SETHU INSTITUTE OF TECHNOLOGY

(An Autonomous Institution)

Pulloor, Kariapatti – 626 115

M.E. POWER ELECTRONICS AND DRIVES

REGULATIONS 2021

CHOICE BASED CREDIT SYSTEM

CURRICULUM AND SYLLABUS

(I SEMESTER to IV SEMESTER)

CHAIRMAN
BOARD OF STUDIES

CHAIRMAN
ACADEMIC COUNCIL

Department Vision

To achieve Excellence in Education and Research in the field of Electrical and Electronics Engineering and provide knowledge based contribution for the development of economy and society

Department Mission

- Providing comprehensive and value based education in Electrical and Electronics engineering and related fields to meet intellectual, ethical and career challenges
- Providing state-of- the-art infrastructure and resources to promote teaching-learning and research activities
- Enriching the skills to enhance employability and entrepreneurship
- Strengthening the collaboration with academia, industry and research organizations
- Fostering Research and Development activities leading to innovation and technological growth in the overall ambit of electrical and electronics engineering
- Offering services to the society through education, science and technology through education and technology.

Program Educational Objectives (PEOs)

After few years of graduation our Power Electronics and Drives Post graduates are expected to:	
PEO I	Acquire technical knowledge, skills and analytical ability to design, develop and test power electronic converters and drives using modern tools.
PEO II	Attain intellectual leadership skills to cater to the changing needs of power electronic industry, academia, society and environment.
PEO III	Engage in life- long learning through independent study, projects, research and to work in multidisciplinary teams

Program Outcomes

PO No.	PROGRAM OUTCOMES
PO1	An ability to Independently carry out research /investigation and development work to solve practical problems
PO2	An ability to Write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program, higher than the requirements in the appropriate bachelor program.
PO4	Apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.
PO5	Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with continuous enthusiasm and commitment to improve knowledge and competence.
PO6	Act with professional and ethical responsibility in research and professional practices with consideration of the impact of outcomes to contribute for the sustainable development of the society.

M.E. Degree Program (Full Time)

CURRICULUM

Regulation 2021

Master of Engineering in Power Electronics and Drives

OVERALL COURSE STRUCTURE

Course Component	Curriculum Content (% of total number of credits of the program)	Total number of Courses	Total number of credits
Program Core	37.14	9	26
Program Electives	25.71	6	18
Open Electives	4.28	1	3
Mini Project	8.57	1	6
Internships/ Seminar	2.86	1	2
Major Project	17.14	1	12
Any other (Mandatory/ Audit Course)	4.28	3	3
		Total number of Credits	**70**

COURSE CREDITS – SEMESTER WISE

Branch	I	II	III	IV	TOTAL
ME-PED	**18**	**22**	**18**	**12**	**70**

M.E POWER ELECTRONICS AND DRIVES

REGULATION – 2021

(Applicable to the students admitted from the Academic Year 2021 – 2022 onwards)

CURRICULUM I TO IV SEMESTERS (FULL TIME)

SEMESTER I

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	21 PPE101	Power Electronic Converters	3	1	0	4
2.	21 PPE102	Modeling and Analysis of Electrical Machines	3	1	0	4
3.		Elective-1	3	0	0	3
4.	21PGM701	Research Methodology and IPR(Mandatory credit course)	3	0	0	3
5.	21PGM801	Pedagogy studies (Audit course -1)	2	0	0	0
PRACTICAL						
6.	21PPE103	Power Electronic Converters Laboratory	0	0	4	2
7.	21PPE104	Power Quality Laboratory	0	0	4	2
Total			**14**	**2**	**8**	**18**

SEMESTER II

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	21PPE201	DC and AC Drives	3	0	0	3
2.	21PPE202	Embedded Control of Power Electronic and Drive systems	3	0	0	3
3.	21PPE203	Electric Vehicles and Energy storage	3	0	0	3
4.	21PPE204	Power Converters for Renewable Energy Systems	3	0	0	3
5.		Elective-2	3	0	0	3
6.		Elective-3	3	0	0	3
PRACTICAL						
7.	21PPE205	Drives and control Laboratory	0	0	4	2
8.	21 PPE206	Term paper and seminar	0	0	4	2
		Total	**18**	**0**	**8**	**22**

SEMESTER III

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.		Elective-4	3	0	0	3
2.		Elective-5	3	0	0	3
3.		Elective-6	3	0	0	3
4.		Open Elective	3	0	0	3
5.	21PGM802	English For Research paper writing (Audit-II)	2	0	0	0
PRACTICAL						
6.	21 PPE301	Phase-I Dissertation	0	0	12	6
Total			13	0	12	18

SEMESTER IV

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	21 PPE401	Phase-II Dissertation	0	0	24	12
		Total	0	0	24	12

TOTAL NO. OF CREDITS: 70

M.E POWER ELECTRONICS AND DRIVES

REGULATION – 2021

(Applicable to the students admitted from the Academic Year 2021– 2022onwards)

CURRICULUM

LIST OF PROGRAM CORE

S.NO	COURSECODE	COURSE TITLE	L	T	P	C
1.	21PPE101	Power Electronic Converters	3	1	0	4
2.	21PPE102	Modeling and Analysis of Electrical Machines	3	1	0	4
3.	21PPE103	Power Electronic Converters Laboratory	0	0	4	2
4.	21PPE104	Power Quality Laboratory	0	0	4	2
5.	21PPE201	DC and AC Drives	3	0	0	3
6.	21PPE202	Embedded Control of Power Electronic and Drive systems	3	0	0	3
7.	21PPE203	Electric Vehicles and Energy storage	3	0	0	3
8.	21PPE204	Power Converters for Renewable Energy Systems	3	0	0	3
9.	21PPE205	Drives and control Laboratory	0	0	4	2
10.	21PPE206	Term paper and seminar	0	0	4	2
11.	21PPE301	Phase-I Dissertation	0	0	12	6
12.	21PPE401	Phase-II Dissertation	0	0	24	12

LIST OF PROGRAM ELECTIVES

S. No.	Course Code	Course Title
1	21PPE501	Advanced Power Electronic Circuits
2	21PPE502	Electric Power Quality
3	21PPE503	Control of Special Electrical Machines
4	21PPE504	Soft Computing Techniques
5	21PPE505	Advanced Control of Electric Drives
6	21PPE506	Modern Rectifiers and Resonant Converters
7	21PPE507	Modern Industrial Drives
8	21PPE508	Advanced Digital Signal Processing
9	21PPE509	Advanced Micro controller based Systems
10	21PPE510	Wind Energy Conversion Systems
11	21PPE511	SCADA Systems and Applications
12	21PPE512	FACTS and Custom Power Devices
13	21PPE513	HVDC Systems and Control
14	21PPE514	Power Electronics Applications to Power System
15	21PPE515	Solar and Energy Storage System
16	21PPE516	Smart Grid
17	21PPE517	Distributed Generation and Micro Grid
18	21PPE518	Optimization Techniques in Power Electronics
19	21PPE519	Microcontroller Application in Power Converters
20	21PPE520	Modeling and control of Power Electronic Systems
21	21PPE521	Embedded control of Electrical Drives
22	21PPE522	Automotive Electronics
23	21PPE523	Design of Motor and Power Converters For Electric Vehicles
24	21PPE524	Design of Electric Vehicle Charging System
25	21PPE525	Design and Modeling of Renewable Energy Systems

LIST OF OPEN ELECTIVES

SL.NO	COURSE CODE	COURSE TITLE
1.	21PCD601	Industrial Safety
2.	21PCS602	Business analytics
3.	21PCM603	IOT for Smart Application
4.	21PPE604	Bio Energy from Waste
5.	21PSE605	Smart City Technologies

SEMESTER I

SEMESTER I

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	21PPE101	Power Electronic Converters	3	1	0	4
2.	21PPE102	Modeling and Analysis of Electrical Machines	3	1	0	4
3.		Elective-1	3	0	0	3
4.	21PGM701	Research Methodology and IPR (Mandatory credit course)	3	0	0	3
5.	21PGM801	Pedagogy studies (Audit course1)	2	0	0	0
PRACTICAL						
6.	21PPE103	Power Electronic Converters Laboratory	0	0	4	2
7.	21PPE104	Power Quality Laboratory	0	0	4	2
Total			14	2	8	18
Total Number of Credits: 18						

21PPE101	POWER ELECTRONIC CONVERTERS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- Understand the operation, characteristics and performance parameters of different converters
- Understand the switching techniques and basic topologies of DC-DC switching regulators
- Understand the working of advanced types of converters such as multilevel inverters and Matrix converters.

UNIT I POWER SEMICONDUCTOR DEVICES AND MODELING 9+3

Current controlled and Voltage controlled devices- Steady State characteristics, switching characteristics, steady state and dynamic models -Gate drive circuit for SCR, MOSFET, IGBTs and base driving for power BJT, Need of snubber circuit – Types of snubber -Design of snubbers.

UNIT II AC TO DC CONVERTERS 9+3

Single phase and three phase Half controlled, Fully controlled converters with R, RL, RLE loads, Freewheeling diode, Dual Converter. Evaluation of performance parameter, Input harmonics and output ripple, smoothing inductance, power factor, effect of source inductance and overlap. Snubber circuit design - Control circuit strategies.

UNIT III DC TO DC CONVERTERS 9+3

DC choppers: Step down dc chopper with R, RL and RLE loads - Control strategies -Two quadrant and four quadrant DC chopper - Multiphase DC chopper - Switching mode regulators: Buck, Boost, Buck-Boost and CUK regulators - Resonant and quasi resonant converters – Control circuit strategies

UNIT IV DC TO AC CONVERTERS 9+3

Single phase and Three phase bridge inverters Voltage source and Current source inverters Voltage control and harmonic minimization in inverters. SVPWM – Multilevel inverters - Comparison of multilevel inverters - Applications of multilevel inverters

UNIT V AC TO AC CONVERTERS 9+3

Principle of phase control, single-phase bi-directional controllers with R, L and R-L loads, 3-phase bi-directional Controllers, different Configurations Analysis with pure R and L loads. Principle of operation - single phase and three phase cyclo converters – Matrix converters.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

- Illustrate the switching characteristics of various power semiconductor devices and operation of converters. [Understand]
- Sketch the input and output waveforms of power electronics converter under various load conditions. [Apply]

- Determine the Performance of Various Chopper and Switching Mode Regulators. [Apply]
- Analyze the performance of AC/DC, DC/DC, DC/AC, AC/AC and matrix converters under various operating modes. [Analyze]
- Design the Converters by applying various control strategies for a given practical application using Matlab. [Create]
- Make an effective communication and presentation to demonstrate the role of power electronics applications in the aspect of energy conservation, societal, environmental and ethical standards. [Valuing]

REFERENCES:

- Ned Mohan, Undeland and Robbin, “Power Electronics: converters, Application and design”, John’s Wiley and sons. Inc, Newyork.
- M.H.Rashid, “Power Electronics”, Prentice Hall of India 1994.
- Sen P.C, “ Modern Power Electronics ”, Wheeler publishing Co, First Edition, New Delhi, 1998.
- Singh M.D, Khanchandani K. B, “Power Electronics”, Tata McGraw Hill Publishing Company Limited, 2nd Edition, 2009.

21PPE102	MODELING AND ANALYSIS OF ELECTRICAL MACHINES	L	T	P	C
		3	1	0	4

OBJECTIVES:

- . To analyze the various types of machines and model with different transformation techniques.
- To study the special machines and its model.

UNIT I CONCEPTS OF ROTATING MACHINES 9+3

Basic Concepts of Rotating Machines-Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine. Introduction to direct axis and quadrature axis theory in salient pole machines

UNIT II INDUCTION MACHINE MODELING 9+3

Static and rotating Reference(s): frames, transformation relationships - Stationary circuit variables transformed to the arbitrary Reference frame treating R, L, C elements separately Application of reference frame theory to three phase symmetrical induction and synchronous machines -Dynamic direct and quadrature axis model in arbitrarily rotating reference frames. Performance analysis of three phase squirrel cage Induction Motor using MAXWELL RMxprt Software. (ANSYS)

UNIT III SYNCHRONOUS MACHINE MODELING 9+3

Application of reference frame theory to three phase synchronous machine-dynamic model analysis—Park's equation - Voltage and torque equations- Deviation of steady state phasor relationship from dynamic model -Generalized theory of rotating electrical machine and Kron's primitive machine

UNIT IV ELECTRICAL MACHINE EQUIVALENT CIRCUIT PARAMETERS 9+3

Determination of Synchronous machine dynamic equivalent circuit parameters - Standard and derived machine time constants - Frequency response test- Analysis and dynamic modeling of two-phase asymmetrical induction machine and single phase induction machine

UNIT V SPECIAL MACHINES 9+3

Permanent magnet synchronous machine, Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines - Construction and operating principle -Dynamic modeling and self controlled operation – Dynamic analysis of Switched Reluctance Motors.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

- Understand the various electrical parameters, reference frame theories and transformation relationships in mathematical form. **[Understand]**
- Apply the theory of transformation of three phase variables to two phase variables. **[Apply]**
- Determine the equivalent circuit parameters and modeling of electrical machines. **[Apply]**
- Analyze the steady state and dynamic operation of DC machine through mathematical modeling. **[Analyze]**
- Analyze the steady state and dynamic operation of three-phase AC machines using transformation theory based mathematical modeling. **[Analyze]**
- Estimate the dynamic modeling of electrical machines under different operating conditions for the sustainable development of the society. **[Evaluate]**

REFERENCES:

1. Harles Kingsley Jr., A.E. Fitzgerald and Stephen D.Umans, “Electric Machinery”, NewYork, McGraw- Hil Higher Education, 2010.
2. Paul C. Krause, Oleg Wasynczuk and Scott D. Sudhoff, “Analysis of Electric Machinery and Drive Systems”, New Jersey, Wiley Student Edition, 2013
3. R. Krishnan, “Electric Motor & Drives: Modeling, Analysis and Control”, New Delhi, Prentice Hall of India, 2001.
4. J. R. Hendershot, James R. Hendershot, Timothy John Eastham Miller, “Design of Brushless Permanent-magnet Machines”,Motor Design Books, 2010.
5. K.T Chau,“Electric Vehicle Machines and Drives: Design, Analysis and Application”, John Wiley & Sons, 2015.

21PGM701 RESEARCH METHODOLOGY AND IPR

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide an overview on selection of research problem based on the Literature review
- To enhance knowledge on the Data collection and Analysis for Research design
- To outline the importance of ethical principles to be followed in Research work and IPR

UNIT I FORMULATION OF RESEARCH PROBLEM 9

Meaning of research problem, Sources of research problem, Criteria- good research problem, and selecting a research problem, Scope and objectives of research problem. Defining and formulating the research problem - Necessity of defining the problem – Types of Literature Review- Sources for Literature Review - Identifying gap areas from literature review.

