Asia 2003.
3) Werner Leonhard, *Control of Electrical Drives*, Springer, 3rd Edition 2001.
4) Bin Wu, *High Power Converters and AC Drives*, Wiley-IEEE Press, 2nd Edition, 2017.
5) Dr. Bimbra P. S., *Power Electronics*, Khanna Publishers, 4th Edition, 2001.
6) Murphy M. D., *Thyristor Control of AC Drives*, Elsevier Science Technology Books,1973.
7) De N. K. and Sen P. K., *Electric Drives*, Prentice Hall of India, 2006.
8) Ned Mohan, Tore M., Undeland and William P Robbins, *Power Electronics Converters Applications and Design*, John Wiley and Sons, 2009.
9) Vedam Subrahmanyam, *Electric Drives*, Mc Graw Hill Education, New Delhi, 2011.
10) Fitzgerald, Kingsley and Umans, *Electric Machinery*, Tata McGraw hill, 4th Edition,1988.

v) COURSE PLAN

Module	Contents	No. of hours
I	Drive system mechanics: Steady state characteristics of different types of motors and loads, Multi-quadrant operation of electric drive. Stability of drive systems DC drives: Separately excited dc motor drives – dynamic behaviour in constant flux mode, Closed-loop control of separately excited dc motor drives – transfer functions of motor.	9
II	Transfer functions of controlled rectifiers and choppers: two quadrant operation with controlled single-phase converter-continuous and discontinuous current operation and three-phase converters, Four quadrant operation of DC drives with Dual converter, Four quadrant operation of DC-DC converter fed drives - Single quadrant, two quadrant and four quadrant choppers.	10
III	Induction Motor Drives: Steady state equivalent circuit of 3phase Induction motor - Stator voltage control – constant V/f speed control with VSI - V/f control with slip compensation – Slip power recovery schemes – sub synchronous and super synchronous speed operation (Static Kramer and Static Scherbius drives).	11
IV	Space Vector Model of Induction motor: Concept of Space Vectors – Evaluation of dwell times - Basic transformations in reference frame theory- Field Orientation Principle-indirect vector control. Direct Torque Control (DTC) of Induction Motor-Basic concepts and block diagram - CSI fed induction motor drives.	11

V	Synchronous motor Drives: VSI fed synchronous motor drives – V/f control and vector control-Line Commutated Inverter fed Synchronous motor drives; CSI fed synchronous motor drives.	**10**
VI	Vector control of Permanent Magnet Brushless DC Motors. Speed Control of Trapezoidal EMF machines (Brushless DC motors) - Basic principles and Control schemes.	**9**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P60F	DESIGN PRINCIPLES OF POWER CONVERTERS	PCC	3	0	0	3	2020

i) COURSE OBJECTIVES:

This course gives basic knowledge in the design of power converter circuits. It imparts knowledge to choose power devices for a particular application. It explains the thermal design of power converters. This course gives a good insight into the design of high frequency transformers and inductors. It provides information about parasitic and noise in power converter circuits and various techniques to minimise them. This course provides knowledge about gate driver circuits. It gives knowledge in various protection schemes used with power electronic circuits. This course also provides basics knowledge in EMI/EMC issues.

ii) COURSE OUTCOMES

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

CO 1	Design a heat sink for a power converter.	Analyse
CO 2	Design high frequency transformer and inductor for power converter circuits.	Analyse
CO 3	Explain the effects of parasitic bus inductance and various techniques to minimise it.	Understand
CO 4	Design gate drive circuit for power converter circuits.	Apply
CO 5	Explain thermal protection schemes used with power converters.	Understand
CO 6	Explain various EMI issues and their solution	Understand

iii) SYLLABUS

Thermal Design of Power modules; Magnetics design based on area-product approach; Techniques in bus-bar design for medium and high-power converters to minimise dc-bus loop inductance; Idea of ground loops; Gate drive circuit design; Popular gate drive circuits for MOSFETs, SCRs, BJTs and IGBTs; Thermal protection de-saturation schemes; Basics of EMI/EMC issues.

iv) a) TEXT BOOKS

1) Umanand L, *Power Electronics: Essentials & Applications*, New Delhi, Wiley India Pvt. Ltd., 2009.
2) Ned Mohan, Undeland, Robbins, *Power Electronics: Converters, Applications and Design*, 3rd Edition, John Wiley, 2006.

b) REFERENCES

1) AN-978, *HV Floating MOS-Gate Driver ICs*, International Rectifiers, 2003.
2) *Mitsubishi Semiconductors Power Module application notes*, Mitsubishi Electric global, 1998.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Thermal Design** Power circuit design, selection of power devices, losses, Thermal design- Typical examples based on DC-DC converters and bridge inverters. Thermal design with cooling fan.	**8**
II	**Magnetic design** Magnetic design based on area-product approach, Design of inductors, transformers. Typical examples based on buck converter and flyback converter.	**7**
III	**Parasitics and noise in PE** Parasitics and their effects and tackling parasitics, leakage inductance and bus-bar inductance, Power circuit assembly, techniques in bus-bar design for medium and high-power converters to minimise dc-bus loop inductance - idea of ground loops and their effects in converter operation.	**8**
IV	**Gate drive circuit design** Necessity of gate driver circuits, popular gate drive circuits for SCRs, MOSFETs, and IGBTs. Gate drive ICs: Typical design using IC IR 2110, isolation, and techniques of isolation opto-isolator based gate drive design, pulse transformer-based design	**7**
V	**Protection of Power converters** Thermal protection, thermal sensor-based protection, short-circuit and over-current protection in IGBTs using de-saturation schemes.	**8**
VI	**Basics of EMI/EMC issues** Types of EMI, conductive and radiated EMI- basic solutions, Differential mode filters, Common mode filters, System integration.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P61A	PROCESS CONTROL AND INDUSTRIALAUTOMATION	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

The course aims to introduce the concepts of process control and automation. It presents modelling and analysis of physical systems in time domain. Students will be introduced to classical controllers and advanced control strategies used in process control and concepts of process identification. Concepts of different automation components like actuators, control valves and PLCs will be discussed. The concepts of SCADA, Distributed Control Systems and safety cycle will also be introduced.

ii) COURSE OUTCOMES:

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

CO 1	Apply time domain techniques for analysis of physical systems	Analyse
CO 2	Explain the concepts of classical controllers and advanced control strategies used in process control.	Understand
CO 3	Explain the concept of digital controllers and techniques for process identification.	Understand
CO 4	Describe the architecture of Industrial Automation Systems and its components such as actuators and control values	Understand
CO 5	Explain the role of PLCs in automation and write ladder programs for simple applications.	Apply
CO 6	Describe the concepts of SCADA, DCS and Safety cycle	Understand

iii) SYLLABUS

Process control principles - Process control block diagram – Response analysis of first order and second order systems - Linearization - Transportation lag.

Study of On-off, P, PI and PID Controllers – Ziegler Nichol's tuning methods - Advanced control strategies - Digital Controllers - Process Identification.

Automation architecture - Actuators - Control Valves - Discrete state process control - Programmable Logic Controllers - Ladder programming – Concepts of SCADA, DCS – Safety Cycle.

iv) REFERENCES

1) Coughanowr D. R., LeBlanc S., *Process Systems Analysis and Control*, 3rd Edition, McGraw-Hill, 2008.
2) Johnson C.D, *Process Control Instrumentation Technology*, Pearson Education, Prentice Hall of India, 8th Edition, 2013.

3) William L. Luyben, *Process Modelling, Simulation and Control for Chemical Engineers*, Mc-Graw Hill, 2nd Edition,2013.
4) Surekha Bhanot, *Process Control - Principles & Applications*, Oxford University Press, 2008.
5) Stephanopoulos G., *Chemical Process Control: An Introduction to Theory and Practice*, Pearson Education, Prentice Hall of India, 2006.
6) Wayne Bequette B., *Process Control, Modeling, Design and Simulation*, Prentice Hall of India (P) Ltd., 2003.
7) Huges T, *Programmable Controllers*, ISA press, 4th Edition Illustrated, 2005.
8) Krishnaswamy K., *Process Control*, New Age International, 2007.
9) Patranabis D., *Principles of Process Control*, Tata McGraw Hill, 3rd edition, 2011..
10) Pao C. Chau, *Process Control – A First Course with MATLAB*, Cambridge series in Chemical Engineering,1st edition,2002..

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introductory concepts**: Process Control principles – self regulated system, Human aided control, Automatic control, Process Control block diagram. **Modelling & response analysis of physical systems**: First order systems - Liquid level control, mixing process and heating process, Concept of linearization of system model Response of first order systems in series – Non-interacting and interacting systems for liquid level control. Modelling of transportation lag	9
II	**Study of Controllers**: Closed loop system - ON-OFF control, Classical controllers - P, PI and PID controllers, Ziegler Nichol's methods for PID tuning. **Advanced Control Strategies**: Cascade control, Feed-forward control, Ratio Control, Smith Predictor control, Selective control, Model Reference Adaptive Control.	8
III	Concepts of Model Predictive Control and Statistical Process Control. **Digital controllers**: Block diagram, Effect of sampling, Digital PID controller. **Process Identification**: Direct methods – Time domain eyeball fitting of Step test data, Direct sine wave testing	8
IV	**Automation**: Architecture of Industrial Automation Systems, Final control operation – Actuators and Control elements. Actuators – Construction, Principle, Advantages and disadvantages of Hydraulic, Pneumatic and Electrical actuators. Control elements – Control Valves construction and principle, Types – quick opening, linear, equal percentage, Classification.	7
V	**Discrete state process control**: Programmable Logic Controllers – architecture and operation, Comparison of PLC & PC, Relays and Ladder Logic, Ladder Programming – Basic symbols used,	7

	Realization of AND, OR logic, Concept of latching. Introduction to Timer/Counters- Simple ladder programs.	
VI	Introduction to SCADA: SCADA Systems, SCADA Architecture - monolithic, distributed and network. Concepts of Distributed control systems – DCS Structure, Advantages and disadvantages- Introduction to IEC 61511/61508 and the safety cycle.	**6**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P61B	NEW AND RENEWABLE SOURCES OF ENERGY	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES

This course is to expose the students to the fundamental concepts of emerging renewable energy sources available, its working principle and advantages.

ii) COURSE OUTCOMES

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

CO 1	Explain the solar radiation measurement.	Understand
CO 2	Describe the applications of solar energy	Understand
CO 3	Compare the methods of energy generation from ocean waves and tides.	Apply
CO 4	Describe the wind energy power generation and wind energy conversion system	Analyse
CO 5	Describe the energy sources like small hydro, biomass, geothermal, hydrogen energy and emerging technologies	Understand

iii) SYLLABUS

Direct solar energy-Solar radiation data- solar radiation measurement; Solar thermal systems- Solar thermal collectors- solar thermal electric systems; estimation of average solar radiation.