UNIT II RESEARCH DESIGN AND ETHICS 9

Research Design – Different Research designs- Sampling design- Types of sampling, Methods of Data collection- primary data, secondary data
Plagiarism, Application of results and ethics - Environmental impacts - Ethical issues - ethical committees

UNIT III DATA ANALYSIS AND TESTING OF HYPOTHESES 9

Data Processing and Analysis strategies -Types of Analysis- Statistics in Research - Measures of Central Tendency - Measures of Dispersion - Measures of Asymmetry (Skewness) -Measures of Relationship - Simple Regression Analysis - Multiple Correlation and Regression Testing of Hypotheses- Chi-square test, Taguchi and ANOVA

UNIT IV REPORT AND RESEARCH PROPOSAL WRITING 9

Significance of Report Writing - Different Steps in Writing Report - Layout of the Research Report - Typesof Reports - Oral Presentation - Mechanics of Writing a Research Report - Bibliography, types of referencing, citations.
Format of research proposal -Research Proposal writing - assessment by a review committee.

UNIT V INTELLECTUAL PROPERTY AND PATENT RIGHTS 9

Nature of Intellectual Property – Patents- Designs, Trade and Copyright- Geographical Indications. Process of Patenting and Development – Patent Search- Invention, Innovation-Documents for Patentfiling - Examination- Grant of Patent.
Scope of Patent Rights - Case Studies

TOTAL: 45 PERIODS

COURSE OUTCOMES

- Design suitable research methodology to pursue the research in scientific and systematic procedure with statistical / IT Tools. [Apply]
- Apply ethical principles in research and reporting to promote healthy scientific practice. [Apply]
- Analyze the literature to identify the research gap in the given area of research. [Analyze]
- Analyze and synthesize the data using research methods and knowledge to provide scientific interpretation and conclusion. [Analyze]
- Conduct patent database search in various countries for the research problem identified. [Analyze]
- Prepare research reports and proposals by properly synthesizing. [Organize]

REFERENCES

1. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

2. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.

3. Wadehra, B.L. 2000. Law relating to patents, Trade Marks, Copy right designs and Geographicalindications. Universal Law Publishing.

4. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPSagreement and policy options. Zed Books, New York.

ADDITIONAL READING

1. https://www.editage.com/insights/how-to-write-the-literature-review-of-your-research-paper
2. https://www.ee.iitb.ac.in/~apte/CV_PRA_TAGUCHI_INTRO.htm

21PGM801 **PEDAGOGY STUDIES**

L	T	P	C
2	0	0	0

OBJECTIVES:

- To make the students understand a range of cognitive capacities in human learners
- To explain the outcome-based education system
- To describe the curriculum design process

UNIT I EDUCATIONAL PSYCHOLOGY AND ENGINEERING EDUCATION 8

Learning process, motivation and engagement, ICT in learning and teaching, Facilitating the learners, Engineering education and recent trends, Research in Engineering education, General maxims of teaching, Teacher-centered, learner-centered and learning-centered approaches, Becoming a reflective teacher, Disruptive Innovation in Education

UNIT II OUTCOME BASED EDUCATION 8

Outcome Based Education: A broad context for quality teaching and learning, planning for quality teaching and learning, Necessity for learning outcomes - Course Outcomes and Program Outcomes, Defining learning outcomes, learning outcomes in the cognitive domain, learning outcomes in the affective domain, learning outcomes in the psychomotor domain, Program Outcomes, Graduate Attributes, Program Educational Objectives, linking learning outcomes to teaching and assessment.

UNIT III CURRICULUM DESIGN 7

Curriculum design cycle, curriculum structure, credit and academic load, need assessment – feedback from stakeholders, concept of “Constructive alignment”, the two loop approach of ABET, tuning approach of curriculum design, CDIO concept of curriculum design and implementation, Industry relevant curriculum design and implementation, concept mapping, Instructional design and delivery.

UNIT IV TEACHING AND ASSESSMENT STRATEGIES 7

Direct instruction as teaching strategy, co-operative learning, problem-solving, industry relevant teaching, role-play, case study, technology enabled teaching, research orientation, measurement and evaluation of students’ achievement, assessment of learning outcomes - assessment tools: direct and indirect assessment tools, rubrics for assessment, attainment analysis, corrective action- curriculum updation, improvement in pedagogy, innovative assessment methods.

TOTAL: 30 Periods

Course Outcomes:

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

- Develop the skills required in preparing daily lesson plans and unit lesson plans using various methods and approaches.
- Apply the knowledge of the relative fields of engineering and sciences relevant to the various complex problems of the society [Apply]
- Analyse the complex problems critically and identify methodology for solution using the knowledge acquired by the students in their curriculum [Analyse]
- Design effective teaching methodologies, approaches and techniques for teaching engineering and sciences

- Develop the skills required among students to solve the complex problems using various engineering methodologies
- Design proper assessment techniques to analyse the knowledge and skills acquired by the learners

References:

1. Dr.Sue Duchesne, Anne McMaugh, Sandra Bochner, Kerri-Lee Krause, "Educational Psychology for Learning and Teaching", Cengage Learning, 4th Edition, 2019.
2. *Lisa R. Lattuca, Patrick T. Terenzini, J. Fredericks Volkwein, and George D. Peterson, "*The Changing Face of Engineering Education*"* The Bridge, National Academy of Engineering, Summer 2006
3. Anderson, L. &Krathwohl , D. A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives . New York: Longman, 2001.
4. Blumberg, P. Developing learner-centred teaching: A practical guide for faculty. San Francisco: Jossey-Bass, 2017.
5. Teaching Support Services. Learning objectives. University of Guelph, Guelph, ntario. Retrieved from http://www.uoguelph.ca/tss/resources/idres/learningobjectives1.pdf
6. O.V. Boev, N.Gruenwald and G.Heitmann, "Engineering Curriculum Design aligned with Accrediation Standards", Hochschule Wismar Publishers, 2013
7. Fink, D. L. Integrated course design. Manhattan, KS: The IDEA Center, 2005. Retrieved from http://www.theideacenter.org/sites/default/files/Idea_Paper_42.pdf

21PPE103	POWER ELECTRONIC CONVERTERS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To train the students with knowledge of the principle of operation of power converter and inverter circuits.
- To simulate different power converters studied in the core courses on power converters.

LIST OF EXPERIMENTS*

1. Single phase half and fully controlled converter with lamp load
2. Three phase fully controlled converter with lamp load.
3. Design and simulation of DC-DC Choppers –Buck, Boost, Buck-Boost.
4. IGBT based single-phase PWM inverter.
5. IGBT based Three-phase PWM inverter.
6. Resonant DC to DC Converter.
7. Step down and Step-up MOSFET based Chopper
8. Simulation of Single phase Semi controlled converter with
    a) R Load
    b) RL load.
    c) RLE (Motor) Load
9. Simulation of Single phase fully controlled converter with
    a) R Load.
    b) RL load.
    c) RLE (Motor) Load using MATLAB & PSIM.
10. Simulation of three phase half controlled converter with
    a) R Load.
    b) RL load.
    c) RLE (Motor) Load
11. Simulation of single phase and three phase AC Voltage Controller.
    a) Lamp load
    b) Motor load
12. Simulation of(i) LC tank circuit resonance using MATLAB & PSIM
    ii) Basic / modified series inverter
    iii) Series loaded series resonant inverter
13. Design and simulation of snubber circuit.

***MINIMUM OF 10 EXPERIMENTS SHOULD BE OFFERED**

TOTAL: 60 Periods

COURSE OUTCOMES:

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

- Analyze the performance and operation of power converter circuits. [Analyze]
- Determine the performance of the power converter and inverter circuits. [Apply]
- Design and develop a Matlab model for various topologies of power converter circuits. [Create]
- Choose and model a power converter circuit for specific application. [Evaluate]
- Analyze the harmonic spectrum in various topologies of converter circuit by considering its standards. [Analyze]
- Make an effective communication and presentation to demonstrate the role of power electronics applications in the aspect of energy conservation, societal, environmental and ethical standards. [Valuing]

21PPE104	POWER QUALITY LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- Understand the different power quality issues to be addressed
- Understand the recommended practices by various standard bodies like IEEE, IEC, etc. on voltage & frequency, harmonics

LIST OF EXPERIMENTS

1. Power quality analysis of nonlinear loads.
2. To demonstrate the voltage and current distortions experimentally.
3. To reduce the current harmonics with filters.
4. To study the voltage sag due to starting of large induction motor.
5. To study the capacitor switching transients.
6. To study the effect of balanced nonlinear load on neutral current, in a three phase circuit
7. To study the effect of ground loop.
8. To study the effect of voltage flicker.
9. To calculate the distortion power factor.
10. Study the effect of harmonics on energy meter reading.
11. To study effect of voltage sag on electrical equipment.

TOTAL: 60 Periods

COURSE OUTCOMES:

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

- Determine harmonics and the effect of harmonics on system equipment and loads **[Apply]**
- Analyze the voltage and current distortions in power systems. **[Apply]**
- Examine the effect of capacitor switching and nonlinear load power quality**. [Evaluate]**
- Analyze the behavior of sag during starting of an induction motor and its effect on the equipment. **[Analyze]**
- Develop various mitigation devices for voltage sag, transients and harmonics. **[Create]**
- Make an effective communication and presentation to demonstrate the role of power electronics applications in the aspect of energy conservation, societal, environmental and ethical standards. **[Valuing]**

21PPE502	ELECTRIC POWER QUALITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the various power quality issues.
- To impart the knowledge of the conventional compensation techniques used for power factorcorrection and load voltage regulation.
- To familiarize the concept of power and power factor in single phase and three phasesystems supplying non linear loads

UNIT I INTRODUCTION **9**

Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves. Symptoms of poor power quality. Power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

UNIT II CONVENTIONAL LOAD COMPENSATION METHODS **9**

Principle of load compensation and voltage regulation – classical load balancing problem: open loopbalancing – closed loop balancing, current balancing – harmonic reduction and voltage sag reduction – analysis of unbalance – instantaneous of real and reactive powers –Extraction of fundamentalsequence component from measured.

UNIT III LOAD COMPENSATION USING DSTATCOM **9**

Compensating single – phase loads – Ideal three phase shunt compensator structure – generatingreference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced – Realization and control of STATCOM – DSTATCOM in Voltage control mode.

UNIT IV SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM **9**

Rectifier supported DVR – Dc Capacitor supported DVR – DVR Structure – voltage Restoration – Series and Shunt Active Filter – PSCAD/EMTDC-Simulation of active filters- Unified power qualityconditioner.

UNIT V DISTRIBUTED GENERATION AND GRID INTERCONNECTION **9**

Distributed Generation – Connection Requirements and impacts on the Network- Interaction and Optimal Location of DG- Power Quality in DG- Islanding Issues- Distribution Line Compensation- Real Generation- Protection Issues for Distributed Generation- Technologies for Distributed Generation- Power Quality impact from different DG types

TOTAL: 45 Periods

COURSE OUTCOMES:

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

- Explain various power quality terms as per IEEE Standards and IEC Electromagnetic Compatibility Standards. **[Understand]**
- Determine the Sources of different power quality issues and choose appropriate Mitigation Technique / Device to solve power quality problems**. [Apply]**
- Select the appropriate compensating devices for the given power quality issue. **[Analyze]**
- Identify the power quality issues with integration of distributed generation, various wiring and grounding problems and their solutions. **[Evaluate]**
- Develop a model to improve the Power Quality in the Power Distribution System under steady / Transient state using simulation software. **[Create]**
- Write an effective report as a team for the given scenario and suggest suitable modern FACTS devices to improve the Power Quality in Power Distribution System. **[Psychomotor Domain]**

REFERENCES:

1. Arindam Ghosh, “Power Quality Enhancement Using Custom Power Devices”, Kluwer AcademicPublishers, 2002.
2. Heydt G.T, “Electric Power Quality”, Stars in a Circle Publications, 2nd edition, 1994.
3. Roger C. Duggan, Mark F. McGranaghan Surya Santoso, Wayne Beauty H, “Electric Power systemQuality” Tata McGraw Hill, Third edition, 2012.
4. Arrillga A.J, “Power system harmonics”. John Wiley & sons, 2003.

SEMESTER II

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	21PPE201	DC and AC Drives	3	0	0	3
2.	21PPE202	Embedded Control of Power Electronic and Drive systems	3	0	0	3
3.	21PPE203	Electric Vehicles and Energy storage	3	0	0	3
4.	21PPE204	Power Converters for Renewable Energy Systems	3	0	0	3
5.		Elective-2	3	0	0	3
6.		Elective-3	3	0	0	3
PRACTICAL						
7.	21PPE205	Drives and control Laboratory	0	0	4	2
8.	21 PPE206	Term Paper and Seminar	0	0	4	2
Total			18	0	8	22
Total Number of Credits: 22						

21PPE201	DC and AC Drives	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn converter and chopper control of dc drives.
- To provide a strong background on various methods of speed control of AC machines. To learn the concept of closed loop control of AC and DC drives.
- To learn about digital control of drives.

UNIT I Controlled Rectifier and chopper control of dc drives 9

Modeling of drive elements – Equivalent circuit, transfer function of separately excited DC motors, model of power converters-Analysis of series and separately excited dc motor with single phase and three phase converters – modes of operation, power factor improvement — analysis of series and separately excited dc motor fed from choppers- chopper based implementation of braking schemes- PV fed DC drives**.**

UNIT II Control of Induction motor and Slip power Recovery Scheme 9

Steady state analysis – speed control techniques of induction motor – variable frequency operation of three phase induction motors – constant flux operation – dynamic and regenerative braking of CSI and VSI fed drives – Torque slip characteristics of wound rotor induction motor – rotor resistance control – static Kramer drive – sub synchronous and super synchronous operation--modified Kramer drives.

UNIT III Synchronous Motor Drives 9

Synchronous motor types, open loop VSI fed drive and its characteristics – self control model – torque angle and margin angle control – power factor control – brushless excitation systems – closed loop control of load commutated inverter fed synchronous motor drive.

UNIT IV Vector Oriented Control 9

Principle of vector control — DC drive analogy — Direct and Indirect methods – Tuning of the vector controller- Flux vector estimation - Direct torque control of Induction Machines — Torque expression with stator and rotor fluxes, DTC control strategy.

UNIT V Digital control of drive 9

P, PI and PID controller characteristics - simulation of converter and chopper fed dc drive- Sensing and feedback elements- Closed loop control of armature and field control — Phase locked loop and micro computer control of dc drives - selection of drives and drive considerations for textile mills, lifts and cranes and hoist drives.