Energy from oceans- Wave energy generation-Wave energy conversion devices; Tidal energy - basic principles, tidal power generation systems, Ocean thermal energy conversion (OTEC), methods of ocean thermal electric power generation.

Wind energy- principle of wind energy conversion systems- design of windmills – site selection considerations – Types of wind machines; Wind energy conversion systems-principle of operation and classification.

Small hydro power stations- civil work design considerations -Turbines and generators for SHP; Biomass and biofuels – Biogas generation: types of biogas plants- Applications of biogas; Energy from waste; Chemical energy generation: fuel cell -types; Batteries.

Geothermal energy-classification of geothermal resources- schematic of geothermal power plants- operational and environmental problems; Power from satellite stations; Hydrogen energy; Nuclear Fusion energy.

iv) REFERENCES

1) Solanki C. S., *Solar Photovoltaic: Fundamentals Technologies and Applications*, Prentice-Hall of India Pvt. Limited, 3rd Edition ,2015

2) Joshua Earnest and Tore Wizelius, *Wind Power Plants and Project Development*, Prentice-Hall of India Learning, 2nd Edition, 2015.
3) Rai. G.D., *Solar Energy Utilization*, Khanna Publishers, 5th Edition, 2014.
4) Rai. G.D., *Non-conventional Energy Sources*, Khanna publishers,6th Edition, 2017.
5) Kothari, *Renewable Energy Sources and Emerging Technologies*, Prentice-Hall of India, Eastern Economy Edition, 2012.
6) Earnest J. and Wizelius T., *Wind Power Plants and Project Development*, PHI Learning, 2011.
7) Khan B. H., *Non-Conventional Energy Resources*, Tata McGraw Hill, 2009.
8) Sawhney G. S., *Non-Conventional Energy Resources*, Prentice-Hall of India Learning, 2012.

v) COURSE PLAN

Module	Contents	No. of hours
I	Direct solar energy-The sun as a perennial source of energy. flow of energy in the universe and the cycle of matter in the human ecosystem, direct solar energy utilization Solar radiation measurements, solar radiation data, estimation of average solar radiation, Solar Thermal Systems.	**6**
II	Applications of solar energy – water heating systems, space heating and cooling of buildings, solar cooking, solar ponds, solar green houses, solar thermal electric systems; solar photovoltaic power generation; solar production of hydrogen	**8**
III	Energy from oceans-Wave energy generation - potential and kinetic energy from waves; wave energy conversion devices. Tidal energy - basic principles, tidal power generation systems, Ocean thermal energy conversion (OTEC), methods of ocean thermal electric power generation - Open Cycle, Closed Cycle and Hybrid Cycle.	**7**
IV	Wind energy - basic principles of wind energy conversion; design of windmills; wind data and energy estimation. Site selection considerations. Types of wind machines-Horizontal axis and Vertical axis machines. Dynamics of Turbine blades.	**8**
V	Classification of small hydro power (SHP) stations; description of basic civil works design considerations; Turbines and generators for SHP; advantages and limitations. Biomass and bio -fuels; energy plantation; biogas generation; types of biogas plants- floating type and fixed dome type. Applications of biogas; energy from wastes, Chemical energy sources-Types of fuel cells-Batteries.	**8**
VI	Geothermal energy- Origin and nature of geothermal energy, classification of geothermal resources, schematic of geothermal power plants, operational and environmental problems; Power from satellite stations, Hydrogen energy –production-storage-transportation –utilization, nuclear fusion energy, cold fusion.	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P61C	APPLICATIONS OF POWER ELECTRONICS IN POWER SYSTEMS	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

This course aims to impart the knowledge to analyse the working and performance of power electronic circuits in FACTS and HVDC Transmission. It also familiarises the problems related to power quality and to determine the requirements of connecting a distributed generator to the utility system.

ii) COURSE OUTCOMES:

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

CO 1	Analyse power flow control using FACTS devices in AC transmission systems.	Analyse
CO 2	Analyse the working of shunt and series compensators.	Analyse
CO 3	Analyse the operation of converter circuits used in HVDC system.	Analyse
CO 4	Explain the power quality issues in distribution systems and methods to mitigate harmonics.	Understand
CO 5	Design control circuits for power devices in distributed generation.	Apply
CO 6	Explain the interface, protection and islanding techniques in distributed generation.	Understand

iii) SYLLABUS

Flexible AC Transmission- Series and Shunt Compensation - Types of FACTS controllers. Operation and control of SVC, STATCOM, TCSC, SSSC
Power Quality problems in distribution systems-harmonics-Passive and active Filters - IEEE standards for power quality.
Need for HVDC, AC vs. DC: Comparative advantages. Converters and their characteristics. Control of the converters.
Distributed generation-Grid Interconnection - Modelling of converters in DG-Protection and control of grid converters.

iv) REFERENCES

1) Hingorani N. G. & L. Gyugyi, *Understanding Facts Concepts and Technology of Flexible AC Transmission Systems*, Standard Publishers Distributors, 2001.
2) Roger C. Ducan, McGranaghan, Santose Beaty, *Electrical Power Systems Quality*, McGraw-Hill, New York, 2nd Edition, 2002.
3) Padiyar K.R, *HVDC Power Transmission Systems*, Wiley eastern Ltd. 2008.

4) Lee Willis & Walter G. Scott, *Distributed Power Generation*, Planning & Evaluation, CRC Press Taylor & Francis Group, Ist Edition,2000.
5) Kramer.W, Chakraborty.S, B. Kroposki, and H. Thomas, *Advanced Power Electronic Interfaces for Distributed Energy Systems Part 1: Systems and Topologies*, Technical Report NREL/TP-581-42672, March 2008.

v) COURSE PLAN

Module	Contents	No. of hours
I	Concept of Flexible AC Transmission--Power flow in Uncompensated transmission line- Effect of series and shunt compensation at the mid-point of the line on power transfer- Benefits of FACTS controllers- Basic types of FACTS controllers. Static Shunt Compensators-Objectives of shunt compensations. Methods of VAR generation-Variable Impedance VAR-Switching Converter VAR-Hybrid VAR (Concept only)	**8**
II	Operation and control of SVC, STATCOM configuration and control, applications of SVC and STATCOM. Static Series Compensators-Objectives of Series Compensation. Principle of Operation, Analysis and Control, Applications of TCSC and SSSC. Principle of phase angle compensation –phase angle compensator	**8**
III	Need for HVDC, AC vs. DC: Comparative advantages. Components of HVDC-Types of Link. Converter Configuration-Analysis of Graetz circuit with and without overlap. Principle of DC link control-Converter control characteristics-constant minimum ignition angle control-constant current control-extinction angle control	**7**
IV	Power quality – Type of power quality disturbances-Sources and effects of power quality in distribution system. Harmonics–Harmonic Indices-Sources of Harmonics. Mitigation of Harmonics-Passive and Active Filters. Types of Active Filters- shunt, series and hybrid filters. IEEE standards on power quality	**8**
V	Distributed generations-Concept of DG- Grid Interconnection Standards, General Power electronic DG interconnection topologies for various sources and control. Control of DG inverters-Current control and DC voltage control for standalone and grid parallel operations. Protection of the converter, Control of grid interactive power converters, phase locked loops, synchronization and phase locking techniques.	**7**
VI	DG Interface to the Utility System. Protection of the converter, Control of grid interactive power converters, phase locked loops, synchronization and phase locking techniques. Local and Remote Techniques for Islanding Detection in Distributed Generators.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P61D	EMBEDDED SYSTEMS AND REAL TIME APPLICATIONS	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

After the successful completion of this course, students will be able to evaluate the different open source development boards used for real time projects. They will be able to analyse the different concepts of real time operating system and program accordingly.

ii) COURSE OUTCOMES:

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

CO 1	Explain the concepts of embedded systems.	Understand
CO 2	Construct embedded C program for serial port communication and time delay using timers/counters of 8051.	Apply
CO 3	Demonstrate the architecture and working of different types of embedded processors available for real time applications.	Understand
CO 4	Describe the architecture and programming of ARM processor.	Understand
CO 5	Explain the basic concepts of real time Operating system design.	Understand
CO 6	Design an embedded controller application.	Apply

iii) SYLLABUS

Embedded Systems: Definition and characteristics, Design issues, Hard and soft real-time systems, 8051 microcontroller architecture, memory management, Addressing modes, Assembly language programming of timers, serial communication, interrupts.

Embedded C programming of 8051 timers, serial communication, interrupts, interfacing keyboard, stepper motor, analog/digital and LCD.

TI MSP 430 microcontroller: Architecture and programming. Case study of 8/16/32 bit microcontroller (8051, PIC/MSP 430, AVR)

ARM processor: Fundamentals, Cortex M3 architecture, Instruction set, Thumb Instructions, memory mapping, Registers. Optimizing ARM assembly code.

Real time operating system: Concepts, Round robin, round robin with interrupts, Function queue scheduling architecture, Semaphores, mutex, mailbox. Memory management, priority inversion, thread synchronization

Embedded Linux, Real Time Linux, Advantages of Linux OS, Examples of Embedded Linux systems- system architecture, Types of host/target architectures for the development of Embedded Linux Systems, Debug setups, Boot Configurations, Processor architectures supported by Linux.

iv) REFERENCES

1) Muhammed Ali Mazidi, *The 8051 Microcontroller and Embedded Systems Using Assembly and C*, 2nd Edition, Pearson India.,2007
2) David E Simon, *An Embedded Software Primer*, Pearson Addison Wesley, 2002.
3) Raj Kamal, *Embedded Systems: Architecture, Programming and Design*, 2nd Edition, Tata McGraw Hill Education Pvt Ltd,2017.
4) Andrew Dominic & Chris, *Arm system developer's guide:Design and optimiing system software*, first edition , MK publishers,2004.
5) Krishna. C.M, Kang G. Shin, *Real-Time Systems*, International Editions, Mc Graw Hill, 1997.
6) Prasad K.V.K.K, *Embedded Real-Time Systems: Concepts, Design & Programming*, Dream Tech Press, 2005.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Embedded Systems:** Definition and characteristics, Recent trends and challenges, Design issues, Hard and soft real-time systems, 8051 microcontroller architecture, memory management, Addressing modes, Assembly language programming of timers, serial communication, interrupts, Bluetooth , Zig-Bee, GPS, Wi-Fi, Wi-Max based communication.	**7**
II	**Embedded C programming** of 8051 timers, serial communication, interrupts, interfacing keyboard, stepper motor, analog/digital and LCD, PWM signal generation, Co-ordinate transformations.	**8**
III	TI MSP 430 microcontroller: Architecture and programming. Case study of 8/16/32 bit microcontroller (8051, PIC/MSP 430, AVR	**7**
IV	**ARM processor:** Fundamentals, Cortex M3 architecture, Instruction set, Thumb Instructions, memory mapping, Registers. Optimizing ARM assembly code.	**8**
V	**Real time operating system:** Concepts, Round robin, round robin with interrupts, Function queue scheduling architecture, Semaphores, mutex, mailbox. Memory management, priority inversion, thread synchronization	**7**
VI	**Embedded Linux**, Real Time Linux, Types of Embedded Linux systems, Advantages of Linux OS, Using distributions, Examples of Embedded Linux systems- system architecture, Types of host/target architectures for the development of Embedded Linux Systems, Debug setups, Boot Configurations, Processor architectures supported by Linux.	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P62A	FLEXIBLE AC TRANSMISSION SYSTEMS	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

This course imparts knowledge on advances in Power electronics Industry that led to rapid development of Power Electronics controllers for fast real and reactive power control. The aim of this course is to familiarise the operation and analysis of different FACTS devices. The insight of introducing this course is to enable students to design a power system with proper control for real and reactive power using FACTS devices.

ii) COURSE OUTCOMES

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

CO 1	Apply the concept of power flow control, fundamental principles of uncompensated AC power transmission system and understand the benefit of FACTS compensators.	Apply
CO 2	Describe reactive power compensation and converters for static compensation.	Understand
CO 3	Apply static shunt compensated system with compensators like TCR, TSR, TSC, FC-TCR and VAr.	Apply
CO 4	Apply static series compensated systems and static voltage and phase angle regulators with different compensators.	Apply
CO 5	Describe the concept of shunt and series compensators with their switching converters.	Understand
CO 6	Explain the converters and controls used in combined series-shunt compensated system.	Understand

iii) SYLLABUS

Power flow control – Voltage regulation and Reactive power flow control. Power flow control. Benefits of FACTS -Transmission line compensation - Phase angle control.

Reactive power compensation – shunt and series compensation principles. Converters for static compensation.

Static shunt Compensator - Objectives - Methods - Variable impedance type VAR Generators -TCR, TSR, TSC, FC-TCR - Principle, configuration, and control. Static Series compensator - Objectives, Variable impedance type series compensators – GCSC, TCSC, TSSC - Principle, configuration, and control.

Static Voltage and Phase Angle Regulators - TCVR &TCPAR - Objectives, Switching converter - Applications

Switching converter type shunt Compensators - Principle, configuration and control, SVC and STATCOM – Regulation – Comparison between SVC and STATCOM. Applications of Switching converter type Series Compensators - SSSC- Principle, configuration, and control.

Combined series-shunt compensator – Unified Power Flow Controller - Operation, and control - Basic principle of P and Q control - Applications. Interline Power Flow Controller. Simulation of FACTS controllers.

iv) REFERENCES

1) Hingorani N.G and Gyugyi L, *Understanding FACTS*, IEEE Press, 2000.
2) Miller T.J.E, *Reactive Power Control in Power Systems*, John Wiley, 1982.
3) Padiyar K.R, *FACTS Controllers in Power Transmission and Distribution*, New Age International Publishers, 2007.
4) Arriliga J and Watson N.R, *Computer modeling of Electrical Power Systems*, Wiley, 2001.
5) Song Y.H and Johns A.T, *Flexible ac Transmission Systems (FACTS)*, IEEE Press, 1999.
6) Ned Mohan et. al, *Power Electronics*, John Wiley and Sons, 1995.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Power flow in Power Systems –** Steady-state and dynamic problems in AC systems – Voltage regulation and reactive power flow control in Power Systems – control of dynamic power unbalances in Power System. **Power flow control** - Constraints of maximum transmission line Loading. **Benefits of FACTS -** Transmission line compensation Uncompensated line -shunt compensation - Series compensation - Phase angle control.	7
II	**Reactive power compensation –** shunt and series compensation principles – reactive compensation at transmission and distribution level – Static versus passive VAr Compensators. **Converters for Static Compensation** - Three Phase Converters and Standard Modulation Strategies. GTO Inverters. Transformer Connections for 12, 24 and 48 pulse operation. Multi-level inverters and their modulation.	7
III	**Static shunt Compensator** - Objectives of shunt compensations, Methods of controllable VAR generation - Variable impedance type VAR Generators -TCR, TSR, TSC, FC-TCR Principle of operation, configuration, and control. **Static Series compensator** - Objectives of series compensations, Variable impedance type series compensators – GCSC, TCSC, TSSC - Principle of operation, configuration, and control.	8
IV	**Static Voltage and Phase Angle Regulators** TCVR &TCPAR - Objectives of Voltage and Phase angle regulators. Thyristor controlled Voltage and Phase Angle Regulators - Switching converter type Voltage and Phase Angle Regulators- Applications.	8

V	**Switching converter type shunt Compensators** - Principle of operation, configuration and control, SVC and STATCOM - Regulation slope – Transfer functions and Dynamic performance Var Reserve Control. Comparison between SVC and STATCOM – Applications - Switching converter type Series Compensators SSSC - Principle of operation, configuration, and control.	**7**
VI	**Combined series-shunt compensator** – Unified Power Flow Controller: Circuit Arrangement, Operation, and control of UPFC-Basic principle of P and Q control - independent real and reactive power flow control- Applications. Introduction to interline power flow controller. Modeling and simulation of FACTS controllers	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P62B	MCROCONTROLLER APPLICATIONS IN POWER ELECTRONICS	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

This course develops the students to know the architecture and operation of 8051 microcontrollers. It will also help to understand how embedded devices can be used in the field of power electronics. The course will make the students understand the utility of 8051 microcontrollers for better controlling of Electrical circuits. The course will impart the knowledge to students about the measurement of electrical and non-electrical quantities using processors.

ii) COURSE OUTCOMES:

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

CO 1	Explain different families of microcontrollers to know the architecture and its operation.	Understand
CO 2	Apply microcontroller for serial port communication/interfacing and time delay using timers/counters of 8051.	Apply
CO 3	Describe functioning of signal conditioning using specific circuits/ transducers and to measure electrical quantities using processors.	Understand
CO 4	Describe controlling of non-electrical quantities using processors.	Understand
CO 5	Identify the use of 8051 microcontroller for better controlling of Electrical circuits.	Apply
CO 6	Apply microcontroller in various control schemes.	Apply

iii) SYLLABUS

Evolution of microcontrollers: Comparison between microprocessor and microcontroller, 8051 architecture- CPU structure- Assembly language, addressing modes-instruction set.

Interrupts & Timers/Counters: Interrupt structure – timers/counters. Serial data input/output, Internal RAM & ROM, interfacing with external memory, ADC & DAC interfacing with the controller, PWM signal generation using timer/counter.

Microprocessor based applications: Importance of measurement and sensing in closed loop control, Signal conditioning using comparators, Measurement of voltage, current, speed, power and power factor using microprocessors.

Microprocessor based control: Measurement of non-electrical quantities like Strain, Temperature, Speed and Torque. Per-unit representation of variables in digital domain-Implementation of P, PI and PID controllers using microprocessors

Applications of MCS-51 Microcontrollers: Square Wave Generation- Rectangular Waves-Pulse Generation- Frequency Counter, Digital pulse width modulation techniques and its comparison with the analog type.

Microcontroller Based Firing Scheme for Converters: Firing schemes for single phase and three phase rectifiers-3-phase AC choppers, Inverters, Typical applications in the control of power electronic converters for power supplies and electric motor drives: Stepper motor control, DC motor control, AC motor control.

iv) REFERENCES

1) Kenheth J. Hintz and Daniel Tabak, *Microcontrollers: Architecture, Implementation and Programming*, McGraw Hill, USA, 1992.
2) John B. Peatman, *Design with Microcontrollers*, McGraw-Hill International Ltd, 1997.
3) *8-bit Embedded Controllers*, Intel Corporation, 1990.
4) John B. Peatman, *Design with PIC Microcontrollers*, Pearson Education Inc., India, 2005.
5) Douglas V. Hall, *Microprocessors and Interfacing: Programming and Hardware*, Tata McGraw-Hill, 11th Edition, 2003.
6) Ajay V Deshmukh, *Microcontrollers - Theory and Applications*, McGraw Hills, 2nd Edition, 2005.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Evolution of microcontrollers:** Comparison between microprocessor and microcontroller, microcontroller development systems; overview on 8051, 8096 and PIC series microcontrollers. 8051 architecture- CPU structure-register file, special function registers, registers and pin description. Assembly language, addressing modes-instruction set.	**7**
II	**Interrupts & Timers/Counters:** Interrupt structure – timers/counters. Serial data input/output. Internal RAM & ROM, interfacing with external memory. ADC & DAC interfacing with the controller. PWM signal generation using timer/counter	**8**
III	**Microprocessor based applications:** Importance of measurement and sensing in closed loop control. Signal conditioning using comparators, Clippers, Clampers, Precision Rectifier and Zero crossing Detector. Measurement of voltage, current, speed, power and power factor using microprocessors.	**7**
IV	**Microprocessor based control:** Measurement of non-electrical quantities like Strain, Temperature, Speed and Torque. Per-unit representation of variables in digital domain, data representation in fixed point and floating point form, round-off errors- Implementation of P, PI and PID controllers using microprocessors.	**7**
V	**Applications of MCS-51 Microcontrollers**: Square Wave Generation- Rectangular Waves- Pulse Generation- Pulse Width	**8**

	Modulation- Staircase Ramp Generation- Sine Wave Generation. Pulse Width Measurement- Frequency Counter. Digital pulse width modulation techniques and its comparison with the analog type.	
VI	**Microcontroller Based Firing Scheme for Converters:** Firing schemes for single phase and three phase rectifiers-3-phase AC choppers, Firing at variable frequency environments, Firing scheme for DC choppers, voltage and current commutation. Inverters, types of pulse width modulation techniques, their implementation. Using microcontrollers, application of the firing schemes to the control of DC drive, induction motors, synchronous motors and other special machines. Typical applications in the control of power electronic converters for power supplies and electric motor drives: Stepper motor control, DC motor control, AC motor control.	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P62C	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES

This course aims to impart understanding about different renewable energy systems and power electronic circuits employed in the harnessing of energy from these systems and operation of grid-integrated energy systems.

ii) COURSE OUTCOMES

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

CO 1	Describe the power generation from Biomass, Ocean, Fuel cell and Hydrogen energy systems	Understand
CO 2	Design a stand-alone PV system according to the requirements.	Apply
CO 3	Describe the WECS and various Power electronic converters involved in WECS	Analyse
CO 4	Analyse the operation of Electrical Machines in Grid integrated wind energy conversion systems.	Analyse
CO 5	Explain grid connection issues and MPPT algorithms of PV and WECS.	Understand

iii) SYLLABUS

Environmental aspects of electric energy conversion; impacts of renewable energy generation on environment; Qualitative study of various renewable energy systems.