TOTAL: 45 Periods

COURSE OUTCOMES:

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

- Explain the operation of the various controlled rectifier fed DC drives and Chopper fed DC Drives. **[Understand]**
- Develop Field Oriented Control and Direct Torque Control strategies for Induction Motor Drives. **[Apply]**
- Analyze the performance of single phase and three phase converter fed AC drives under different load conditions. **[Analyze]**
- Analyze the performance of DC Motors using various converter control techniques. **[Analyze]**
- Examine the different speed control concepts of AC drives under various operating conditions **[Evaluate]**
- Model the digital drive control technique for given applications. **[Apply]**

REFERENCES:

1. Bimal K Bose, “Modern Power Electronics and AC Drives”, Pearson Education, Asia, 2002.
2. Vedam Subramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw Hill, SecondEdition, 1994.
3. Gopal K Dubey, “Power Semiconductor controlled Drives”, Prentice Hall Inc, New Yersy, 1989.
4. J.M.D. Murphy and Turnbull, Thyristor Control of AC Motors, Pergamon Press, Oxford,1973.

21PPE202	EMBEDDED CONTROL OF POWER ELECTRONIC AND DRIVE SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To give knowledge on DSP & FPGA.
- To provide knowledge of control of electrical drives employing Digital controllers.
- To outline the overview of ADC.

UNIT I INTRODUCTION TO THE C2XX DSP 9

Introduction to the C2xx DSP core and code generation, The components of the C2xx DSP core, Mapping external devices to the C2xx core , peripherals and Peripheral Interface ,System configuration registers , Memory , Types of Physical Memory , memory Addressing Modes , Assembly Programming using C2xx DSP, Instruction Set, Software Tools.

UNIT II INTERRUPTS AND I/O REGISTERS 9

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.

UNIT III OVERVIEW OF ADC 9

ADC Overview , Operation of the ADC in the DSP , Overview of the Event manager (EV) ,Event Manager Interrupts , General Purpose (GP) Timers , Compare Units, Capture Units And Quadrature Enclosed Pulse (QEP) Circuitry , General Event Manager Information.

UNIT IV INTRODUCTION OF FPGA 9

Introduction to Field Programmable Gate Arrays – CPLD Vs FPGA – Types of FPGA ,Xilinx XC3000 series , Configurable logic Blocks (CLB), Input/ Output Block (IOB) –Programmable Interconnect Point (PIP) – Xilinx 4000 series –overview of Spartan 3E and Virtex II pro FPGA boards- case study.

UNIT V APPLICATIONS 9

Controlled Rectifier with VHDL Programming, Switched Mode Power Converters, PWM Inverters, DC motor control, Induction Motor Control.

TOTAL: 45Periods

COURSE OUTCOMES:

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

- Illustrate the overview of DSP, ADC, Interrupts and FPGA in Power Electronics. **[Understand]**
- Develop Assembly Language Program for controlling Electrical drives using Digital Signal Processors **[Apply]**
- Select and use Interrupts, ADCs and Event Managers for PWM generation. **[Apply]**
- Compare different FPGA boards and digital signal processors available for controlling Electrical drives. **[Analyze]**
- Recommend a suitable processor based on the Power Electronic Applications. **[Evaluate]**
- Design and develop DSP based control for various motors drive application. **[Create]**

REFERENCES:

1. Hamid A. Toliyat, Steven G. Campbell, " DSP Based Electro Mechanical Motion Control ", CRC Press, New York, 2004.
2. "XC 3000 series datasheets", Xilinx, Inc, (version 3.1), USA, 1998.
3. "XC 4000 series datasheets", Xilinx, Inc, (version 1.6), USA, 1999.
4. Wayne Wolf, "FPGA based system design", Prentice hall, 2004.

21PPE203	ELECTRIC VEHICLES AND ENERGY STORAGE	L	T	P	C
		3	0	0	3

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OBJECTIVES:

- To familiarize Electric vehicles and Architecture of Electric Vehicle mechanics.
- To impart the knowledge on Energy Storage System.
- To outline the power training components.

UNIT I ELECTRIC VEHICLES AND VEHICLE MECHANICS 9

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings, Comparisons of EV with internal combustion Engine vehicles, Fundamentals of vehicle mechanics.

UNIT II ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS 9

Architecture of EV's and HEV's – Plug-n Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT III CONTROL OF DC AND AC DRIVES 9

DC/DC chopper based four quadrant operations of DC drives – Inverter based V/f Operation (Motoring and braking) of induction motor drive system – Induction motor and permanent motor based vector control operation – Switched reluctance motor (SRM) drives.

UNIT IV BATTERY ENERGY STORAGE SYSTEM 9

Battery Basics, Different types, Battery Parameters, Battery modeling, Traction Batteries.

UNIT V ALTERNATIVE ENERGY STORAGE SYSTEMS 9

Fuel cell – Characteristics- Types – hydrogen Storage Systems and Fuel cell EV – Ultra capacitors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Interpret the concept of electric vehicle and energy storage systems. **[Understand]**
- Apply the concept of power train topology and power flow control for electric vehicles in the selection of particular application **[Apply]**
- Infer the operation of various types of electric drive systems suitable for electric vehicle operation. **[Apply]**
- Analyze the various strategies related to energy storage systems for electrical vehicles. **[Analyze]**
- Estimate the performance parameters associated with an electric vehicle under different operating conditions. **[Evaluate]**
- Design a suitable electric drive scheme for developing an electric hybrid vehicle depending on resources and present a technical report on modeling and operation of Electric vehicle. **[Create]**

REFERENCES:

1. Iqbal Husain, “Electric and Hybrid Vehicles Design Fundamentals”, CRC Press, Taylor & Francis Group, 2011.
2. Ali Emadi, MehrdadEhsani, John M.Miller , “Vehicular Electric Power Systems”, Special Indian Edition, Marcel dekker, Inc 2010.
3. Bimal K Bose, “Modern Power Electronics and AC Drives”, Pearson Education, Asia, 2002.
4. Gopal K Dubey, “Power Semiconductor controlled Drives”, Prentice Hall Inc, New Yersy, 1989.

21PPE204	POWER CONVERTERS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain different renewable energy resources, the principles involved in the conversion of PV & Wind energy to electrical energy.
- Give an idea on hybrid energy systems.
- To outline the power electronics for PV and Wind power systems.

UNIT I INTRODUCTION **9**

Overview of Indian energy scenario – Energy sources and availability – Energy crisis – Need to develop new energy technologies – Solar energy availability in India – Wind survey in India – Emerging trends in electrical energy utility – Energy and environment.
Modeling of renewable energy sources- PV array, Wind Electric generators , Fuel cells etc in MATLAB/PSCAD Simulink environment .

UNIT II POWER ELECTRONICS FOR PHOTOVOLTAIC SYSTEMS **9**

Solar cell fundamentals – Conversion of sunlight to electricity – Cell performance – Basics of photovoltaic –Types of PV power systems – Design of PV Systems -Standalone PV systems – Battery charging – PV charge controllers – Maximum Power Point Tracking (MPPT) – Inverters for standalone PV systems – Solar water pumping – Power conditioning unit for PV water pumping.

UNIT III HYBRID AND GRID CONNECTED PV SYSTEMS **9**

PV Diesel hybrid systems – Control of PV – Diesel hybrid system – Grid connected PV systems – Inverters for grid connected applications – Inverter – Inverter types – Power control through PV inverters – System configuration – Grid inverter characteristics.

UNIT IV POWER ELECTRONICS FOR WIND POWER SYSTEM **9**

Basics of wind power – Types of wind turbines – Types of wind generators – Types of wind power systems – Standalone wind diesel hybrid systems – Grid connected wind energy systems.

UNIT V SYSTEM MANAGEMENT OF WIND ENERGY CONVERTER **9**

Control circuitry – Microcontroller – Complex programmable logic device – Gate driver circuitry for wind energy applications - Modeling and simulation of hybrid renewable power system in MATLAB/PSCAD .Simulation and study of various power quality problems in hybrid /renewable energy power system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Interpret the stand-alone, grid-connected, and hybrid renewable energy systems. **[Understand]**
- Determine the performance of various electrical machine involved in wind energy conversion systems. **[Apply]**
- Sketch the performance characteristics of power electronics converters used for interfacing Renewable energy systems **[Apply]**
- Analyze the impacts of renewable energy technologies on the environment and demonstrate them to harness electrical power. **[Analyze]**
- Design the stand-alone, grid-connected, and hybrid renewable energy systems with MPPT **[Create]**
- Make an effective communication and presentation to demonstrate the role of power converter for renewable energy systems in the aspect of societal, environmental and ethical standards. **[Valuing]**

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee,"Wind Electricaal Systems", Oxford University Press,2009.
2. Erickson R, Angkrtitrakul S, Nasean O and Lujan G, " Novel power electronics systems for wind energy applications ", Final report, National Renewable Energy Laboratory, Colorado, US, Aug 24, 1999 – Nov 30, 2002.
3. Rai G. D, "Non conventional energy sources", Khanna publishers, 4th Edition, 2000.
4. Khan B.H, "Non Conventional Energy Resources", Tata McGraw Hill, 2nd Edition, 2006.
5. Manwell J.K, McGowan J.G, Rogers A.L, " Wind energy explained – Theory Design and applications ", John Wiley & Sons, 2nd Edition, 2009.
6. Rai. G.D, " Solar energy utilization", Khanna publishes, Delhi , 1993.

21PPE205	DRIVES AND CONTROL LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To design and analyze the various DC and AC drives.
- To generate the firing pulses for converters and inverters using digital
- processors

LIST OF EXPERIMENTS

- Thyristor control of D.C Drive.
- Chopper Fed DC Motor.
- A.C single phase motor speed control using TRIAC.
- Simulation of PWM inverter fed three phase induction motor.
- Simulation of VSI/CSI fed induction motor drive.
- V/f control of three phase induction motor.
- Simulation of PWM inverter fed permanent magnet synchronous motor drive.
- Simulation of Regenerative/ Dynamic breaking operation for DC motor.
- Simulation of Regenerative/ Dynamic breaking operation for AC motor.
- PC/PLC based AC/DC motor control operation

TOTAL: 60 Periods

COURSE OUTCOMES:

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

- Apply the various control techniques in electric drive systems. **[Apply]**
- Determine the performance of PC/PLC based AC/DC motor control. **[Apply]**
- Analyze the characteristics waveforms of v/f control, PWM inverter, VSI and CSI fed induction motor drive **[Analyze]**
- Analyze the performance of permanent magnet synchronous motor drive fed by PWM inverter. **[Analyze]**
- Examine the operation of various breaking methods involved in AC/DC drives in MATLAB. **[Evaluate]**
- Make an effective communication and presentation to demonstrate the role of power electronics applications in the aspect of energy conservation, societal, environmental and ethical standards. **[Valuing]**

21PPE206	TERM PAPER AND SEMINAR	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To inculcate the importance of communication skills
- To familiarize with the concepts in emerging engineering field

DESCRIPTION:

This course is introduced to enrich the communication skills of the student and to create awareness on recent development in Electrical and Electronics Engineering through Technical presentation. In this course, a student has to present at least two Technical papers or recent advances in Engineering / Technology that will be evaluated by a Committee constituted by the Head of the Department.

Students should work on a small research problem. Students have to carry out the project under the guidance of faculty member using the knowledge of subjects that he/she has learned. The student should submit the report at the end of the semester. The product should be demonstrated at the time of examination.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After the successful completion of this course, the student will be able to

- Identify and formulate a technical problem to reach substantiated conclusion using basic technical knowledge. **[Analyze]**
- Choose the appropriate methodology for solving the problem identified using research methods and analysis **[Analyze]**
- Design/Develop proto type / model for societal needs applying the basic engineering knowledge. **[Create]**
- Evaluate the performance of the developed solution using appropriate techniques and tools. **[Evaluate]**
- Write comprehensive technical report with proper citation and research ethics **[Organization]**
- Present the seminar with effective communication skills with clarity of ideas and concepts on recent technology **[Valuing]**

21PPE503 Control of Special Electrical Machines

L	T	P	C
3	0	0	3

Course Objective:
To impart knowledge on

- To impart knowledge on the constructional features and operating principles of various types of special electrical machines.
- To make the students compare and analyze the static and dynamic characteristics of special electrical machines.
- To provide knowledge on the different types of drive systems and controllers used in special electrical machines.

Unit I STEPPING MOTORS 9

Constructional features - principle of operation - modes of excitation - torque production in Variable Reluctance (VR) stepping motor – Characteristics - Linear and Non Linear Analysis - Drive systems and Control of stepping motor

Unit II SYNCHRONOUS RELUCTANCE MOTORS AND PERMANENT MAGNET SYNCHRONOUS MOTORS 9

Constructional features of axial and radial air gap Motors - operating principle - reluctance torque – phasor diagram - motor characteristics Principle of operation – EMF and Torque equations - Phasor diagram - Power controllers – Torque speed characteristics – Self control, Vector control, Microprocessor based control schemes

Unit III SWITCHED RELUCTANCE MOTORS 9

Constructional features-principle of operation-Inductance profile-Torque equation- Types of Power controllers and converter topologies used – Current control schemes – Torque Speed Characteristics – Hysteresis and PWM -Microprocessor based controller and Sensorless Controller

Unit IV PERMANENT MAGNET BRUSHLESS DC MOTORS 9

Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and Emf equation, Torque-Speed characteristics, Controllers-Magnetic Circuit Analysis-Microprocessor based controller

Unit V LINEAR MOTORS 9

Linear Induction Motor (LIM) classification – construction – Principle of operation – Concept of current sheet – goodness factor – DC Linear Motor (DCLM) types – circuit equation - DCLM control applications – Linear Synchronous Motor(LSM) – Types - Performance equations – Applications.

Course Outcome:

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

- Illustrate the operation of various special electrical machines. **[Understand]**
- Determine the operation and performance of various stepper motors. **[Apply]**
- Analyze the characteristics and different types of controllers for synchronous reluctance motors and permanent magnet synchronous motors. **[Analyze]**
- Analyze the characteristics and different types of controllers for permanent magnet brushless DC motors **[Analyze]**
- Design different types of controllers and control technique for switched reluctance motors **[Create]**
- Make an effective communication and presentation to demonstrate the role of special electrical machines in the aspect of societal, environmental and ethical standards. **[Valuing]**

Reference Book:

1. Miller, T.J.E. “Brushless permanent magnet and reluctance motor drives ", Clarendon Press, Oxford, 1989.

2. Kenjo, T, “Stepping motors and their microprocessor control", Clarendon Press, Oxford, 1989.

3. Naser A and Boldea L, “Linear Electric Motors: Theory Design and Practical Applications”, Prentice Hall Inc., New Jersey 1987.

4. Kenjo, T and Naganori, S “Permanent Magnet and brushless DC motors ", Clarendon Press, Oxford, 1989.

5. Kenjo, T. “Power Electronics for the microprocessor Age”, Oxford University Press1994.

6. B.K. Bose, “Modern Power Electronics & AC drives”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2001.

7. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

8. R.Krishnan, “Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design and Applications” CRC Press, 2001.

21PPE504	SOFT COMPUTING TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide adequate knowledge about FLC and NN toolbox.
- To expose the ideas about genetic algorithm.
- To provide adequate knowledge about feedback neural networks.