Solar PV Systems-block diagram-boost and buck-boost converters-Charge controllers-Batteries.

Design of a Standalone PV System -Selection of inverter, Battery sizing, Array sizing;

Wind Energy Conversion Systems-Block diagram-AC Voltage controllers -Grid interactive inverters-matrix converters.

Electrical machines for Renewable Energy conversion: Principle of operation and analysis of SCIG, DFIG and PMSG- Operation of Standalone and Grid integrated WECS.

Grid Integrated solar system - Hybrid Renewable Energy systems- Need for Hybrid Systems-Type of Hybrid systems- MPPT algorithms of PV and WECS.

iv) REFERENCES

1) Solanki C. S., *Solar Photovoltaic: Fundamentals Technologies and Applications*, Prentice Hall of India Pvt. Limited, 3rd Edition,2015.

2) Joshua Earnest and Tore Wizelius, *Wind Power Plants and Project Development*, Prentice Hall India Learning, 2nd Edition, 2015.
3) Rai. G.D., *Non-conventional Energy Sources*, Khanna publishers,6th Edition, 2017.
4) Ahmed, *Wind energy Theory and Practice*, Prentice Hall India, Eastern Economy Edition, 2012.
5) Rashid M.H., *Power Electronics Circuits, Devices and Applications*, 3rd Edition, Prentice Hall India, New Delhi, 2004.
6) Earnest J. and Wizelius T., *Wind Power Plants and Project Development*, Prentice Hall India Learning, 2011.
7) Leon Freris, David Infield, *Renewable Energy in Power Systems*, John Wiley &Sons., 2008.
8) http://freevideolectures.com/Course/2342/Energy-Resources-and-Technology.

v) COURSE PLAN

Module	Contents	No. of hours
I	Environmental aspects of electric energy conversion - impacts of renewable energy generation on environment, cost - GHG Emission Qualitative study of different renewable energy resources: ocean, Biomass, Fuel cell, and Hydrogen energy systems and solar thermal system.	**6**
II	Solar energy-Radiation and Measurement. Solar Cell: Solar cell parameters, losses in solar cell, PV cell characteristics & Equivalent circuit-PV Cell efficiency - Series and Parallel interconnection of cells, Mismatch in series and parallel connection, Ratings of PV module.	**8**
III	Block diagram of solar photo voltaic system -Principle of operation: Boost and buck-boost converters- Charge Controllers-Types of charge controllers, Batteries-Battery Parameters-Battery Types, MPPT. Standalone PV system configuration, Design of a Standalone PV System -Selection of inverter, Battery sizing, Array sizing.	**8**
IV	Wind Energy: Qualitative study of wind energy systems, Wind Energy Conversion System- Power electronic converters for WETS -AC-DC-AC converters, PWM Inverters, Grid Interactive Inverters, Matrix converters, Three phase AC voltage controllers.	**8**
V	Review of reference theory fundamentals. Principle of operation and analysis: SCIG, PMSG, and DFIG. Grid integrated PMSG and SCIG Based WECS-Grid Integrated DFIG based WECS, Standalone operation of fixed and variable speed wind energy conversion systems. Power control, voltage regulation, frequency regulation in WECS.	**8**
VI	Grid Integrated solar system-single stage grid connected PV system, Hybrid Renewable Energy systems- Need for Hybrid Systems- Type of Hybrid systems. Grid connection Issues, Maximum Power Point Tracking (MPPT) algorithms of wind and PV.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P62D	DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS	PEC	1	2	0	3	2020

i) COURSE OBJECTIVES:

This course aims to impart knowledge to Analyse the circuits and select them for the suitable applications. Students will acquire skills to determine the problems associated with the modelling of Power Electronic circuits. They will be able to apply software tools for the analysis of power electronic systems**.**

ii) COURSE OUTCOMES:

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

CO 1	Apply the principle of modelling on various power semiconductor devices.	Apply
CO 2	Develop models for control circuits for power electronic circuits.	Analyse
CO 3	Apply state space averaging in AC circuit analysis	Apply
CO 4	Analyse different approaches on modelling machines, PWM techniques, DC-DC Converters and Two-level VSC	Analyse
CO 5	Apply PSPICE simulation software for analysis of Power electronic systems	Apply
CO 6	Apply analog modelling using Micro Sim PSPICE A/D.	Apply

iii) SYLLABUS

Principles of Modelling Power semiconductor Devices; Modelling of Diode, Thyristor TRIAC, IGBT and Power Transistors.

Modelling of Control circuits for power electronics switches; Computer Formulation of equations for Power Electronic Systems.

AC equivalent circuit modelling; Modelling of electrical Machines.

Modelling and simulation of DC-DC converters-Two-level VSC.

Circuit analysis Software Micro SimPspice A/D.

Analog behaviour Modelling.

iv) REFERENCES

1) Robert W. Erickson, *Fundamentals of Power Electronics*, Chapman & Hall, 2nd Edition,1997 Marcel Dekker, Incorporation.
2) *Micro SimPSpice A/D and Basics+: Circuit Analysis Software*, User's Guide Micro Sim Corporation.
3) Jai P.Agarwal, *Power Electronic Systems-Theory and Design*, Pearson, 2001.

4) *Micro Sim Schematics: Schematic Capture User's Guide*, Micro Sim Corporation.
5) *Simulink Reference Manual*, Math works, USA.
6) Randall Shaffer, *Fundamentals of Power Electronics with MATLAB*, Firewall Media, India, 2007.
7) Farzin Asadi Kei Eguchi, *Simulation of Power Electronics Converters Using PLECS*, Academic Press, November 2019.
8) Amirnaser Yazdani, Reza Iravani, *Voltage-Sourced Converters in Power Systems: Modeling, Control, and Applications*, Wiley-IEEE Press,2010.

v) COURSE PLAN

Module	Contents	No. of hours
I	Principles of Modelling Power semiconductor Devices, Macro Models versus Micro models, Modelling of diode in simulation. Diode with R, R-L, R-C and R-L-C load with ac supply. Thyristor models-Semiconductor Device modelled as Resistance, resistance –Inductance and Inductance–Resistance-Capacitance combination, Modelling of TRIAC, IGBT and Power Transistors in simulation	7
II	Modelling of Control circuits for power electronics switches. Computer Formulation of equations for Power Electronic Systems. Review of Graph Theory as applied to Electrical Networks Systematic method of formulating state equations-computer solution of state equations. Explicit integration method-implicit integration method	8
III	AC equivalent circuit modelling, Basic AC modelling approach-State space averaging circuit, Averaging and averaged switch modelling, Modelling the PWM, Modelling of electrical Machines-induction, DC and synchronous machines	8
IV	Modelling and simulation of DC-DC converters– State space averaging Dynamic model of buck, boost and buck-boost converter-PID controller design for buck converter. Models and control of two-level VSC - Averaged Model of Two-Level VSC- Model of Two-Level VSC in αβ-frame and dq-frame	8
V	Circuit analysis Software Micro Sim Pspice A/D, Simulation overview-creating and preparing a circuit for simulation, simulating a Circuit with Pspice A/D-displaying simulation results - Pspice A/D analysis, Simple multi run analysis-Statistical analysis - Simulation examples of Power Electronic systems.	7
VI	Micro Sim PSPICE A/D –Preparing a schematic for simulation – creating symbols-creating models-Analog behaviour Modelling – Setting up and Running analyses-viewing results-examples of power electronic systems.	7
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P63A	SOFT COMPUTING TECHNIQUES	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

Goal of this course is to provide students the concepts of different soft computing techniques. It gives an insight into the different types of Artificial Neural Network architectures, the learning processes and algorithms, the properties and operations of fuzzy logic, the working of a fuzzy logic system, the operators of Genetic Algorithms and finally some of the hybrid systems. It also gives an idea on the application of soft computing techniques on different systems. It also aims to provide a basic knowledge on using the different soft computing toolboxes in Computer.

ii) COURSE OUTCOMES:

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

CO 1	Explain the fundamentals of Artificial Neural Networks.	Understand
CO 2	Distinguish the different Artificial Neural Network architectures and use appropriate networks for solving problems.	Apply
CO 3	Express the fundamentals of Fuzzy Logic and Genetic Algorithm.	Understand
CO 4	Apply fuzzy logic in appropriate systems.	Apply
CO 5	Attain an optimal solution to a given problem using Genetic Algorithm.	Understand
CO 6	Identify the hybrid techniques to be chosen according to the given problems.	Understand

iii) SYLLABUS

Basic Introduction – Difference between soft computing and hard computing, artificial intelligence.

Artificial Neural Networks – Biological foundations, ANN models, architecture, Learning, Supervised and unsupervised learning, Back propagation network, Adaptive Resonance Theory, Applications, Case studies.

Fuzzy logic – Fuzzy set properties and operations; membership functions, Fuzzy logic systems, Applications.

Genetic Algorithm – basic concepts, operators, steps.