UNIT I INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS 9

Introduction of soft computing - soft computing vs. hard computing- various types of soft computing techniques- applications of soft computing-Neuron- Nerve structure and synapse-Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- McCullochPitts neuron model- perceptron model-Adaline and Madaline- multilayer perception model- back propogation learning methods-effect of learning rule coefficient -back propagation algorithm- factors affecting back propagation training applications.

UNIT II SPECIAL ARTIFICIAL NEURAL NETWORKS 9

Counter propagation network- architecture- functioning & characteristics of counter-Propagation network-Hopfield/ Recurrent network- configuration- stability constraints-associative memory and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications-Implementation and training-Associative Memory.

UNIT III FUZZY LOGIC SYSTEM 9

Introduction to crisp sets and fuzzy sets- basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control- Fuzzification- inference and defuzzification- Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system.

UNIT IV GENETIC ALGORITHM 9

Basic concept of Genetic algorithm and detail algorithmic steps-adjustment of free Parameters- Solution of typical control problems using genetic algorithm- Concept on some other search techniques like tabu search and ant colony search techniques for solving optimization problems.

UNIT V HYBRID SYSTEMS 9

Integration of neural networks and fuzzy systems, adaptive neuro fuzzy inference systems, ANN-GA-Fuzzy synergism and its application, Identification and control of linear and nonlinear dynamic systems using MATLAB-neural network toolbox. Implementation of fuzzy logic controller using MATLAB fuzzy logic toolbox.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Illustrate the architectures of NN, Fuzzy sets, GA and hybrid intelligent control techniques **[Understand]**
- Apply fuzzy logic, genetic algorithm, neural networks and reasoning to handle uncertainty and solve engineering problems. **[Apply]**
- Apply Genetic Algorithm and particle swarm optimization for power electronic optimization problems. **[Apply]**
- Examine the concepts of neural network learning methods, PSO and GA to improve competence in context of technological updation. **[Analyze]**
- Analyze the functions of ANN and fuzzy logic based models and control schemes for different non-linear systems. **[Analyze]**
- Develop intelligent control techniques for real time applications. **[Create]**

REFERENCES:

1. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”,3rd Edition, Wiley, 2010.
2. Zimmermann H.J, "Fuzzy set theory and its Applications", Springer international edition, 2011.
3. Chaturvedi, “Soft Computing Techniques and its Applications in Electrical Engineering”, Springer, 2008
4. Laurene V. Fausett, “Fundamentals of Neural Networks: Architectures, Algorithms And Applications”, Pearson Education,1993.
5. David E.Goldberg, “Genetic Algorithms in Search, Optimization, and Machine Learning”, Pearson Education, 2009.
6. W.T.Miller, R.S.Sutton and P.J.Webrose, “Neural Networks for Control”, MIT Press, 1996.
7. Jacek.M.Zurada, “Introduction to Artificial Neural Systems”, Jaico Publishing House, 1999.
8. KOSKO.B, “Neural Networks and Fuzzy Systems”, Prentice-Hall of India Pvt. Ltd., 1994.
9. Kalyanmoy Deb, “Multi-Objective Optimization Using Evolutionary Algorithms”, Wiley, 3rd Edition, 2010.
10. Sivanandam. S.N, Deepa. S.N., “Principles of Soft Computing”, Wiley India, 2008.
11. Rajasekaran. S, Pai G.A.V, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2008.

SEMESTER III

SEMESTER III

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.		Elective-3	3	0	0	3
2.		Elective-4	3	0	0	3
3.		Elective-5	3	0	0	3
4.		Open Elective	3	0	0	3
5.	21PGM802	English For Research paper writing (Audit-II)	2	0	0	0
PRACTICAL						
5.	21PPE301	Phase-I Dissertation	0	0	12	6
Total			13	0	12	18

21PGM802 ENGLISH FOR RESEARCH PAPER WRITING

L	T	P	C
2	0	0	0

OBJECTIVES:

- To give and exposure on writing skills and readability
- To impart the knowledge of each section of the paper
- To enhance the student to write the good quality Research paper

UNIT-I INTRODUCTION TO RESEARCH 9

Introduction to Research Paper, Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs, Clarity and Removing Redundancy, Highlighting the Findings, Hedging and Criticizing, Paraphrasing and Plagiarism - Useful idioms & phrases.

UNIT-II STRUCTURE OF RESEARCH PAPER 6

Types of the Research papers, Regular Research Paper - Review Research Paper – Case Study Research Paper – Research Letters - Sections of a Paper, Title, Author names and affiliations - Corresponding author - Abstracts, Keywords, Highlights, Graphical Abstract - Introduction, Methods, Results, Discussion, Conclusions, Acknowledgment - the First Draft.

UNIT-III METHODOLOGY, RESULTS & DISCUSSION AND CONCLUSION 9

Introduction – Writing preview of Research work – Review of literature – assimilating the points – Logical flow – Research gap - Writing the Methodology – Sequence - Specification – Explaining results – Interpretation and plotting – Discussion of the salient findings – Critical analysis – Writing the Conclusion

UNIT-IV SUBMISSION OF RESEARCH PAPER 6

References – Citations and Checking the Citations – Various forms of Citation - Guidelines for authors –Manuscript submission – Conflict of Interest - Authors reply for Reviewer comments – Point by Point Explanation – Resubmission – Acceptance – Copyright – Proof reading and final submission.

TOTAL: 30 PERIODS

COURSE OUTCOMES

After successful completion of this course, the students will be able to

- Understand that how to improve your writing skills and level of readability (understand)
- Learn about what to write in each section (Analyse)
- Understand the skills needed when writing a Title (understand)
- Understand the skills needed when writing the Conclusion (understand)
- Ensure the good quality of paper at very first-time submission (Valuing)

REFERENCES

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Additional Reading

1. MLA Handbook for Writers of Research Papers, The Modern Language Association of America, New York 2009.

21PPE301	PHASE-I DISSERTATION	L	T	P	C
		0	0	12	6

PROJECT DESCRIPTION

Every candidate shall be permitted to undertake a research based project work of his choice related to his / her discipline in consultation with the Head of the Department. The project shall be supervised by a faculty member of the department in which the candidate registered a course.

In case of a project work at Industrial / Research organization, the project work shall be jointly supervised by the faculty supervisor and an expert from the organization.

He / She shall be required to undergo three reviews in a semester to assess the progress of the project work. The project work shall be evaluated based on the project report submitted by the candidate and Viva-voce examination conducted by a committee consisting of an external examiner, internal examiner, and the supervisor of the candidate.

TOTAL: 180 PERIODS

COURSE OUTCOMES

- Apply the knowledge gained from theoretical and practical courses in formulating problem statement and solving problems with innovative solutions. **[Apply]**
- Demonstrate the ability to assess societal, health and safety issues and the consequent responsibilities relevant to the professional engineering practice **(Valuing – Affective Domain)**
- Design and develop optimal solutions by analysing the data/information from various literature sources and synthesize the information to provide valid conclusions**. [Create]**
- Utilize the new tools, algorithms, techniques to provide valid conclusion following the norms of engineering practice. **[Apply- Modern tool usage]**
- Write effective reports and make clear presentation to the engineering community and society. **[Organizing - Affective Domain]**
- Engage in learning for effective project implementation in the broadest context of technological change. **[Phycomotor domain-Life long learning]**

SEMESTER IV

SEMESTER IV

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	21 PPE401	Phase-II Dissertation	0	0	24	12
Total			0	0	24	12

21PPE401	PHASE-II DISSERTATION	L	T	P	C
		0	0	32	16

PROJECT DESCRIPTION

Every candidate shall be permitted to undertake a research based project work of his choice related to his / her discipline in consultation with the Head of the Department. The project shall be supervised by a faculty member of the department in which the candidate registered a course.

In case of a project work at Industrial / Research organization, the project work shall be jointly supervised by the faculty supervisor and an expert from the organization.

He / She shall be required to undergo three reviews in a semester to assess the progress of the project work. The project work shall be evaluated based on the project report submitted by the candidate and Viva-voce examination conducted by a committee consisting of an external examiner, internal examiner, and the supervisor of the candidate.

TOTAL: 480 PERIODS

COURSE OUTCOMES

- Analyze and review the research literature critically and evolve suitable methodologies for solving the complex engineering problem **[Analyze]**
- Analyze the complex engineering problem critically to provide optimal solution usign engineering standards after considering public health, safety, ethical, societal and environmental factors. **[Analyze]**
- Design/Develop sustainable solutions after independently carrying out research and investigation to solve practical problems. **[Create]**
- Utilize modern engineering tools, algorithms and techniques including prediction and modeling for complex engineering activities and augment the effectiveness of the solution with an understanding of the limitations. **[Modern Tool Usage]**
- Write effective reports and make clear presentation to the engineering community and society. **[Organizing - Affective Domain]**
- Engage in learning for effective project implementation with a commitment to improve knowledge and competence in context of technological updation. **[Life Long Learning]**

PROGRAM ELECTIVES

21PPE501 ADVANCED POWER ELECTRONIC CIRCUITS

L	T	P	C
3	0	0	3

OBJECTIVES:

- Understand the operation of advanced power electronic circuit topologies.
- Understand the control strategies involved.
- Learn few practical circuits, used in practice

UNIT I SMPS TOPOLOGY **9**

Three phase utility interphases and control-Buck, Boost, Buck-Boost SMPS Topologies Boost type APFC and control

UNIT II PUSH-PULL AND FORWARD CONVERTER **9**

Modes of operation –Push-Pull and Forward Converter Topologies - Voltage Mode Control. Half and Full Bridge Converters. Fly back Converter.

UNIT III RESONANT CONVERTERS **9**

Introduction to Resonant Converters. Load Resonant Converter. Zero Voltage Switching Clamped Voltage Topologies

UNIT IV HIGH FREQUENCY CONVERTERS **9**

Resonant DC Link Inverters with Zero Voltage Switching. High Frequency Link Integral Half Cycle Converter.

UNIT V PWM CONVERTERS9

Bus clamping PWM-Space vector based PWM-Advanced PWM techniques- Practical devices in converter- Calculation of switching and conduction power losses-SISO & MISO converters.

Total: 45 periods

COURSE OUTCOMES:

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

- Analyze and design the Load Commutated CSI and PWM CSI [Analyse]
- Acquire and apply knowledge of mathematics in power converter analysis [Analyse]
- Model, analyze and understand power electronic systems and equipments. [create]
- Formulate, design and simulate phase controlled rectifiers for generic load and for machine loads [Apply]
- Design and simulate switched mode inverters for generic load and for machine loads [create]
- Select device and calculate performance parameters of power converters under various operating modes [Valuing]

REFERENCES

1. Rashid “Power Electronics” Prentice Hall India 2007.
2. G.K.Dubey et.al “Thyristorised Power Controllers” Wiley Eastern Ltd., 2005, 06.
3. Dewan & Straughen “Power Semiconductor Circuits” John Wiley &Sons., 1975.
4. G.K. Dubey& C.R. Kasaravada “Power Electronics & Drives” Tata McGraw Hill., 1993
5. Cyril W Lander “Power Electronics” McGraw Hill., 2005.
6. B. K Bose “Modern Power Electronics and AC Drives” Pearson Education (Asia)., 2007
7. Abraham I Pressman “Switching Power Supply Design” McGraw Hill Publishing Company., 2001.

21PPE502	ELECTRIC POWER QUALITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the various power quality issues.
- To impart the knowledge of the conventional compensation techniques used for power factorcorrection and load voltage regulation.
- To familiarize the concept of power and power factor in single phase and three phasesystems supplying non linear loads

UNIT I INTRODUCTION **9**

Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves. Symptoms of poor power quality. Power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

UNIT II CONVENTIONAL LOAD COMPENSATION METHODS **9**

Principle of load compensation and voltage regulation – classical load balancing problem: open loopbalancing – closed loop balancing, current balancing – harmonic reduction and voltage sag reduction – analysis of unbalance – instantaneous of real and reactive powers –Extraction of fundamentalsequence component from measured.

UNIT III LOAD COMPENSATION USING DSTATCOM **9**

Compensating single – phase loads – Ideal three phase shunt compensator structure – generatingreference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced – Realization and control of STATCOM – DSTATCOM in Voltage control mode.

UNIT IV SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM **9**

Rectifier supported DVR – Dc Capacitor supported DVR – DVR Structure – voltage Restoration – Series and Shunt Active Filter – PSCAD/EMTDC-Simulation of active filters- Unified power qualityconditioner.

UNIT V DISTRIBUTED GENERATION AND GRID INTERCONNECTION **9**

Distributed Generation – Connection Requirements and impacts on the Network- Interaction and Optimal Location of DG- Power Quality in DG- Islanding Issues- Distribution Line Compensation- Real Generation- Protection Issues for Distributed Generation- Technologies for Distributed Generation- Power Quality impact from different DG types

TOTAL: 45 Periods

COURSE OUTCOMES:

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

- Explain various power quality terms as per IEEE Standards and IEC Electromagnetic Compatibility Standards. **[Understand]**
- Determine the Sources of different power quality issues and choose appropriate Mitigation Technique / Device to solve power quality problems. **[Apply]**
- Select the appropriate compensating devices for the given power quality issue. **[Analyze]**
- Identify the power quality issues with integration of distributed generation, various wiring and grounding problems and their solutions. **[Evaluate]**
- Develop a model to improve the Power Quality in the Power Distribution System under steady / transient state using simulation software**. [Create]**
- Write an effective report for the given scenario and suggest suitable modern FACTS devices to improve the Power Quality in Power Distribution System. **[Valuing]**

REFERENCES:

1. Arindam Ghosh, "Power Quality Enhancement Using Custom Power Devices", Kluwer AcademicPublishers, 2002.
2. Heydt G.T, "Electric Power Quality", Stars in a Circle Publications, 2nd edition, 1994.
3. Roger C. Duggan, Mark F. McGranaghan Surya Santoso, Wayne Beauty H, "Electric Power systemQuality" Tata McGraw Hill, Third edition, 2012.
4. Arrillga A.J, "Power system harmonics". John Wiley & sons, 2003.

21PPE503	Control of Special Electrical Machines	L	T	P	C
		3	0	0	3

Course Objective:
To impart knowledge on

- To impart knowledge on the constructional features and operating principles of various types of special electrical machines.
- To make the students compare and analyze the static and dynamic characteristics of special electrical machines.
- To provide knowledge on the different types of drive systems and controllers used in special electrical machines.