Hybrid Systems – Adaptive Neuro-fuzzy Inference System, Genetic algorithm based back propagation networks, fuzzy back propagation networks.

iv) REFERENCES

1) Timothy J. Ross, *Fuzzy logic with Engineering Applications*, Wiley Publications, 3rd Edition, 2010.
2) Sivanandan S. N., Deepa S. N., *Principles of Soft Computing*, Wiley India, 2007.
3) Zurada J. M., *Introduction to Artificial Neural Systems*, Jaico Publishers, 2003.
4) Rajasekharan S., Vijayalakshmi Pai G. A., *Neural Network, Fuzzy Logic and Genetic Algorithms Synthesis and Applications*, Prentice Hall India, 2003.
5) Ronald R. Yager and Dimitar P. Filev, *Essentials of Fuzzy Modelling & Control*, John Wiley & Sons, Inc, 2002.
6) Bart Kosko, *Neural Network and Fuzzy Systems*, Prentice Hall of India, 2002
7) Hassoun Mohammed H., *Fundamentals of Artificial Neural Networks*, Prentice Hall of India, 2002.
8) Simon Haykin, *Neural Networks a Comprehensive foundation*, Pearson Education, 1999.
9) Jang J. S. R., Sun C. T., Mizutani E., *Neuro-Fuzzy and Soft Computing*, Prentice Hall, 1997.
10) Suran Goonatilake & Sukhdev Khebbal (Eds.), *Intelligent Hybrid Systems*, John Wiley, 1995.
11) Driankov D., Hellendoorn H., Reinfrank M, *An Introduction to Fuzzy Control*, Narosa Publications, 1993.
12) Goldberg D. E., *Genetic Algorithms in Search Optimisation and Machine Learning*, Pearson Education, 1989.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction**: Conventional and Modern Control System, Soft and Hard Computing, Artificial Intelligence. **Artificial Neural Networks**: Biological foundations – ANN models - Characteristics of ANN - Types of activation function - McCulloch-Pitts neuron model. **Neural network architecture and learning:** Single layer, multilayer, recurrent network architectures. Learning process - Supervised and unsupervised learning, Error correction learning - Hebbian learning – Boltzmann learning - competitive learning.	9
II	Perceptrons, Adaptive Linear Neuron, Multiple Adaptive Linear Neuron, Back propagation network and its architecture, Derivation of the back-propagation algorithm, Radial basis function network. Applications of Neural Networks, Neural Network Toolbox in MATLAB.	9
III	**Fuzzy sets and Fuzzy logic**: Introduction, Fuzzy sets versus crisp sets, Membership functions, properties, operations on fuzzy sets. Block diagram - Fuzzification, rule base, inference engine and defuzzification methods.	6
IV	**Fuzzy logic controller**: Fuzzy models - Mamdani Fuzzy Models, Sugeno Fuzzy Models, fuzzy controllers, fuzzy pattern recognition,	8

	fuzzy image processing. Engineering Applications - inverted pendulum, home heating system. Fuzzy logic toolbox in MATLAB.	
V	**Genetic Algorithm**: Introduction - basic concepts of Genetic Algorithm, encoding, fitness function, reproduction, cross over, mutation operator, bit-wise operators, generational cycle.	**6**
VI	**Hybrid Systems**: Adaptive Neuro-fuzzy Inference System (ANF1S), Genetic algorithm based back propagation networks, fuzzy back propagation networks.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P63B	HYBRID ELECTRIC VEHICLES	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES

Goal of this course is to familiarize a comprehensive overview of Electric and Hybrid Electric Vehicle and it also discusses how to choose proper energy storage systems for vehicle applications. It gives an insight into the electric propulsion unit and its control for application of electric vehicles. It also intends to deliver design of Hybrid Electric Vehicle and various communication protocols and technologies used in vehicle networks.

ii) COURSE OUTCOMES

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

CO 1	Analyse the change in acceleration and angular acceleration of rigid bodies as a result of applied forces and moments.	Analyse
CO 2	Analyse the various aspects of hybrid and electric drive train configurations and its power flow control depending on resources.	Analyse
CO 3	Analyse the types of electric machine suitable for hybrid and electric vehicles applications.	Analyse
CO 4	Analyse fundamental electrochemistry of battery operation and performance requirements and choose proper energy storage systems for vehicle applications.	Analyse
CO 5	Design and develop basic schemes of electric vehicles and hybrid electric vehicles.	Design
CO 6	Identify various communication protocols and technologies used in vehicle networks.	Understand

iii) SYLLABUS

Introduction to Hybrid Electric Vehicles, Conventional Vehicles, Basics of vehicle performance: Dynamics of electric and hybrid vehicles vehicle.

Hybrid Electric Drivetrains- various hybrid drive-train topologies, power flow control.

Electric Propulsion unit, Configuration and control of DC Motor, Induction Motor drives, Permanent Magnet Motor drives, Switched reluctance motor.

Energy Storage Requirements in Hybrid and Electric Vehicles, Hybridization of different energy storage devices.

Sizing the drive system, Matching the electric machine and the internal combustion engine.

Design of a Hybrid Electric Vehicle and Battery Electric Vehicle.

In vehicle networks, Energy Management Strategies, implementation issues of energy management strategies.

iv) a) TEXT BOOKS

1) Iqbal Hussein, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2003.
2) Gianfranco Pistoia, *Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market*, Elsevier,2010.
3) Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, 2004.
4) Sheldon S. Williamson, *Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles*, Springer, 2013.

b) REFERENCES

1) James Larminie, John Lowry, *Electric Vehicle Technology Explained*, Wiley, 2003.
2) Chris Mi , Abul Masrur M., *Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives*, Second Edition, John Wiley & Sons Ltd,2017.
3) Fuhs A. E., *Hybrid Vehicles and the Future of Personal Transportation*, CRC Press, 2009.
4) Chan C.C. and Chau K.T., *Modern Electric Vehicle Technology*, OXFORD University Press, 2001.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Hybrid Electric Vehicles:** History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drivetrains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance, Maximum Tractive effort.	7
II	**Hybrid Electric Drive-trains**: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies.	7
III	**Electric Propulsion unit**: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, Configuration and control of Permanent Magnet Motor drives, Configuration and control of Switched Reluctance Motor drives.	8
IV	**Energy Storage**: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super	8

	Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.	
V	**Sizing the drive system**: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).	**8**
VI	**Communications, supporting subsystems**: In vehicle networks-CAN, ISO-OSI Seven-layer Model. Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, implementation issues of energy management strategies.	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P63C	MODERN POWER CONVERTERS	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

Goal of this course is to impart knowledge about the different DC-DC converters and its control techniques. It also gives an introduction to electromagnetic and radio frequency interference and classification of switched mode AC power supplies.

ii) COURSE OUTCOMES:

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

CO1	Analyse and design different DC-DC converter circuits.	Analyse
CO2	Summarize the working of different isolated DC-DC converters.	Apply
CO3	Explain the different resonant converters.	Understand
CO4	Analyse the control of switched mode DC power supplies.	Analyse
CO5	Explain the Electromagnetic interferences in power supplies.	Understand
CO6	Illustrate the working of different AC power supply circuits.	Understand

iii) SYLLABUS

Switched mode power converters: Buck Converter; Boost converter, Buck- Boost converter, Cuk Converter- Continuous conduction mode, discontinuous conduction mode.

DC-DC converter with isolation: Flyback converter, Forward Converter, Push – Pull converter, Half Bridge converter, Full Bridge converter.

Series and parallel resonant inverters; Zero current and Zero voltage switching resonant converters;

Control of switched mode DC power supplies: Single Phase: Monolithic PWM control circuit, Electromagnetic and radio frequency interference.

AC power supplies, classification: Resonant AC power supplies, Introduction power line disturbances.

iv) REFERENCES

1) Fang Lin Luo and Fang Lin Luo, *Advanced DC/DC Converters*, CRC Press, NewYork,2004.
2) Kazmier Krishnan P and Frede Blaabjerg, *Control in Power Electronics Selected Problem*, Marian Academic Press, Elsevier Science, 2002.
3) Rashid M.H., *Power Electronics Circuits, Devices and Applications*, 4th Edition, Prentice Hall India, New Delhi, 2013.
4) Pressman A. I., *Switching Mode Power Supply Design*, Tata McGraw-Hill, 1992.

5) Ned Mohan, Tore M. Undeland and William P. Robbins, *Power Electronics Converters, Applications, and Design*, 3rd Edition, Wiley India Pvt Ltd, 2010.
6) Umanand L., *Power Electronics: Essentials and Applications*, Wiley, 2009.
7) Joseph Vithayathil, *Power Electronics: Principles and Applications*, McGraw-Hill, 1994.
8) Michel D., *DC-DC Switching Regulator Analysis*, Newness, 2000.
9) Lee Y., *Computer Aided Analysis and Design of Switch Mode Power Supply,* 1993.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to switched mode power converters, Generalized comparison between switched mode and linear DC regulators, Operation and steady state performance of Buck, Boost, Buck-Boost and Cuk Converters: Continuous conduction mode, discontinuous conduction mode and boundary between continuous and discontinuous mode of operation, output voltage ripple calculation, effect of parasitic elements.	8
II	DC-DC converter with isolation: Fly back converters- other fly back converter topologies, forward converter, the forward converter switching transistor- Variation of the basic forward converter. Push pull converter transistor-Limitation of the Push Pull circuit-circuit variation of the push pull converter-the half bridge and full bridge DC-DC converters.	8
III	Resonant Pulse Converters, Series and parallel resonant inverters - zero current and Zero voltage switching resonant converters, frequency response. Two quadrant zero voltage switching resonant converters.	7
IV	Control of switched mode DC power supplies: Voltage feed forward PWM control, current mode control, digital pulse width modulation control, isolation techniques of switching regulator systems: soft start in switching power supply designs, current limit circuits, over voltage protection circuit	8
V	A typical monolithic PWM control circuit and their application: TL 494. Power factor control in DC-DC converters. Electromagnetic and radio frequency interference, conducted and radiated noise, EMI suppression, EMI reduction at source, EMI filters, EMI screening, EMI measurements and specifications.	7
VI	AC power supplies, classification switched mode ac power supplies Resonant AC power supplies, bidirectional ac power supplies, multistage conversions, control circuits and applications. Introduction power line disturbances, power conditioners, uninterruptible Power supplies – applications	7
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P69B	MINI PROJECT	PWS	0	0	4	2	2020

i) COURSE OBJECTIVES

The goal of this course is to make students design and develop a system or application in the area of their specialization.

ii) APPROACH

The student shall present two seminars and submit a report. The first seminar shall highlight the topic, objectives, methodology, design and expected results. The second seminar is the presentation of the work / hardware implementation

iii) COURSE OUTCOMES

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

CO 1	Select a suitable problem relevant to their stream with an attention to real life problems faced by the society and to solve problems by designing and implementing a system.	Apply
CO 2	Test the designed system or application.	Analyse
CO 3	Present the results from the work comprehensively through presentation	Apply

iv) CONTINUOUS INTERNAL EVALUATION PATTERN

Distribution of marks for the seminar shall be as follows.

Marks for the project work and output : 40%

Marks for the report : 30%

Marks for presentation and viva voce : 30%

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P68B	DRIVES AND SIMULATION LAB	PCC	0	0	2	1	2020

i) COURSE OBJECTIVES

The main objective of the course is to expose the students to the simulation software PSpice, simulate dc drives using MATLAB and hands-on session of drives.

ii) COURSE OUTCOMES

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

CO 1	Analyse the rectifier circuits using PSpice	Analyse
CO 2	Analyse the rectifier control of DC drive using MATLAB	Analyse
CO 3	Analyse the working of parallel inverters and choppers	Analyse
CO 4	Analyse the open loop control of DC and AC drives	Analyse

iii) LIST OF EXPERIMENTS

1) Simulation of Power Electronic Systems using PSpice
    a) Single phase uncontrolled half wave & Full wave rectifier
    b) Single phase half wave and Full wave controlled rectifier
2) Simulation of rectifier fed Electric Drives using Computer
    a) Single phase semi converter Fed separately excited DC motor
    b) Single phase Full converter Fed separately excited DC motor
    c) Three Phase Converter fed separately excited DC motor
3) Simulation of Chopper control Fed separately excited DC motor using Computer
4) Study of single phase parallel inverter.
5) Study of three phase parallel inverter
6) Open loop control of DC drive.
7) Open loop control of AC drive.
8) Jones chopper.

iv) REFERENCES

1) Rashid M H, *Power Electronics – Circuits, Devices and Applications*, Prentice Hall of India, New Delhi, 4th Edition, 2014.
2) Ned Mohan, Tore M. Undeland, William P.Robbins, *Power Electronics: Converters, Applications and Design*, 3rd Edition 2020.
3) Dubey G. K., *Power semiconductor control drives*, Prentice Hall, Englewood Cliffs, New Jersey, 1989.

v) COURSE PLAN

Expt. No.	Contents	No. of hours
1	Simulation of Power Electronic Systems using PSpice a) Single phase uncontrolled half wave & Full wave rectifier b) Single phase half wave & Full wave controlled rectifier	**4**
2	Simulation of rectifier fed Electric Drives using MATLAB a) Single phase semi converter Fed separately excited DC motor b) Single phase Full converter Fed separately excited DC motor c) Three Phase Converter fed separately excited DC motor	**3**
3	Simulation of Chopper control Fed separately excited DC motor using MATLAB a) Set-up the chopper fed dc drive using MATLAB b) Observe and Plot the waveforms for various duty cylces	**4**
4	Study of single-phase parallel inverter a) Set-up three phase parallel inverter b) Plot the trigger pulse and output waveforms	**3**
5	Study of three phase parallel inverter a) Set-up three phase parallel inverter b) Plot the trigger pulse and output waveforms	**4**
6	Open loop control of DC drive. a) Set-up Open loop control of DC drive b) Plot the trigger pulse and output waveforms	**4**
7	Open loop control of AC drive. a) Set-up Open loop control of DC drive b) Plot the trigger pulse and output waveforms	**4**
8	Jones chopper. a) Set-up Jones chopper circuit b) Plot the trigger pulse and output waveforms	**4**
	Total Hours	**30**

SEMESTER III

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P71A	ADVANCED INSTRUMENTATION	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

The goal of the course is to provide an introduction to the field of Instrumentation and covers process variables and the various instruments used to sense, measure, transmit and control these variables. This course also introduces plant level automation, Petrinet models and various sensors used. The course concludes with a study of virtual instrumentation and review of a VI software.

ii) COURSE OUTCOMES:

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

CO 1	Describe the performance characteristics of instruments, dynamic and frequency response of different order systems.	Apply
CO 2	Describe the various sensors used in industrial instrumentation.	Understand
CO 3	Explain the various process in plant level automation.	Understand
CO 4	Describe the concept of virtual instrumentation and to develop basic VI programs.	Analyse

iii) SYLLABUS

Generalized performance characteristics of instruments.

General concept of transfer function, Dynamic response and frequency response studies, Response of a general form of instrument.

Plant level automation- process and instrumentation diagrams Performance modelling, Telemetry, Pneumatic Instrumentation; Reliability in Instrumentation and Control.

Petrinet models, Smart Sensors, Wireless sensors and Wireless Sensor network protocol.

Virtual instrumentation – Definition, flexibility – Block diagram and architecture of virtual instruments– Virtual instruments versus traditional instruments

Review of software in virtual instrumentation - VI programming techniques.

iv) REFERENCES

1) Doeblin.B.D, *Measurement systems - Application and Design*, McGraw Hill New York.
2) John P. Bentley, *Principles of Measurement System*, Pearson Education
3) Walt Boyes, Butterworth-Heinemann, *Instrumentation Reference Book*, 3rd Edition, 2002.
4) Dally.J.W, Reley.W.F and Mc Connel K. G., *Instrumentation for Engineering measurements* , 2nd Edition, John Wiley & sons Inc, New York, 1993.

5) Curtis D. Johnson, *Process Control Instrumentation Technology*, Prentice Hall of India Private Limited, New Delhi.
6) Dale E. Soberg, Thomson F Edgar, *Process Dynamics and Control*, 2/e, Wiley.
7) Klaasen.K.B, *Electronic Measurement and Instrumentation*, Cambridge University Press.
8) Waltenegus Dargie & Christian Poella Bauer, *Fundamentals of Wireless Sensor networks*, Wiley Series.
9) Jun Zheng & Abbas Jamalipour, *Wireless sensor Networks - A Networking perspective*, Wiley.
10) Silvano Donati, *Electro-Optical Instrumentation: Sensing and Measurements with lasers*, PHI, 2010.

v) COURSE PLAN

Module	Contents	No. of hours
I	Generalized performance characteristics of instruments - Static characteristics, static calibration, memory, precision and bias, dynamic characteristics, development of mathematical model of various measurement systems. Classification of instruments based on their order.	6
II	General concept of transfer function (with special reference to measuring systems) Dynamic response and frequency response studies of zero order, first order and second order instruments. Response of a general form of instrument to a periodic input. Response of a general form of instrument to a transient input. Requirement of instrument transfer function to ensure accurate measurement.	9
III	Plant level automation- process and instrumentation diagrams- Performance modeling — role of performance modeling- performance measures.	9
IV	Petrinet models- introduction to petrinets - basic definitions and analytical techniques, Smart Sensors, Wireless sensors and Wireless Sensor network protocol	7
V	Virtual instrumentation – Definition, flexibility – Block diagram and architecture of virtual instruments – Virtual instruments versus traditional instruments	7
VI	Review of software in virtual instrumentation - VI programming techniques, sub VI, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, string and file input / output	7
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P71B	DIGITAL CONTROLLERS IN POWER ELECTRONICS	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

This course aims to impart knowledge about the architecture and peripherals of DSP. It also aims to provide understanding about different applications of microcontrollers.

ii) COURSE OUTCOMES:

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

CO 1	Explain the architecture and operation of C2XX DSP.	Understand
CO 2	Describe assembly programming and explain the interrupt structure	Understand
CO 3	Compare between programmable devices and DSPs.	Understand
CO 4	Apply HDL programming using FPGA	Apply
CO 5	Illustrate the use of 8051 Microcontrollers in different control applications	Apply

iii) SYLLABUS

C2xx DSP core and code generation - Assembly Programming using C2xx DSP, instruction Set, Software Tools, Types of Physical Memory, memory addressing modes

Assembly Programming using C2xx DSP - Instruction Set, Software Tools, Pin multiplexing (MUX) and general Purpose I/O overview.

ADC overview - Operation of the ADC in the DSP, Overview of the event Manager, Event Manager, Interrupts.

Introduction to Field Programmable gate – Arrays, CPLD Vs FPGA, types of FPGA, Xilinx XC3000 series, configurable logic Blocks (CLB), Input/output block-Programmable interconnect Point (PIP)-Xilinx 4000 series.

HDL programming - overview of Spartan 3E and Virtex II pro FPGA boards – case study, 8051 microcontroller-typical applications-DC motor speed control, speed measurement, Temperature control, stepper motor control, PID control

iv) REFERENCES

1) Hamid A. Toliyat, Steven G. Campbell, *DSP based Electromechanical Motion Control*, Press New York 2004.

2) Sen M. Kuo, Woon Seng Gan, *Digital Signal Processors: Architecture, Implementation and Applications*, Pearson, 2005.
3) XC3000 series data sheets (Version 3.1) Xilinx Inc., USA 19984.
4) XC4000 series data sheets (Version 1.6) Xilinx Inc., USA 19995.
5) Wayne Wolf, *FPGA based system Design*, Prentice Hall 2004.
6) Phil Lapsley, Bler, Sholam, E.A. Lee, *DSP Processor Fundamentals*, IEE Press, 1997.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to the C2xx DSP core and code generation: -The components of C2xx DSP core, Mapping external devices to the C2xx DSP core, peripherals and Peripheral Interface, System configuration registers, Memory: -Types of Physical Memory, memory addressing modes	**8**
II	Assembly Programming using C2xx DSP, instruction Set, Software Tools. Pin multiplexing (MUX) and general Purpose I/O overview, Multiplexing and general Purpose I/O Control registers, Introduction to Interrupts, Interrupt Hierarchy, Interrupt control registers, Initializing and servicing Interrupts in software	**8**
III	ADC overview:- Operation of the ADC in the DSP, Overview of the event Manager, Event Manager, Interrupts:-General purpose (GP) timers, compare units Capture units and Quadrature enclosed Pulse(QEP) circuitry, General Event Manager Information	**8**
IV	Introduction to Field Programmable gate Arrays-CPLD Vs FPGA-types of FPGA, Xilinx XC3000 series, configurable logic Blocks (CLB), Input/output block-Programmable interconnect Point (PIP)-Xilinx 4000 series	**8**
V	HDL programming-overview of Spartan 3E and Virtex II pro FPGA boards –case study PID control.	**7**
VI	8051 microcontroller-typical applications-applications-PI controller, Clarks and Park transformation, PWM generation, PLL and unit sine wave generation.	**6**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P71C	EHVAC AND DC TRANSMISSION	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

To enable the student, gain a fair knowledge on the concepts and technology of Extra High Voltage DC and AC Transmission.