Unit I STEPPING MOTORS 9

Constructional features - principle of operation - modes of excitation - torque production in Variable Reluctance (VR) stepping motor – Characteristics - Linear and Non Linear Analysis - Drive systems and Control of stepping motor

Unit II SYNCHRONOUS RELUCTANCE MOTORS AND PERMANENT MAGNET SYNCHRONOUS MOTORS 9

Constructional features of axial and radial air gap Motors - operating principle - reluctance torque – phasor diagram - motor characteristics Principle of operation – EMF and Torque equations - Phasor diagram - Power controllers – Torque speed characteristics – Self control, Vector control, Microprocessor based control schemes

Unit III SWITCHED RELUCTANCE MOTORS 9

Constructional features-principle of operation-Inductance profile-Torque equation- Types of Power controllers and converter topologies used – Current control schemes – Torque Speed Characteristics – Hysteresis and PWM -Microprocessor based controller and Sensorless Controller

Unit IV PERMANENT MAGNET BRUSHLESS DC MOTORS 9

Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and Emf equation, Torque-Speed characteristics, Controllers-Magnetic Circuit Analysis-Microprocessor based controller

Unit V LINEAR MOTORS 9

Linear Induction Motor (LIM) classification – construction – Principle of operation – Concept of current sheet – goodness factor – DC Linear Motor (DCLM) types – circuit equation - DCLM control applications – Linear Synchronous Motor(LSM) – Types - Performance equations – Applications.

Course Outcome:

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

- Illustrate the operation of various special electrical machines. [Understand]
- Determine the operation and performance of various stepper motors. [Apply]
- Analyze the characteristics and different types of controllers for synchronous reluctance motors and permanent magnet synchronous motors. [Analyze]
- Analyze the characteristics and different types of controllers for synchronous reluctance motors and permanent magnet synchronous motors. [Analyze]
- Design different types of controllers and control technique for switched reluctance motors. [Create]
- Make an effective communication and presentation to demonstrate the role of special electrical machines in the aspect of societal, environmental and ethical standards. [Valuing]

Reference Book:

1. Miller, T.J.E. “Brushless permanent magnet and reluctance motor drives '', Clarendon Press, Oxford, 1989.

2. Kenjo, T, “Stepping motors and their microprocessor control", Clarendon Press, Oxford, 1989.

3. Naser A and Boldea L, “Linear Electric Motors: Theory Design and Practical Applications”, Prentice Hall Inc., New Jersey 1987.

4. Kenjo, T and Naganori, S “Permanent Magnet and brushless DC motors ", Clarendon Press, Oxford, 1989.

5. Kenjo, T. “Power Electronics for the microprocessor Age”, Oxford University Press1994.

6. B.K. Bose, “Modern Power Electronics & AC drives”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2001.

7. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

8. R.Krishnan, “Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design and Applications” CRC Press, 2001.

21PPE504	SOFT COMPUTING TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide adequate knowledge about FLC and NN toolbox.
- To expose the ideas about genetic algorithm.
- To provide adequate knowledge about feedback neural networks.

UNIT I INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS 9

Introduction of soft computing - soft computing vs. hard computing- various types of soft computing techniques- applications of soft computing-Neuron- Nerve structure and synapse-Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- McCullochPitts neuron model- perceptron model-Adaline and Madaline- multilayer perception model- back propogation learning methods-effect of learning rule coefficient -back propagation algorithm- factors affecting back propagation training applications.

UNIT II SPECIAL ARTIFICIAL NEURAL NETWORKS 9

Counter propagation network- architecture- functioning & characteristics of counter-Propagation network-Hopfield/ Recurrent network- configuration- stability constraints-associative memory and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications-Implementation and training-Associative Memory.

UNIT III FUZZY LOGIC SYSTEM 9

Introduction to crisp sets and fuzzy sets- basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control- Fuzzification- inference and defuzzification- Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system.

UNIT IV GENETIC ALGORITHM 9

Basic concept of Genetic algorithm and detail algorithmic steps-adjustment of free Parameters- Solution of typical control problems using genetic algorithm- Concept on some other search techniques like tabu search and ant colony search techniques for solving optimization problems.

UNIT V HYBRID SYSTEMS 9

Integration of neural networks and fuzzy systems, adaptive neuro fuzzy inference systems, ANN-GA-Fuzzy synergism and its application, Identification and control of linear and nonlinear dynamic systems using MATLAB-neural network toolbox. Implementation of fuzzy logic controller using MATLAB fuzzy logic toolbox.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- llustrate the architectures of NN, Fuzzy sets, GA and hybrid intelligent control techniques. **[Understand]**
- Apply fuzzy logic, genetic algorithm, neural networks and reasoning to handle uncertainty and solve engineering problems for the given requirement. **[Apply]**
- Apply Genetic Algorithm and particle swarm optimization for power electronic optimization problems. **[Apply]**
- Examine the concepts of neural network learning methods, PSO and GA to improve competence in context of technological updation. **[Analyze]**
- Analyze the functions of ANN and fuzzy logic based models and control schemes for different non-linear systems. [**Analyze]**
- Develop intelligent control techniques for real time applications. **[Create]**

REFERENCES:

1. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”,3rd Edition, Wiley, 2010.
2. Zimmermann H.J, "Fuzzy set theory and its Applications", Springer international edition, 2011.
3. Chaturvedi, “Soft Computing Techniques and its Applications in Electrical Engineering”, Springer, 2008
4. Laurene V. Fausett, “Fundamentals of Neural Networks: Architectures, Algorithms And Applications”, Pearson Education,1993.
5. David E.Goldberg, “Genetic Algorithms in Search, Optimization, and Machine Learning”, Pearson Education, 2009.
6. W.T.Miller, R.S.Sutton and P.J.Webrose, “Neural Networks for Control”, MIT Press, 1996.
7. Jacek.M.Zurada, “Introduction to Artificial Neural Systems”, Jaico Publishing House, 1999.
8. KOSKO.B, “Neural Networks and Fuzzy Systems”, Prentice-Hall of India Pvt. Ltd., 1994.
9. Kalyanmoy Deb, “Multi-Objective Optimization Using Evolutionary Algorithms”, Wiley, 3rd Edition, 2010.
10. Sivanandam. S.N, Deepa. S.N., “Principles of Soft Computing”, Wiley India, 2008.
11. Rajasekaran. S, Pai G.A.V, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2008.

21PPE505 ADVANCED CONTROL OF ELECTRIC DRIVES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To study the industrial advanced control methods of AC and DC drives
- To Understand the theory and applications of advanced Industrial AC and DC drive systems
- To analyze the operation of advanced Artificial-Intelligence Based Drives.

UNIT I INTRODUCTION TO ADVANCED CONTROL 9

Need for advanced controls, advanced control strategies for electrical drives -Scalar control open loop and closed loop control. Vector control, direct and indirect vector control. Direct torque control, Power Converter Control using State-Space Averaged Models - Sliding-Mode Control of Power Converters.

UNIT II INDUCTION MOTOR DRIVES 9

Scalar control - Principle of vector or field oriented control - Direct and Indirect vector control-Derivation of indirect vector control scheme-Direct torque control of Induction motor – Multilevel converter fed induction motor drive - Sensor less control and flux observers.

UNIT III PERMANENT MAGNET SYNCHRONOUS MOTOR DRIVES 9

Types of permanent magnet synchronous machines – Vector control of PM synchronous machine – model of PMSM – Vector control – control strategies – constant torque-angle control, unity power factor control, constant mutual flux-linkages control, optimum torque per ampere control, sensor less PMSM drive.

UNIT IV BRUSHLESS DC AND SYNCHRONOUS RELUCTANCE DRIVES 9

PM brushless DC motor – Modeling – Drive scheme- Synchronous Reluctance Drives-Current vector control of Synchronous Reluctance Drives- Switched Reluctance Drives.

UNIT V ARTIFICIAL-INTELLIGENCE BASED DRIVES 9

AI-Based Techniques - Applications in Electrical Machines and Drives - Neural-Network-Based Drives -commercial AI based Drives. The Fuzzy Logic Concept- Applications of Fuzzy Logic to Electric Drives - Fuzzy Logic Control of Power Converters- Hardware System Description.

Total: 45 periods

COURSE OUTCOMES:

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

- Explain the concepts of advanced control methods of AC and DC drives. [Understand]
- Apply the knowledge of advanced control methods in the selection of motors and drive systems for industrial applications. [Apply]
- Model the vector control and torque control strategies for the Induction motor and PMSM based drive systems. [Apply]
- Analyze the operation of vector control based AC machine drive under different operating condition. [Analyze]
- Develop suitable intelligent controllers for electric drives for a given application. [Create]
- Make an effective communication and presentation to develop advanced controller for electric drives in the aspect of energy conservation, societal, environmental and ethical standards. [Valuing]

REFERENCES:

1. Rik De Doncker ,Duco W.J. Pulle , André Veltman , "*Advanced Electrical Drives: Analysis, Modeling, Control*", Published on 2011.

2. Ned Mohan, "*Advanced Electric Drives: Analysis, Control, and Modeling Using MATLAB / Simulink"*, Wiley Publications, 2014

3. Malcolm Barnes, "*Practical Variable Speed Drives and Power Electronics* ", Newness, 2003.

4. Grafame Holmes D and Thomas A Lipo, "*Pulse Width Modulation for Power Converters-Principles and Practice"*- IEEE Press, 2003

5. N.P.Quang and J.A. Dittrich, "*Vector Control of Three-Phase AC Machines"*, publishedon 2008.

6. Tze-Fun Chan, Keli Shi, "*Applied Intelligent Control of Induction Motor Drives*", JohnWiley & Sons, 2011.

7. Rik De Doncker and DucoW.J.Pulle, *Advanced Electrical Drives,* Springer,2014.

21PPE506 MODERN RECTIFIERS AND RESONANT CONVERTERS L T P C

3 0 0 3

OBJECTIVES:

- To explain the dynamic analysis of DC to DC Converters.
- Give knowledge on Modern Rectifiers and resonant converters with their controls.
- To familiarize the control of techniques of resonant converters.

UNIT I POWER SYSTEM HARMONICS & LINE COMMUTATED RECTIFIERS

Average power-RMS value of a waveform-Power factor-AC line current harmonic standards IEC 1000-IEEE 519- The Single phase full wave rectifier-Continuous Conduction Mode-Discontinuous Conduction Mode-Behavior when C is large-Minimizing THD when C is small-Three phase rectifiers - Continuous Conduction Mode-Discontinuous Conduction Mode-Harmonic trap filters.

UNIT II PULSE WIDTH MODULATED RECTIFIERS

Properties of Ideal rectifiers-Realization of non ideal rectifier-Control of current waveform-Average current control-Current programmed Control- Hysteresis control- Nonlinear carrier control-Single phase converter system incorporating ideal rectifiers-Modeling losses and efficiency in CCM high quality rectifiers-Boost rectifier Example -expression for controller duty cycle-expression for DC load current-solution for converter -Efficiency η.

UNIT III RESONANT CONVERTERS

Review on Parallel and Series Resonant Switches-Soft Switching- Zero Current Switching -Zero Voltage Switching -Classification of Quasi resonant switches-Zero Current Switching of Quasi Resonant Buck converter, Zero Current Switching of Quasi Resonant Boost converter, Zero Voltage Switching of Quasi Resonant Buck converter, Zero Voltage Switching of Quasi Resonant Boost converter: Steady State analysis. ZVS Three-level PWM –Converter.

UNIT IV DYNAMIC ANLYSIS OF SWITCHING CONVERTERS

Review of linear system analysis-State Space Averaging-Basic State Space Average Model-State Space Averaged model for an ideal Buck Converter, ideal Boost Converter, ideal Buck Boost Converter, for an ideal Cuk Converter- Continuous Conduction Mode-Discontinuous Conduction Mode.

UNIT V CONTROL OF RESONANT CONVERTERS

Pulse Width Modulation-Voltage Mode PWM Scheme-Current Mode PWM Scheme-Design of Controllers: PI Controller, Variable Structure Controller, Optimal Controller for the source current shaping of PWM rectifiers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Understand the standards for supply current harmonics and its significance. **[Understand]**
- Determine the performance and operation of resonant converters **[Apply]**
- Develop the transfer function of resonant converter under various control schemes. **[Apply]**
- Analyse the characteristics of switched-mode dc-dc power converters under steady-state and dynamic condition. **[Analyze]**
- Analyse the performance of zero voltage and zero current switching resonant converters. **[Analyze]**
- Design the DC power supplies using advanced techniques **[Create]**

REFERENCES:

1. Robert W. Erickson, Dragon Maksimovic, “Fundamentals of Power Electronics”, Springer science and Business media, Second Edition, 2001.
2. William Shepherd and Li zhang, “Power Converters Circuits”, Marcel Dekker,Inc, Third Edition, 2004.
3. Simon Ang and Alejandro Oliva, “Power- Switching Converters”, CRC Press, Taylor & Francis Group, Second Edition,2005.
4. Ned Mohan, Undeland and Robbins, “Power Electronics: converters, Application and design”, John Wiley and sons. Inc, third edition, Newyork, 2007.

21PPE507	MODERN INDUSTRIAL DRIVES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide an overview of PLC and DCS based control of drives.
- To know about the FPGA based controls.
- To familiarize the student with the ARM and DSP based control of electrical Machines

UNIT I PLC BASED INDUSTRIAL CONTROL 9

PLC architecture, Ladder logic Programming, Programming based on Timer And Counter, PLC Interface, Introduction to SCADA Software, PLC based Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller and Variable speed AC motor drive.

UNIT II DISTRIBUTED CONTROL AND COMPUTER NUMERICAL SYSTEM 9

Basics DCS introduction, DCS components/block diagram, DCS specification, latest trend and developments, Computer Numerically Controlled (CNC) Machines, Basic CNC Principle, servo control, types of servo control for motion axes, CNC based Lathe and drilling machine control.

UNIT III FPGA BASED CONTROLS 9

FPGA-architectures-Types of FPGA ,Xilinx XC3000 series ,Configurable logic Blocks (CLB), Input/ Output Block (IOB) , overview of Spartan 3E and Virtex III pro FPGA boards-Introduction to VHDL programming-simple programs-Control of DC motor-Induction motor speed control-Synchronous motor drive.

UNIT IV ARM PROCESSOR BASED MACHINE CONTROL 9

Introduction of ARM Processors - ARM7 Architecture -Instruction Set –Programming-RTOS support-Control of DC motor-Induction motor speed control- Synchronotordrie.