ii) COURSE OUTCOMES

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

CO 1	Explain the configuration of HVDC systems.	Understand
CO 2	Analyse the operation of converter circuits.	Analyse
CO 3	Explain harmonic production and remedial measures and reactive power requirement in converter circuits.	Analyse
CO 4	Explain protection in HVDC substation and earth electrodes.	Understand
CO 5	Apply the knowledge of voltage gradient in corona loss calculation.	Apply
CO 6	Explain the insulation requirement and insulation coordination in substations.	Understand

iii) SYLLABUS

EHV AC transmission- interconnected AC networks-HVDC transmission system- Power flow in AC and HVDC lines-steady state Ud/Id characteristics. Converter circuits- analysis of converters- control characteristics; Harmonics and filters. Reactive power requirements in HVDC substations- planning of HVDC; DC line oscillations and line dampers-over voltage protection; Earth electrode; EHV AC Transmission; Corona; Insulation requirements of EHV AC and DC transmission lines; insulation coordination; switching over voltage.

iv) a) TEXT BOOKS

1) Rao.S, *EHV AC and HVDC Transmission Engineering & Practice*, Khanna Publishers,3rd Edition, 1993.
2) Kimbark.E.W, *Direct Current Transmission Volume*, John Wiley, New York, 1st Edition, 1971
3) Padiyar.K.R, *HVDC Power Transmission Systems*, Wiley Eastern Ltd**,** 3rd Edition,2017.

b) REFERENCES

1) Rakosh Das Begamudre, *EHV AC Transmission Engineering*, New Age International Pvt. Ltd., 3rd Edition 2006.

v) COURSE PLAN

Module	Contents	No. of hours
I	**EHVAC and HVDC systems:** EHV AC transmission-configuration-features, intermediate substations-applications; interconnected AC networks, HVDC system-classification-configuration, equipment in HVDC substations, Major HVDC systems in India, EHV AC vs. HVDC-economic comparison, HVDC power flow, power conversion principle, power loss in DC system, steady state Ud/Id characteristics.	8
II	**Converter circuits**: single phase and three phase circuits, analysis of bridge converter, with and without overlap, control characteristics, constant minimum ignition angle control, constant current control, extinction angle control.	7
III	**Harmonics**: characteristic harmonics in AC; non characteristic harmonics in AC, means of reducing harmonics-filters-single frequency and double frequency-tuned filters, DC harmonic filter, telephone interference. **Reactive power requirements in HVDC substations**: effect of delay angle and extinction angle, significance of short circuit ratio for planning of HVDC links.	7
IV	**Protection:** DC line Oscillations and line dampers, Over voltage protection, DC lightning arresters, DC circuit breakers- basic concepts, types and characteristics. **Electrodes**: location and configuration, earth return, materials of anode, sea electrode, shore electrode, troubles by earth currents and remedial measures.	8
V	**EHV AC Transmission:** Components of transmission system-voltage gradients of conductor-single and bundled conductor. **Corona:** Corona and corona losses in EHVAC and HVDC-critical surface gradient-Peeks law-critical disruptive voltage and critical electric stress for visual corona.	7
VI	**Insulation requirements:** Insulation requirements of EHV AC and DC transmission lines - Electrostatic field of EHV lines-biological effects-live wire maintenance **Insulation co-ordination:** insulation for power frequency-voltage-switching, over voltage-lightning performance.	8
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P71D	POWER SYSTEM PROTECTION	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

Objective of the course is to impart basic knowledge in computer relaying. It gives mathematical basis for relaying algorithms. This course explains transmission relaying algorithms and protection of transformers, machines and buses. It provides information about the hardware organization necessary for computer relaying.

ii) COURSE OUTCOMES

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

CO 1	Explain the basics in computer relaying.	Understand
CO 2	Describe the mathematical basis for protective relaying algorithms.	Understand
CO 3	Select suitable algorithm in transmission line relaying.	Apply
CO 4	Select suitable algorithm in the relaying of transformers, machines and buses.	Apply
CO 5	Describe the necessary hardware organization for relaying and system relaying and control.	Understand
CO 6	Describe the developments in relaying principles with travelling waves.	Understand

iii) SYLLABUS

Introduction to computer relaying; Review of relaying practices; Review of mathematical basis for protective relaying algorithms; Transmission line relaying algorithms; Protection of transformers, Machines and buses; Power transformer algorithms; digital protection of generators and motors; Hardware organization; System relaying and control; Development in new relaying principles; recent developments in relaying.

iv) a) TEXT BOOKS

1) Arun G. Phadke and James S Thorp, *Computer Relaying for Power Systems*, John Wiley & Sons Inc, New York.
2) Ravindra P. Singh, *Digital Power System Protection*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

b) REFERENCES

1) Johns T., Salman S. K., *Digital Protection for Power Systems*, Peter Peregrinus Ltd., 1995.
2) Ali Abur& Antonio Gomez Exposito, Marcel Dekkerjnc, *Power System State Estimation-Theory and Implementation*.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to computer relaying:** Development and historical background, expected relay architecture, A-D converters, Anti –aliasing Filters, substation computer hierarchy. Review of relaying practices: functions of a protective system, Protection of transmission lines, Transformers, Reactors and generator Protection, Bus Protection, Performance of current and voltage transformers.	7
II	**Review of mathematical basis for protective relaying algorithms:** Fourier series, Orthogonal expansions, Fourier transforms, Discrete Fourier transforms, Introduction to probability and random processes, Kalman Filtering.	8
III	**Transmission line relaying algorithms:** Introduction, sources of error, relaying as parameter estimation, Symmetrical component distance relay, Protection of series compensated lines	7
IV	**Protection of transformers, Machines and buses:** Power transformer protection algorithms, digital protection of generators and motors, protection of buses.	7
V	**Hardware organization:** Computers for relaying, substation environment, Industry environmental standards, counter measures against EMI, Redundancy and Back up. **System relaying and control:** Measurement of frequency and phase, sampling clock synchronization, Application of phase measurements to static and dynamic state estimation, system monitoring.	8
VI	**Development in new relaying principles:** Travelling waves in single phase and three phase lines travelling waves due to faults, directional wave relay, Travelling wave distance relay, Differential Relaying with phasors, travelling wave differential relays, adaptive relaying fault location algorithms, recent developments in relaying.	8
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P72A	SWITCH MODE POWER CONVERTERS	PEC	3	0	0	3	2020

i) COURSE OVERVIEW

This course aims to impart the knowledge to analyse the working and performance of various power electronic converters and to design converters. The course also imparts knowledge about Switched mode power supplies, its control methods and modelling.

ii) COURSE OUTCOMES

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

CO 1	Explain the various control methods of switch mode power Supplies.	Understand
CO 2	Apply AC modelling to converter circuits	Apply
CO 3	Describe the concepts of state space averaging of DC-DC converters	Understand
CO 4	Analyse the working of different resonant converters	Analyse

iii) SYLLABUS

Voltage mode control of SMPS- Current mode control of SMPS- Volt sec balance & small signal approximation-Boost converter analysis- Equivalent Circuit Modelling of Ideal Power Converters.

Introduction to AC modelling-Averaged AC modelling-Perturbation & Linearization-Modelling the pulse width modulator; State Space averaging- Circuit averaging and averaged switch modelling –Modelling of Flyback converter.

Introduction to Resonant converters- Classification- Load resonant converters-Resonant switch converters; Zero Voltage switching- resonant DC Link inverters with zero voltage switching – High frequency link integral half cycle converter.

iv) REFERENCES

1) Abraham I Pressman, *Switching Power Supply Design*, McGraw-Hill Publishing Company.
2) Erickson R. W., *Fundamental of Power Electronics*, Chapman & Hall Publishers.
3) Rashid M.H., *Power Electronics Circuits, Devices and Applications*, 3rd Edition, Prentice Hall a. India, New Delhi, 2014.
4) Ned Mohan, Undeland and Robbins, *Power Electronics: Converters, Applications and Design*, 3rd Edition, John Wiley, 2003.
5) Umanand L., *Power Electronics: Essentials and Applications*, Wiley, 2009 Rai. G.D, Solar Energy Utilization, Khanna Publishers, 5th Edition, 2014.

6) Mitchel D. M., *DC-DC Switching Regulator Analysis*, McGraw-Hill Ltd, 1988.
7) Umanand L and Bhatt S. R., *Design of Magnetic Components for Switched Mode Power Converters*, New Age International, New Delhi, 2001.

v) COURSE PLAN

Module	Contents	No. of hours
I	Voltage Mode Control of SMPS - Loop gain and Stability Considerations - Shaping the Error Amplifier gain versus frequency characteristics - Error amplifier Transfer function – Tran conductance Error amplifiers, High power factor converters.	**7**
II	Current Mode Control of SMPS – Current Mode Control Advantages. Current Mode versus Voltage Mode Control of SMPS – Current Mode Deficiencies - Slope Compensation. Volt sec balance & small signal approximation-Boost converter analysis- Equivalent Circuit Modelling of Ideal Power Converters-DC transformer model-Modelling converter losses.	**8**
III	Modelling of SMPS - Basic AC modelling Approach Perturbation and Linearization-Modelling the pulse width modulator-– Modelling of non ideal fly back converter	**7**
IV	State Space Averaging – basic state space averaged model – State space averaging of non ideal buck boost converter - Circuit averaging and averaged switch modelling – Modelling of flyback converter-Compensator design for feedback controllers.	**8**
V	Introduction to Resonant Converters – Classification of Resonant Converters – Basic Resonant circuit concepts – load resonant converters – resonant switch converters	**7**
VI	Zero voltage switching, clamped voltage topologies – resonant DC Link inverters with zero voltage switching – High frequency link integral half cycle converter, Zero Current switching converters, EMI consideration for high frequency operation.	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P72B	FINITE ELEMENT METHODS FOR ELECTRICAL MACHINES	PEC	3	0	0	3	2020

i) COURSE OBJECTIVE

Goal of this course is to expose the students to understand the basic electromagnetic field equations and the problem formulation for CAD applications and the concepts of Finite element and finite difference methods as applicable for Electrical Engineering.

ii) COURSE OUTCOMES

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

CO 1	Describe the basic electromagnetic field equations and the problem formulation.	Understand
CO 2	Identify various methods like Finite Element Method and Finite Difference Method as applicable to Electrical Engineering.	Understand
CO 3	Apply Finite Element Method for analyzing the performance of electrical machines	Apply
CO 4	Apply Variational Method for the design of different Electrical apparatus	Apply
CO 5	Interpret the organization of a typical CAD package and problem formulation for different applications.	Apply

iii) SYLLABUS

Need for Field Analysis based design- Recent Trends Mathematical Formulation of Field Problems- Development of Torque/Force

Electromagnetic Field Equations - Magnetic Vector/Scalar Potential - Electrical Vector/Scalar Potential- Inductances - Maxwell Equations - Laplace and Poissons Equations

Philosophy of FEM- Differential/Integral Equations - Finite Difference Method - Finite Element Method- boundary conditions.