UNIT V DSP PROCESSOR BASED MACHINE CONTROL 9

Introduction to the DSP core -The components of the DSP core, Mapping external devices to the core, Peripherals and Peripheral Interface, Assembly Programming using DSP, Instruction Set, Software Tools. DSP Based control of Stepper Motors, Permanent Magnet Brushless DC machines and Permanent Magnet Synchronous machines.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Understand the SCADA and FPGD based motor controls [Understand]
- Understand PLC Architecture [Understand]
- Integrate PLC with SCADA in Motor Control [Apply]
- Understand ARM and DSP processor based machine control. [Understand]
- Learn the DSP Processor Based Machine Control [Understand]
- Analyze FPGA Control Solutions for Motor controls [Analyze]

REFERENCES:

1. William Bolton, "*Programmable Logic Controllers*", Elsevier, 2011.

2. Hamid Toliyat and Steven Campbell, *"DSP-Based Electromechanical Motion Control"*, CRC Press, 2011.

3. Wayne Wolf, *"FPGAbased system design*",Prenticehall, 2004.

4. J.R.Gibson, "*ARM Assembly language An Introduction"*, CENGAGE Learning, 2011.

5. Kenneth W. Evans, John Polywka, Stanley Gabrel, "*Programming of Computer Numerically Controlled Machines*", Second Edition, Industrial Press, 2001

21PPE508	ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study about the discrete random process and spectral estimation techniques
- To understand the algorithm used in linear estimation and prediction
- To study about various filters and multi rate signal processing

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9

Discrete Random Processes – Ensemble averages, stationary processes, Autocorrelation and Auto covariance matrices – Parsevals Theorem – Wiener-Khintchine Relation – Power Spectral Density – Periodogram Spectral Factorization – Filtering random processes – Low Pass Filtering of White Noise – Parameter estimation: Bias and consistency.

UNIT II SPECTRUM ESTIMATION 9

Estimation of spectra from finite duration signals Non- Parametric Methods Correlation Method – Periodogram Estimator – Performance Analysis of Estimators – Unbiased, Consistent Estimators – Modified periodogram – Bartlett and Welch methods – Blackman – Tukey method - Parametric Methods – AR, MA, and ARMA model based spectral estimation – Parameter Estimation –Yule-Walker equations – Solutions using Durbins algorithm.

UNIT III LINEAR ESTIMATION AND PREDICTION 9

Linear prediction – Forward and backward predictions – Solutions of the Normal equations Levinson-Durbin algorithms – Least mean squared error criterion – Wiener filter for filtering and prediction – FIR Wiener filter and Wiener IIR filters – Discrete Kalman filter.

UNIT IV ADAPTIVE FILTERS9

FIR adaptive filters – Adaptive filter based on steepest descent method – Widrow-Hoff LMS adaptive algorithm– Normalized LMS – Adaptive channel equalization – Adaptive echo cancellation – Adaptive noise cancellation– Adaptive recursive filters (IIR) – RLS adaptive filters – Exponentially weighted RLS – Sliding window RLS.

UNIT V MULTIRATE DIGITAL SIGNAL PROCESSING 9

Mathematical description of change of sampling rate – Interpolation and Decimation by an integer factor – Interpolation by an integer factor – Sampling rate conversion by a rational factor – Filter implementation for sampling rate conversion – direct form FIR structures – Polyphase filter structures – Time- variant structures – Multistage implementation of multirate system – Application to sub band coding – Wavelet transform and Daubechies Wavelet.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Able to analyze and implement the frequency analysis & correlation of discretetime linear time invariant systems. [Analyze]
- Able to implement sampling rate conversion by decimation & Interpolation process and design digital filter banks [Analyze]
- Able to analyze forward and backward linear prediction of a stationary random process using Levinson-Durbin Algorithm [Analyze]
- Able to understand and analyze adaptive filters and its application using LMS algorithm & RLS algorithm. [Analyze]
- Able to understand parametric & non-parametric methods for power spectrum estimation. [Understand]

REFERENCES

1. MonsonH.Hayes,"StatisticalDigitalSignalProcessingandModeling",NewJersey,JohnWiley and Sons,2009

2. John G. ProakisandDimitris. G. Manolakis, "Digital Signal Processing", New Delhi,PearsonEducation, 2011

3. Steven M. Kay, "Fundamentals of Statistical Signal Processing": Practical algorithmdevelopment Prentice-Hall PTR, 2013

4. J.S.Chitode, "Digital Signal Processing, Technical Publications", 2008

5. LokenathDebnath, Firdous Shah, "Wavelet Transforms and Their Applications",Springer, 2014

21PPE509	ADVANCED MICROCONTROLLER BASED SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the architecture of advance microcontrollers
- To understand the applications of these controllers
- To get some introduction to FPGA

UNIT-I: INTRODUCTION TO MICROPROCESSORS **9**

Basic Computer Organization -Accumulator Based Processors -Architecture -Memory Organizations -I/O Organizations -Assembly Language Programming -Addressing -Operations -Stack and Subroutines. Interrupts -DMA -Stages of Microprocessor based Program Development.

UNIT-II MICROCONTROLLERS **9**

Introduction to Microcontrollers -Motorola 68HC11 -Intel 8051 -Intel 8096 -Registers -Memories -I/O Ports -Serial Communications -Timers -Interrupts

9

UNIT-III PIC CONTROLLERS

PIC 16F877-Architecture -Memory Interfacing -Interfacing I/O devices -Instruction Set -Serial I/O and Data Communication.

UNIT-IV ARM EMBEDDED SYSTEMS AND ARM PROCESSOR FUNDAMENTALS 9

The RISC design philosophy, ARM design philosophy, embedded system hardware- AMBA bus protocol, embedded system software- applications. ARM core data flow model, Registers, CPSR-Processor modes, Banked registers. Pipeline- Characteristics

UNIT VFPGA BASED CONTROLLER **9**

FPGA-architectures-Types of FPGA ,Xilinx XC3000 series ,Configurable logic Blocks (CLB), Input/ Output Block (IOB) , overview of Spartan 3E and Virtex III pro FPGA boards-Introduction to VHDL programming-simple programs-Control of DC motor-Induction motor speed control-Synchronous motor drive.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- understand the features of microcontroller Intel 8096 [understand]
- Ability to understand the features of PIC microcontroller. [understand]
- Ability to grasp the interfacing concepts involving in the design of microcontroller based systems. [understand]
- Understand the architecture of 8051 and 68HC11 microcontrollers. [understand]

- Develop assembly language programs employing 8051 & 16F876 microcontrollers.[create]
- Analyze the microcontroller programming using MPLAB and develop typical programs for power converter applications. [Analyze]

REFERENCES:

1. John.F.Wakerly: Microcomputer Architecture and Programming, John Wiley and Sons 1981

2. Ramesh S.Gaonker: Microprocessor Architecture, Programming and Applications with the 8085, PenramInternational Publishing (India), 1994

3. Raj Kamal: The Concepts and Features of Microcontrollers, Wheeler Publishing, 2005

4. Kenneth J. Ayala, The 8051 microcontroller, Cengage Learning, 2004

5. John Morton, The PIC microcontroller: your personal introductory course, Elsevier, 2005

6. Dogan Ibrahim, Advanced PIC microcontroller projects in C: from USB to RTOSwith the PIC18F Series, Elsevier, 2008

7. Micro chip datasheets for PIC16F877

8. J.R.Gibson, “ARM Assembly language An Introduction”, CENGAGE Learning, 2011

21PPE510	WIND ENERGY CONVERSION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To discuss the power generated using different types of wind turbines.
- To explain the modeling of fixed and variable speed Wind turbine in WECS and about the impact of Grid connected WEC systems.
- To outline the grid integration issues.

UNIT I INTRODUCTION **9**

Wind survey in India-Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory- Power coefficient- Aerodynamics of Wind turbine.

UNIT II WIND TURBINES **9**

Basics of wind power – Types of wind turbines – Types of wind generators – Types of wind power systems– Stand alone wind diesel hybrid systems-HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio - No. of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.

UNIT III FIXED SPEED SYSTEMS **9**

Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model-Generator model for Steady state and Transient stability analysis.

UNIT IV VARIABLE SPEED SYSTEMS **9**

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling - Variable speed variable frequency schemes.

UNIT V GRID CONNECTED SYSTEMS **9**

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Explain the modeling of fixed and variable speed Wind turbine in WECS. **[Understand]**
- Develop the mathematical modelling and control of the Wind Turbine **[Apply]**
- Analyze the Grid Integration issues and current practices of wind interconnections with power systems **[Analyze]**
- Analyze the performance characteristics of DFIG and PMSG **[Analyze]**
- Evaluate the steady state and transient stability of wind systems and the life cycle costing of wind turbines **[Evaluate]**
- Make an effective communication and presentation to demonstrate the role of wind energy conversion systems in the aspect of societal, environmental and ethical standards. **[Valuing]**

REFERENCES:

1. Freris.L. L, “Wind Energy conversion Systems”, Prentice Hall, 1990.
2. Ion Boldea, “Variable speed generators”, Taylor & Francis group, 2006.
3. Golding. E.W, “The generation of Electricity by wind power”, Redwood burn Ltd, Trowbridge, 1976.
4. Heir. S, “Grid Integration of WECS”, Wiley, 1998.

21PPE511	SCADA SYSTEMS AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamentals of SCADA.
- To analyze the SCADA Components, Communication, Monitoring and Control.
- To analyze the application of SCADA in power System

UNIT I INTRODUCTION TO SCADA 9

Evolution of SCADA, SCADA definitions, SCADA Functional requirements and Components, SCADA Hierarchical concept, SCADA architecture, General features, SCADA Applications, Benefits.

UNIT II SCADA SYSTEM COMPONENTS 9

Remote Terminal Unit (RTU), Interface units, Human- Machine Interface Units (HMI), Display Monitors/Data Logger Systems, Intelligent Electronic Devices (IED), Communication Network, SCADA Server, SCADA Control systems and Control panels.

UNIT III SCADA COMMUNICATION 9

SCADA Communication requirements, Communication protocols: Past, Present and Future, Structure of a SCADA Communications Protocol, Comparison of various communication protocols, IEC61850 based communication architecture, Communication media like Fiber optic, PLCC etc. Interface provisions and communication extensions, synchronization with NCC, DCC.

UNIT IV SCADA MONITORING AND CONTROL 9

Online monitoring the event and alarm system, trends and reports, Blocking list, Event disturbance recording.Control function: Station control, bay control, breaker control and disconnector control.

UNIT V SCADA APPLICATIONS IN POWER SYSTEM 9

Applications in Generation, Transmission and Distribution sector, Substation SCADA system Functionaldescription, System specification, System selection such as Substation configuration, IEC61850 ringconfiguration, SAS cubicle concepts, gateway interoperability list, signal naming concept. System Installation, Testing and Commissioning.

TOTAL: 45 Periods

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

- Understand basics of SCADA systems and its various functions. [understand]
- Acquire knowledge regarding SCADA System Components and Programmable Logic Controller (PLC). [understand]
- Analyze SCADA architectures, advantages and disadvantages. [Analyze]
- Investigate various industrial communication technologies. [create]
- Apply the SCADA Applications in Transmission and Distribution sector operations and industries. [Apply]

REFERENCES:

1. Stuart A. Boyer: SCADA-Supervisory Control and Data Acquisition, Instrument Society of AmericaPublications,USA,2004
2. Gordon Clarke, Deon Reynders: Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems, Newnes Publications, Oxford, UK,2004.
3. William T. Shaw, Cybersecurity for SCADA systems, PennWell Books, 2006
4. David Bailey, Edwin Wright, Practical SCADA for industry, Newnes, 2003
5. Michael Wiebe, A guide to utility automation: AMR, SCADA, and IT systems for electric Power, PennWell, 1999.
6. Dieter K. Hammer, Lonnie R.Welch, Dieter K. Hammer, “Engineering of Distributed Control Systems”,Nova Science Publishers, USA, 1st Edition, 2001
7. Mini S Thomas, John DMcDonald, “Power system SCADA and Smart Grids”, CRC Press, Taylor and Francis, 2015.

21PPE512	FACTS AND CUSTOM POWER DEVICES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the active and reactive power flow control in power system
- To understand the need for static compensators
- To develop the different control strategies used for compensation

UNIT I REACTIVE POWER FLOW CONTROL 9

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.

UNIT II REACTIVE POWER SHUNT COMPENSATION 9

Reactive power compensation – Shunt and Series compensation principles – Reactive compensation at transmission and distribution level – Static versus passive VAR compensator, Static shunt compensators: SVC and STATCOM – Operation and control of TSC, TCR and STATCOM – Compensator control – Comparison between SVC and STATCOM.

UNIT III REACTIVE POWER SERIES COMPENSATION 9

Static series compensation: TSSC, SSSC – Static voltage and phase angle regulators – TCVR and TCPAR Operation and Control – Applications, Static series compensation – GCSC, TSSC, TCSC and Static synchronous series compensators and their Control. SSR and its damping

UNIT IV UNIFIED POWER FLOW CONTROLLER AND OTHER MULTI-CONVERTER DEVICES 9

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 analysis of FACTS Controllers – Simulation of FACTS controllers

UNIT V POWER QUALITY PROBLEMS 9

Power quality problems in distribution systems, harmonics – Loads that create harmonics, modeling, harmonic propagation, series and parallel resonances, mitigation of harmonics, passive filters, active filtering – shunt, series and hybrid and their control – Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners – IEEE standards on power quality.

Total: 45 Periods

Course Outcomes:
On the successful completion of the course, students will be able to:

- knowledge about the fundamental principles of Passive and Active Reactive Power Compensation Schemes at Transmission and Distribution level in Power Systems. [understand]
- Learn various Static VAR Compensation Schemes like Thyristor/GTO Controlled. [understand]
- Understand Reactive Power Systems, PWM Inverter based Reactive Power Systems and their controls. [understand]
- Develop analytical modeling skills needed for modeling and analysis of such Static VAR Systems. [create]

REFERENCES:

1. K.R.Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International Publishers, 2007.
2. X.P.Zhang, C.Rehtanz, B.Pal, “Flexible AC Transmission Systems - Modelling and Control”,SpringerVerlag, Berlin, 2006.
3. N.G.Hingorani, L.Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.
4. K.S.Sureshkumar, S.Ashok, “FACTS Controllers & Applications”, E-book edition, Nalanda Digital Library, NIT Calicut, 2003.
5. G.T.Heydt, “Power Quality”, McGraw-Hill Professional, 2007.
6. T.J.E.Miller, “Static Reactive Power Compensation”, John Wiley and Sons, New York, 1982.

21PPE513	HVDC SYSTEMS AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on operation, modelling and control of HVDC link.
- To perform steady state analysis of AC/DC system.
- To expose various HVDC simulators.

UNIT I DC POWER TRANSMISSION TECHNOLOGY 9

Introduction - Comparison of AC and DC transmission **–** Application of DC transmission – Description of DC transmission system - Planning for HVDC transmission **–** Modern trends in DC transmission – DC breakers – Cables, VSC based HVDC-**HVDC light System**.

UNIT II ANALYSIS OF HVDC CONVERTERS AND HVDC SYSTEM CONTROL 9

Pulse number, choice of converter configuration **–** Simplified analysis of Graetz circuit - Converter bridge characteristics – characteristics of a twelve pulse converter- detailed analysis of converters.