Rayleigh Ritz and Galerkin Approach to finite Elements- Normal gradient boundary conditions- Forced and natural boundary conditions.

Elements of CAD Systems - Preprocessing - Modeling - meshing - Material Properties - Boundary Conditions - Setting up Solutions- The electric field-finite element analysis.

iv)a) TEXT BOOKS

1) Sheppard J. Salon, Kluwer, *Finite Element Analysis of Electrical Machines*, Springer-Verlag New York Incorporation,2019.

2) Krishna Moorthy C. S., *An Introduction to Computer Aided Electromagnetic Analysis, Vector Field Finite Element Analysis*, Tata McGraw Hill Publishing Company Limited, New Delhi, 2014.
3) Peter P Silvester. Ronald L Ferrari. *Finite Elements for Electrical Engineers*, Cambridge University Press, 2012.

b) REFERENCES

1) Rantajeevan H. Hoole S., *Computer Aided analysis and design of electromagnetics devices*, Elsevier Science Publishing company, New York, 2005.
2) Lowther D. A. and Silvester P. P., *Computer Aided design in Magnetics*, Springer Verlag, Berline Heidelberg, New York, 2017.
3) Nicola Bianchi, *Electrical Machine Analysis Using Finite Elements*, CRC Press,2017.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction:** Conventional design Procedures - Limitations - Need for Field Analysis based design - History of development and Applications - Recent Trends Mathematical Formulation of Field Problems: Review- Development of Torque/Force.	7
II	**Electromagnetic Field Equations** - Magnetic Vector/Scalar Potential - Electrical Vector/Scalar Potential - Stored Energy in Field Problems - Inductances - Maxwell Equations - Laplace and Poissons Equations - Energy Functional. Numerical Problems.	8
III	**Principle of Energy Conversion Philosophy of FEM**: Mathematical Models - Differential/Integral Equations - Finite Difference Method - Band Matrix method- Finite Element Method - Energy Minimization - Field problems - Discretization - Shape Functions - Stiffness Matrix. Numerical Problems.	8
IV	**Variational Method** - Direct and Indirect Method-Moment Method, Point Collocation, Sub domain Collocation, Least Squares. Weighing Functions. **Rayleigh Ritz and Galerkin Approach to finite Elements** - Normal gradient boundary conditions- Forced and natural boundary conditions- - Galerkin Method for poison equation -Numerical example.	8
V	**Solution Techniques CAD Packages and Design Applications**: Elements of CAD Systems - Preprocessing - Modeling - meshing - Material Properties - Boundary Conditions - Setting up Solutions.	7
VI	**Electric and Magnetic Fields** in a co-axial cable - The magnetic field - The electric field-finite element analysis - Case study of machines. **Thermal modelling of power devices.**	7
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P72C	BIOMEDICAL INSTRUMENTATION	PEC	3	0	0	3	2020

i) COURSE OBJECTIVES:

Goal of this course is to give the basic concepts of Instrumentation involved in medical field and human physiology. Biomedical Instrumentation is application of technology for Medical field. During the course, students will explore Electro- physiological measurements, medical imaging, image processing, therapeutic equipment etc.

ii) COURSE OUTCOMES:

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

CO 1	Describe the bioelectric potentials, the electrode theory, different types of electrodes and transducers.	Understand
CO 2	Explain the working and concepts of ECG, EMG, EEG.	Understand
CO 3	Explain blood flow measurements and various Therapeutic Equipment.	Understand
CO 4	Describe the basic concepts of biomedical image and signal processing.	Understand
CO 5	Identify the instruments used in clinical laboratory and modern imaging modalities.	Apply

iii) SYLLABUS

Introduction to the physiology of cardiac, nervous; muscular and respiratory systems; Action potentials -De-polarization; repolarization; Absolute and relative refractory periods; Generation propagation and transmission.

Measurement of electrical activities in heart, Electrocardiography; Measurement of electrical activities in brain, Electroencephalogram; Measurement of electrical activities in muscles; Determination of conduction velocity in a nerve fiber. Important applications of EMG

Measurement of blood flow; Direct and Indirect methods; Therapeutic Equipment - Cardiac pace-makers, Types of pace-makers; Defibrillators, Types of defibrillators, Electrodes used in defibrillators, diathermy machines, Micro wave and short wave diathermy machines.

Introduction to Biomedical signal processing; Analysis of x-rays; CT and MRI images; Basic methods; Instrumentation for clinical laboratory; Measurement of pH value of blood, ESR measurements, GSR measurement, modern imaging modalities; X-ray machines, Diagnostic X-rays- Computed Tomography; Ultra sonography.

iv) REFERENCES

1) Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., *Biomedical Instrumentation and Measurement*, Dorling Kingsley, 2nd Edition, 2006.
2) Carr, J.J. and Brown, J.M., *Introduction to Biomedical Equipment Technology*, Prentice Hall, 4th Edition, 2000.
3) Geddes, L.A., and Baker, L.E., *Principles of Applied Biomedical Instrumentation*, Wiley InterScience, 3rd Edition 1989.
4) Khandpur, R.S., *Handbook of Biomedical Instrumentation*, McGraw Hill, 2nd Edition, 2003.
5) Webster, J.G., *Medical Instrumentation Application and Design*, John Wiley, 3rd Edition, 2007.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to the physiology of cardiac, nervous, muscular and respiratory systems. Transducers and Electrodes, Action potentials-De-polarization – repolarization- Absolute and relative refractory periods-generation propagation and transmission. Significance of after potentials, Different types of transducers and their selection for biomedical applications.	7
II	Electrode theory, Different types of electrodes, reference electrodes, hydrogen, calomel, Ag-AgCl, pH electrode, selection criteria of electrodes.	6
III	Measurement of electrical activities in heart, brain and muscles - Electrocardiography - EEG machine, Disease diagnosis from ECG, Computer aided electrocardiographs- Applications of ECG. Electroencephalogram and their interpretation. EEG machine applications, Rapid eye movement- Electromyography, EMG machines, Conduction velocity in a nerve fiber. Important applications of EMG.	9
IV	Electromagnetic and ultrasonic measurement of blood flow, various methods, Therapeutic Equipment - Cardiac pace-makers, Types of pace-makers, Defibrillators, Types of defibrillators, Electrodes used in defibrillators, diathermy machines, Microwave and short wave diathermy machines.	9
V	Introduction to Biomedical signal processing, Methods of signal processing – Digital and analogue. Introduction to Biomedical image processing- Analysis of x-rays, CT and MRI images – Basic methods.	7
VI	Instrumentation for clinical laboratory - Measurement of pH value of blood, ESR, and GSR measurement, modern imaging modalities - X-ray machines, Diagnostic x-rays - Computed Tomography- Ultrasonography - Magnetic resonance imaging - Nuclear medicine - Radio isotopic instrumentation - Medical uses of isotopes- Applications of robotics in medical field- Cyber knife.	7
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P79A	SEMINAR II	PWS	0	0	2	2	2020

i) COURSE OBJECTIVES

The goal of this course is to make students to:

1. Identify the current trends in the specific stream.
2. Collect recent publications related to the identified topics.
3. Prepare a comprehensive report based on literature survey.
4. Deliver presentation based on the preparations.
5. Improve the writing and presentation skills.

ii) APPROACH

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

iii) COURSE OUTCOMES

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

CO 1	Attain good exposure in the recent topics relevant to the specified stream.	Apply
CO 2	Develop good communication and presentation skills.	Apply
CO 3	Explore domains of interest so as to pursue project work.	Analyse

iv) CONTINUOUS INTERNAL EVALUATION PATTERN

Distribution of marks for the seminar shall be as follows.

Report	: 30%
Presentation	: 40%
Ability to answer questions on the topic	: 30%

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P79B	PROJECT (PHASE I)	PWS	0	0	12	6	2020

i) COURSE OBJECTIVES

The goal of this course is to make students to:

1. Do independent study on the area of specialization.
2. Explore a subject in depth of his/her own choice.
3. Start the preliminary background studies towards the project by conducting literature survey in the relevant field.
4. Broadly identify the area of the project work, familiarize with the tools required for the design and analysis of the project.
5. Plan the experimental platform, if any, required for project work

ii) APPROACH

The student has to present two seminars and submit an interim Project report. The first seminar would highlight the topic, objectives, methodology and expected results. The first seminar shall be conducted in the first half of this semester. The second seminar is the presentation of the interim project report of the work completed and scope of the work which has to be accomplished in the fourth semester

iii) COURSE OUTCOMES

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

CO 1	Select a suitable problem relevant to the streams connecting real life problems faced by the society	Analyse
CO 2	Identify the phases for scheduling work plan of the project work	Understand

iv) CONTINUOUS INTERNAL EVALUATION PATTERN

Evaluation scheme for Project (Phase I) : 50 Marks

Sl. No.	Description	Marks	Total Marks
1	Review - 1	Review committee: 5 Project Supervisor(s): 5	10
2	Review - 2	Review committee: 15 Project Supervisor(s): 5	20
3	Review - 3	Review committee: 10 Project Supervisor(s): 10	20

SEMESTER IV

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE1P79C	PROJECT (PHASE II)	PWS	0	0	23	12	2020

i) COURSE OBJECTIVES

The goal of this course is to make students

1. Continue and complete the project work identified in Project (Phase I)

ii) APPROACH

There shall be two seminars (a mid-term evaluation on the progress of the work and pre submission seminar to assess the quality and quantum of the work). At least one technical paper has to be prepared for possible publication in journals / conferences based on their project work.

iii) COURSE OUTCOMES

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

CO 1	Implement innovative ideas in the field of the domain of interest and pursue future research activities	Evaluate
CO 2	Present his/her work in a conference or publish the work in a peer reviewed journal	Apply

iv) PROJECT PHASE II EVALUATION PATTERN

Continuous Assessment Marks : 70

Sl. No.	Description	Marks	Total Marks
1	Review - 1	Review committee: 5 Project Supervisor(s): 5	10
2	Review - 2	Review committee: 15 Project Supervisor(s): 10	25
3	Review - 3	Review committee: 20 Project Supervisor(s): 15	35

End Semester Examination Marks: 30