General principles of DC link control **–** Converter control characteristics **–** System Control hierarchy - Firing angle control **–** Current and extinction angle control **–**Starting and stopping of DC link power control-Generation of harmonics and filtering - power control **–** Higher level controllers- Telecommunication requirements.

UNIT III MULTITERMINAL DC SYSTEM 9

Introduction – Potential application of MTDC systems – Types of MTDC systems –Control and protection of MTDC systems - Study of MTDC systems.

UNIT IV POWER FLOW ANALYSIS IN AC/DC SYSTEMS 9

Per unit system for DC Quantities - Modeling of DC links - Solution of DC load flow -Solution of AC-DC power flow - Case studies.

UNIT V SIMULATION OF HVDC SYSTEMS 9

Introduction **–** System simulation: Philosophy and tools **–** HVDC system simulation **–** Modeling of HVDC systems for digital dynamic simulation – Dynamic in traction between DC and AC systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Evaluate AC & DC transmission systems. [Analyze]
- Analyze the HVDC converters. [Analyze]
- Model the DC link for power flow analysis in AC/DC systems. [create]

- Explain HVDC components on power system stability and various simulators. [understand]
- Model HVDC systems for digital dynamic simulation. [create]

REFERENCES:

1. Padiyar K.R, " HVDC Power Transmission Systems ", New Age International (P) Ltd, New Delhi, 2002.
2. Arrillaga J, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd, London, 1983.
3. Kundur P, "Power System Stability and Control", McGraw-Hill, 1993.
4. Erich Uhlmann, "Power Transmission by Direct Current", BS Publications, Hyderabad, 2004.
5. Sood V.K, "HVDC and FACTS Controllers – Applications of Static Converters in Power System", Kluwer Academic Publishers,April 2004.

21PPE514 Power Electronics Applications to Power System

L	T	P	C
3	0	0	3

Course Objectives

- Impart knowledge on different types of converter configurations.
- Study the different characterizes applications of converters in HVDC systems.
- Design and analyse the different types of reactive power compensation schemes for converters

UNIT I HVDC SYSTEM **9**

HVDC configurations, components of HVDC system: Converter, transformer, smoothing reactor, harmonic filter. Reactive power support, operation of 6-pulse controlled rectifier in inverting mode of operation. Operation of 12- pulse converter. Control of HVDC system, Rectifier and inverter characteristics, mode stabilization, current control, voltage dependent current order limit, combined rectifier-inverter characteristics, valve blocking and by - passing, limitations HVDC system using line commutated converters, modern HVDC system - HVDC light.

UNIT II ANALYSIS OF CONVERTERS AND THEIR CONTROL **9**

Pulse number-analysis of Graetz circuit-characteristics of twelve pulse converter - Dc link control - converter Principal of DC Link Control - Converters Control Characteristics - Firing angle control - Current and extinction angle control - Effect of source inductance on the system; Starting and stopping of DC link; Power Control.

UNIT III LOAD BALANCING **9**

Limitations of load balancing using passive elements, Use of VSI as a Var generator, Indirect current controlled synchronous link converter Var Compensator (SLCVC). Bi-directional power flow in VSI, Use of VSI as active filter cum Var generator, Current controlled SLCVC, Strategy-1: Sensing the compensator current, Strategy-2: Sensing the source current, Use of two VSIs, one as Var generator and another as active filter.

UNIT IV REACTIVE POWER COMPENSATION **9**

Instantaneous reactive power theory, expression for active and reactive powers in terms of d-q components. Reactive power compensator using instantaneous reactive power theory, stationary to rotating frame transformation. Reference wave generation (hardware method), harmonic oscillator, Phase locked loop (PLL) Introduction on one cycle control, discussion on one cycle controlled Var generator and active filter.

UNIT V SHUNT AND SERIES COMPENSATION **9**

Introduction, methods of Var generation, analysis of uncompensated AC line, Passive reactive power compensation, Compensation by a series capacitor connected at the mid point of the line, Effect on Power Transfer capacity, Compensation by STATCOM and SSSC, Fixed capacitor-Thyristor controlled reactor (FC-TCR), Thyristor-switched capacitor- Thyristor controlled reactor (TSC-TCR), static var compensators.

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

- Illustrate the characteristics of different types of HVDC converter Configurations [Apply]
- Determine the different control functions required for HVDC link [understand]
- Evaluate load balancing in AC and DC system. [Analyze]
- Analyze the reactive power compensation methods [Analyze]
- Analyze Compensation engineering problems and identify suitable shunt or Series Compensation devices for given applications [Analyze]

Reference(s)

1. K.R. Padiyar, “HVDC Power Transmission System - Technology and System Interaction", New Delhi, New Age International, 2002.

2. Jos Arrillaga, Y. H. Liu, Neville R. Watson, “Flexible Power Transmission: The HVDC Option's", John Wiley &Sons, 2007.

3. Ewald Fuchs, Mohammad A. S. Masoum, "Power Quality in Power Systems and Electrical Machines", Academic Press, 2011.

4. =Ned Mohan, Power Electronics Converters Applications and Design, New York, John Wiley and Sons, 2002.

5. R. Mohan Mathur, Rajiv K. Varma, "Thyristor-Based FACTS Controllers for Electrical Transmission Systems", John Wiley & Sons, 2002.

6. Mohd. Hasan Ali, Bin Wu, Roger A. Dougal," An Overview of SMES Applications in Power and Energy Systems", IEEE Transactions on Sustainable Energy, vol. 1, no. 1, April 2010.

21PPE515 SOLAR AND ENERGY STORAGE SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES:

- To discuss the characteristics of solar energy source and behavior of solar cells.
- To explain about design of standalone and grid connected PV system.
- To Review about different solar energy storage systems and application of PV system.

UNIT I INTRODUCTION **9**

Characteristics of sunlight – semiconductors and P-N junctions –behavior of solar cells – cell properties – PV cell interconnection.

UNIT II STAND ALONE PV SYSTEM **9**

Solar modules – storage systems – power conditioning and regulation - protection – stand alone PV systems design – sizing.

UNIT III GRID CONNECTED PV SYSTEMS **9**

PV systems in buildings – design issues for central power stations – safety – Economic aspect –Efficiency and performance - International PV programs.

UNIT IV ENERGY STORAGE SYSTEMS **9**

Impact of intermittent generation – Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage.

UNITV APPLICATIONS **9**

Water pumping – battery chargers – solar car – direct-drive applications –Space – Telecommunications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Understand various behaviors and properties of PV cell **[Understand]**
- Select suitable energy storage methods for onboard and off board storage. [**Apply**]
- Design and model standalone and grid integrated PV system [**Apply**]
- Analyze the various factors affecting performance of grid connected PV system. **[Analyze]**
- Design the power conditioning systems for solar PV applications [**Create**]
- Make an effective communication and presentation to demonstrate the role of solar energy systems in the aspect of societal, environmental and ethical standards. [**Valuing**]

REFERENCES:

1. Eduardo Lorenzo, “Solar Electricity: Engineering of Photovoltaic Systems” ,Progensa, 1994.
2. Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, “Applied Photovoltaics”, Earthscan, UK, 2007.
3. Frank S. Barnes and Jonah G. Levine, “Large Energy storage Systems Handbook”, CRC Press, 2011.
4. McNeils, Frenkel and Desai , “Solar and Wind Energy Technologies”, Wiley Eastern, 1990
5. Sukhatme S.P , “Solar Energy” ,Tata McGraw Hill, New Delhi,1987.

Ph.D ELECTIVES

21PPE516	SMART GRID	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To summarize the power quality issues in smart grid.
- To familiarize the high performance computing for smart grid applications.

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Relate with the smart resources, smart meters and other smart devices. [understand]
- Explain the function of Smart Grid. [understand]
- Experiment the issues of Power Quality in Smart Grid. [create]
- Analyze the performance of Smart Grid. [Analyze]
- Recommend suitable communication networks for smart grid applications [Evaluate]
- Evaluate power quality and EMC issues in smart grid. [create]

REFERENCES:

1. Stuart Borlase, " Smart Grids :Infrastructure, Technology and Solutions ", CRC Press, 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley publication, First Edition, 2012.
3. VehbiC,Güngör, DilanSahin, TaskinKocak, SalihErgüt, ConcettinaBuccella, Carlo Cecati, and Gerhard P.Hancke, "Smart Grid Technologies: Communication Technologies and Standards ", IEEE Transactions on Industrial Informatics, Vol. 7, No. 4, November 2011.
4. Xi Fang, SatyajayantMisra, GuoliangXue and Dejun Yang, "Smart Grid – The New and Improved Power Grid: A Survey", IEEE communications surveys and tutorials, Transaction Vol.14, No. 4, Fourth Quarter, 2012.

21PPE517	DISTRIBUTED GENERATION AND MICRO GRID	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To illustrate the concept of distributed generation.
- To outline the impact of grid integration.
- To explain the concept of Micro grid and its operation& control.

UNIT I INTRODUCTION 9

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

UNIT II DISTRIBUTED GENERATIONS (DG) 9

Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.

UNIT III IMPACT OF GRID INTEGRATION 9

Requirements for grid interconnection, limits on operational parameters,: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

UNIT IV INTRODUCTION OF MICROGRID 9

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

UNIT V OPERATION AND CONTROL OFMICROGRID 9

Modes of operation and control of micro grid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, micro grid communication infrastructure, Power quality issues in micro grids, regulatory standards, Micro grid economics, Introduction to smart micro grids.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Understand the concepts of Distributed Generation and Microgrids. [understand]
- Gain Knowledge about the various DG resources. [understand]

- Analyze with the planning and protection schemes of Distributed Generation. [Analyze]
- Learn the concept of Microgrid and its mode of operation. [understand]
- Acquire knowledge on the impacts of Microgrid. [understand]
- Analyze the impact of grid integration. [Analyze]

REFERENCES:

1. AmirnaserYezdani, Reza Iravani, “Voltage Sourced Converters in Power Systems: Modeling, Control and Applications”, IEEE John Wiley Publications, 2010.
2. Dorin O. Neacsu, “Power -Switching Converters: Medium and High Power”, CRC Press, 2006.
3. Chetan Singh Solanki, “Solar Photo Voltaic”, PHI learning Pvt. Ltd., New Delhi, 2009.
4. Manwell J. F, McGowan J.G , Rogers A.L , “ Wind Energy Explained: Theory, Design and Applications”, Wiley Publications,2002.
5. Hall D.D, Grover R. P, “BiomassRegenerable Energy”, John Wiley, New York, 1987.

21PPE518	OPTIMIZATION TECHNIQUES IN POWER ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide detailed understanding of Optimization Techniques Applied to extract maximum power from photo voltaic systems and Wind Electric conversion System.
- To acquire an in-depth knowledge on application of Optimization Techniques to Power Electronics.
- To impart knowledge on various Optimization Techniques Applied to Power Electronics engineering.

UNIT I INTRODUCTION **9**

Introduction to fitness evaluation, Definition-classification of optimization problems, unconstrained and constrained optimization, optimality conditions, classical optimization techniques (Linear and non linear programming, Quadratic programming, Mixed integer programming)-. Encoding and decoding functions, Introduction to constraint-handling techniques.

UNIT II EVOLUTIONARY COMPUTATION TECHNIQUES **9**

Fundamentals of evolutionary algorithms-principle of simple Genetic Algorithm- Evolutionary Strategy and Evolutionary Programming- Direction based Search-Genetic operators-selection, crossover and mutation- issues in GA implementation.

UNIT III ADVANCED OPTIMIZATION METHODS **9**

Fundamental principle, velocity updating, advanced operators, hybrid approaches implementation issues (Hybrid of GA and PSO, Hybrid of EP and PSO); Simplifying Particle Swarm Optimization, Optimizer Simplification & Meta-Optimization. Fundamental principle, Classification of Differential Evolution techniques, Bacterial foraging, Bees colony algorithm, Concept of MPPT.

UNIT IV MULTI OBJECTIVE OPTIMIZATION **9**

Concept of pareto optimality-Conventional approaches for MOOP-Multi objective GA-Fitness assignment-Sharing function-NSGA-II, -Multi objective PSO (Dynamic neighbourhood PSO, Vector evaluated PSO)

UNIT V OPTIMISATION TECHNIQUE APPLIED TO POWER ELECTRONICS APPLICATIONS **9**

Passive filter design using genetic algorithm, harmonics elimination in inverters, Tuning of controllers, PV systems-Wind Electric conversion System - GA, PSO, DE, Optimized fuzzy logic control for the Maximum Power Point Tracking (MPPT).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Apply optimization techniques power electronics applications. [Apply]
- Learn about different classifications of optimization problems and techniques. [understand]
- Attain knowledge on linear programming concepts [understand]
- Understand the application of non-linear programming in optimization techniques [understand]
- Apply the fundamental concepts of dynamic programming [Apply]
- Gain knowledge about Genetic algorithm and its application to power system optimization. [Understand]

REFERENCES:

1. Singiresu S.Rao,"Engineering Optimization – Theory and Practice" by John Wiley & Sons, Inc., New Jersey, 2009.
2. Kothari D.P. and Dillon J.S., "Power system optimization", PHI, 2004.
3. Thomas Back, David B Fogel and ZbigniewMichalewicz, "Evolutionary Computation 2 Advanced Algorithms and Operators" Institute of Physics Publishing, UK, 2000.
4. Kalyanmoy Deb, "Muti-objective Optimization using Evolutionary Algorithms", John Wiley & Sons 2001.
5. Kennedy J, "Swarm Intelligence", Morgan Kaufmann Publishers, Eberhart R 2001.
6. Kaddah, S.S, "Genetic algorithm based optimal operation for photovoltaic systems under different fault criteria", Proceedings of IEEE Power Systems Conference, 2006.
7. F.Jafari, A.Dastfan, "Optimization of Single-phase PWM Rectifier Performance by Using the Genetic Algorithm", International Conference on Renewable Energies and Power Quality (ICREPQ'10)

   Granada (Spain), 23rd to 25th March, 2010.

21PPE519	MICROCONTROLLER APPLICATIONS IN POWER CONVERTERS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To expose the students to the fundamentals of microcontroller based system design.
- To impart knowledge on PIC Microcontroller based system design.
- To introduce Microchip PIC 8 bit peripheral system Design.

UNIT I 8051 ARCHITECTURE **9**

Architecture – memory organization – addressing modes – instruction set – Timers - Interrupts -I/O ports, Interfacing I/O Devices – Serial Communication.

UNIT II 8051 PROGRAMMING **9**

Assembly language programming – Arithmetic Instructions – Logical Instructions –Single bit Instructions – Timer Counter Programming – Serial Communication Programming Interrupt Programming – RTOS for 8051 – RTOS Lite – FullRTOS – Task creation and run – LCD digital clock/thermometer using Full RTOS.

UNIT III PIC MICROCONTROLLER **9**

Architecture – memory organization – addressing modes – instruction set – PIC programming in Assembly & C –I/O port, Data Conversion, RAM & ROM Allocation, Timer programming**.**

UNIT IV PERIPHERAL OF PIC MICROCONTROLLER **9**

Timers – Interrupts, I/O ports- I2C bus-A/D converter-UART- CCP modules -ADC, DAC and Sensor Interfacing –Flash and EEPROM memories.

UNIT V SYSTEM DESIGN – CASE STUDY **9**

Introduction to MPLAB IDE and PICSTART plus-Device Programming using MPLAB and PICSTART plus - Generation of Gate signals for converters and Inverters - Motor Control – Controlling DC/ AC appliances – Measurement of frequency – Stand alone Data Acquisition System.

TOTAL : 45 Periods

COURSE OUTCOMES:

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

- Explain PIC Microcontroller based system design. [understand]
- Generate the gate signals for converter and inverter using PIC Microcontroller. [create]
- Apply PIC Microcontroller in System Design [Apply]
- Interface microcontroller to power converter circuits. [understand]
- Analyze and Generate Gate Signals for Power Electronics [Analyze]
- Write the program for LCD digital clock/thermometer using full RTOS. [create]

REFERENCES:

1. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey , “PIC Microcontroller and Embedded Systems using Assembly and C for PIC18”, Pearson Education 2008.
2. John Iovine, “PIC Microcontroller Project Book “, McGraw Hill 2000.
3. MykePredko, “Programming and customizing the 8051 microcontroller”, Tata McGraw Hill 2001.
4. Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, “The 8051 Microcontroller and Embedded Systems” Prentice Hall, 2005.
5. Rajkamal, “Microcontrollers- Architecture, Programming, Interfacing & System Design”, 2nd Edition , Pearson Publication,2012.
6. Scott Mackenzie and Raphael C.W. Phan, “The Micro controller”, Pearson, Fourth edition, 2012.

21PPE520	MODELING AND CONTROL OF POWER ELECTRONIC SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives

- Impart Knowledge on the equilibrium, dynamics and control of Power Electronic Circuits.
- Study the various types of power electronic converters

UNIT I CONVERTERS IN EQUILIBRIUM 9

Principles of steady state converter analysis - Steady-state equivalent circuit modeling, Losses, and Efficiency - Switch realization - The discontinuous conduction mode.

UNIT II CONVERTER DYNAMICS AND CONTROL 9

AC equivalent circuit modeling - The basic AC modelling approach, State-Space averaging, circuit averaging and averaged switch modeling, the canonical circuit model, Modeling the pulse-width modulator

UNIT III CONVERTER TRANSFER FUNCTIONS 9

Review of Bode Plots - Pole zero response, frequency inversion, quadratic pole response: resonance, the low-Q approximation, approximate roots of an arbitrary- degree polynomial. Analysis of converter transfer function, Graphical construction of impedance and transfer functions - series impedance, series resonant, parallel impedance, parallel resonant, voltage divider transfer functions. Graphical construction of converter transfer functions.

UNIT IV CONTROLLER DESIGN 9

Effect of negative feedback on the network transfer functions - construction of important quantities 1/(1+T) and T/(1+T) and the closed-loop transfer functions – regulator design - measurement of loop gains

UNIT V AC AND DC EQUIVALENT CIRCUIT MODELING OF THE DISCONTINUOUS CONDUCTION MODE 9

DCM averaged switch model - Small-Signal AC modeling of the DCM switch network - High-Frequency dynamics of converters in DCM

Course Outcomes:

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

- Analyze the equivalent circuit of converter circuit and its losses and efficiency. [Analyze]
- Examine the different modeling approach of power converters and analyze the dynamics of the converter. [understand]
- Analyze the stability of power converters with the help of transfer function. [Analyze]
- Analyze the stability improvement by implementing the closed loop control systems. [Analyze]
- Explain the small signal modeling of power converters. [understand]

Reference(s)

1. Ericson, "Fundamentals of Power Electronics", Springer Science & Business Media, 2013.

2. Seddik BACHA, "Power Electronic Converters Modeling and Control", Springer Science & Business Media, 2013.

3. S.K..Bhattacharya , "Fundamental of power electronics", UBS Publishers, Second edition 2009.

4. Ned Mohan , "Power electronics", WILEY edition, 2009.G.K.. Dubey, "Fundamental of electric drives", Second edition, Alpha Science.

5. Seddik Bacha, "Power Electronic Converters Modeling and Control", Springer Science & Business Media, 2013.

21PPE521 EMBEDDED CONTROL OF ELECTRIC DRIVES

L	T	P	C
3	0	0	3

Course Objectives

- Study the internal architecture and interfacing of different peripheral devices with microcontrollers.
- Integrate 8051 and PIC micro controller based control of electric drives.
- Design real time embedded controller based on microcontrollers.

UNIT I 8051 ARCHITECTURE 9

Basic organization - 8051 CPU structure - Memory Organization - Addressing modes - Instruction set- Programming - Timing diagram - Memory expansion

UNIT II PERIPHERALS AND VERSIONS OF 8051 9

Parallel Ports -Timers and Counters - Interrupts -Serial Communication - Simple Programs ADC, DAC and Analog Comparator - PWM and Watch dog timer options in PIC 16F877A.

UNIT III ARCHITECTURE OF DSPIC 9

DSPIC30F4011-Architecture -Timer- I/O ports-PWM module-ADC-Case study.

UNIT IV PERIPHERALS INTERFACING OF DSPIC 9

I/O Ports -Timers / Counters - Capture / Compare / PWM modules - Master Synchronous Serial Port (MSSP) module - USART - A / D Converter module -Comparator module

UNIT V APPLICATIONS USING 8051 AND PIC16F87XA 9

Real Time Clock - DC motor speed control - Generation of gating signals for Converters and Inverters - Frequency measurement - Temperature control - Speed control of induction motors -Implementation of PID controller

Course Outcomes:

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

- Interpret the architecture of 8051 microcontroller and classify the addressing modes. . [understand]
- Explain the peripheral interfacing used in 8051 microprocessor. [understand]
- Analyzethe architecture & instruction set of DSPIC microcontroller. [Analyze]
- Analyze the interfacing of different peripheral devices with DSPIC Microcontrollers. [Analyze]

- Execute the applications using 8051 and PIC16f87XA microcontroller programming. . [understand]

Reference(s)

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay," The 8051 Microcontroller and Embedded Systems- Using Assembly and C, Prentice Hall of India, New Delhi, 2008.

2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, PIC Microcontroller and

Embedded Systems: Using Assembly and C for PIC18, Prentice Hall of India, New Delhi, 2007.

3. Dogan Ibrahim, Designing Embedded Systems with 32-Bit PIC Microcontrollers and MikroC Newnes, 2013.

4. Muhammad Rashid,"Power Electronics Hand book" ,Elsevier, 2011

5. Kenneth Ayls, "The 8051 Microcontroller",Cengage Learning 3rd Edition,2007. David Calcutt, Fred Cowan, Hassan Parchizadeh, 8051 Microcontrollers - An Application Based Introduction, Elsevier, 2006.

6. Subrata Ghoshal, Embedded Systems & Robots: Projects Using The 8051 Microcontroller, Cengage Learning, 2nd Edition, 2009.

21PPE522	AUTOMOTIVE ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the internal structure and the switching and operating characteristics of the basic power devices.
- To study the advanced power devices and its working principle.

UNIT I INTRODUCTION 9

Evolution of electronics in automobiles – emission laws – introduction to Euro I, Euro II, EuroIII, Euro IV, Euro V standards – Equivalent Bharat Standards, Charging systems: Working and design of charging circuit diagram – Alternators – Requirements of starting system – Starter motors and starter circuits.

UNIT II IGNITION AND INJECTION SYSTEMS 9

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition– Distribution less ignition -Direct ignition – Spark Plugs. Electronic fuel Control: Basics of combustion – Engine fuelling and exhaust emissions –Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.

UNIT III SENSOR AND ACTUATORS 9

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall Effect, Throttle angle, temperature, exhaust gas oxygen sensors – study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, and vacuum operated actuator.

UNIT IV ENGINE CONTROL 9

Control modes for fuel control- engine control subsystems – ignition control methodologies different ECU"s used in the engine management – block diagram of the engine management system. In vehicle networks: CAN standard, format of CAN standard – diagnostics systems in modern automobiles.

UNIT V CHASSIS AND SAFETY SYSTEMS 9

Traction control system – Cruise control system – electronic control of automatic transmission antilock braking system –electronic suspension system – working of airbag and role of MEMS in air bag systems – centralized door locking system –climate control of cars.

Total: 45 periods

COURSE OUTCOMES:

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

- Analyze response of Transducers and sensors for automotive applications [Analyze]
- Understand the various after treatment and alternative fuel-based systems. [understand]
- Comprehend the operation of petrol engine management systems. [Apply]
- Understand the operation of automotive sensors and fuel injection systems. [understand]
- Comprehend the Electronic control unit pertaining to chassis and body.
- Illustrate the various Automotive subsystems.[Apply]

REFERENCES:

1. Tom Denton. "*Automobile electrical and electronic system*", Edward Arnold publishers, 4th Edition , 2012

2. William B. Ribbens, "*Understanding Automotive Electronics*", Newness 7th Edition2012.

3. Al Santini,"*Automotive Electricity & Electronics*" Cengage Learning, 2012

4. Muhammad Rashid,"*Power Electronics Hand booke*, Elsevier, 2011

5. William B.Ribbens, *Understanding automotive electronics, an engineering perspective,* Elsevier 2014

21PPE523	DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To review the drive cycles and requirements of EVs
- To know the working of motors used in Electric Vehicle
- To analyze and model the buck/boost converter operation and to design the same
- To learn the simulation basics of control systems
- To derive transfer functions for DC-DC converters

UNIT I ELECTRIC VEHICLE DYNAMICS 6

Standard drive cycles-Dynamics of Electric Vehicles-Tractive force-Maximum speed, torque, power, energy requirements of EVs.

UNIT II MOTORS FOR ELECTRIC VEHICLES 6

Introduction – Speed And Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-Choice of electric machines for EVs.

UNIT III BASICS OF SIMULATION IN CONTROL SYSTEMS 6

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

UNIT IV MODELING OF DC-DC CONVERTERS 6

Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling – Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage - Frequency Response of Converter

UNIT V POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS 6

Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function, Load Current-to-Output Transfer Function.

Total: 30 PERIODS

LAB COMPONENT: **30 PERIODS**

1. Simple simulation exercises of basic control systems

2. Bode plots and calculation of Gain margin and Phase margin for power stage transfer function via simulation.

3. Design of buck converter

4. Design of boost converter

5. Simulation of buck, boost and buck boost converter-open loop (With power circuit and Transfer function).

TOTAL: 30+30 = 60 PERIODS

COURSE OUTCOMES:

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

- Use appropriate electric machine for electric vehicle application [Analyze]
- Compute transfer function with factors such as constant, integral, differential, first order factor and second order factor (both numerators & denominators)
- Compute transfer function from state models [Apply]
- Design buck, boost and buck-boost converter. [Create]
- Compute a power stage transfer functions for DC-DC converters [Apply]
- Simulate DC-DC converters and to obtain gain margin and phase margin. [Create]

REFERENCES:

1. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.

2. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, 2nd Edition, 2013, Lakshmi publications

3. Feedback Control problems using MATLAB and the Control system tool box, Dean Frederick and Joe Cho, 2000, 1st Edition, Cengage learning.

4. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005,1st Edition.

5. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley,2021, 1st Edition.

6. Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design, and Control, Md. Rabiul Islam,Md. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press,2021, 1st Edition.

7. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Second Edition” CRC Press, Taylor & Francis Group, Third Edition 2021.

21PPE524	DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To know the charging station and standards
- To learn the concepts of power converters in charging
- To find the charging scheme in renewable based EV charging
- To demonstrate the wireless power transfer technique
- To design & simulate power factor correction circuits

UNIT I CHARGING STATIONS AND STANDARDS 6

Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, International standards and regulations

UNIT II POWER ELECTRONICS FOR EV CHARGING 6

Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC–DC bidirectional converter topologies- Half-bridge bidirectional converter.

UNIT III EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS 6

Introduction- - EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system , Operation modes of EVC-HSP system , Control strategy of EVCHSP system - fast-charging infrastructure with solar PV and energy storage.

UNIT IV WIRELESS POWER TRANSFER 6

Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs -Charging Modes in EVs – Benefits of WPT. - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363

UNIT V POWER FACTOR CORRECTION IN CHARGING SYSTEM 6

Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses-

Total: 30 PERIODS

LAB COMPONENT: **30 PERIODS**

1. Simulation and analysis for bi-directional charging V2G and G2V.
2. Design and demonstrate solar PV based EV charging station.
3. Simulate and infer wireless power charging station for EV charging.
4. Simulation of boost converter based power factor correction.

TOTAL: 30+30 = 60 PERIODS

COURSE OUTCOMES:

- illustrate various charging techniques and to know charging standards and regulations. [Analyze]
- Demonstrate the working o DC-DC converters used for charging systems and principles [Analyze]
- Illustrate the advantages of renewable system based charging systems [Analyze]
- Demonstrate the principles of wireless power transfer. [Apply]
- Analyze the standards for wireless charging [Analyze]
- Design and simulate boost converter based power factor correction. [Create]

REFERENCES:

1. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 2016, 1st Edition.

2. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher 1 Edition. 2020.

3. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles Modern Technologies and Trends. Springer Publisher 1st Edition, 2021.

4. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1 stEdition.

5. Electric and Hybrid Electric Vehicles, James D Halderman, Pearson, 2022, 1Edition.

6. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

21PPE525	DESIGN AND MODELING OF RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To review the renewable energy systems and technology
- To learn the Single phase grid-connected photovoltaic systems and three phase photovoltaic systems
- To illustrate the small wind energy systems
- To simulate the Doubly-fed induction generator based WECS

UNIT I **RENEWABLE ENERGY SYSTEMS: TECHNOLOGY OVERVIEW AND PERSPECTIVES** **(7+2 Skill) 9**

Introduction-State of the Art- Examples of Recent Research and Development Challenges and Future Trends

UNIT II **SINGLE-PHASE GRID-CONNECTED PHOTOVOLTAIC SYSTEMS** **(7+2 Skill) 9**

Introduction- Demands for Grid-Connected PV Systems-Power Converter Technology for SinglePhase PV Systems, Transformer less AC-Module Inverters (Module-Integrated PV Converters, Transformer less Single-Stage String Inverters, DC-Module Converters in Transformer less Double-Stage PV Systems

UNIT III **THREE-PHASE PHOTOVOLTAIC SYSTEMS: STRUCTURES, TOPOLOGIES** **(7+2 Skill) 9**

Introduction-PV Inverter Structures, Three-Phase PV Inverter Topologies- -Control Building Blocks for PV Inverters, Modulation Strategies for Three-Phase PV Inverters, Implementation of the Modulation Strategies., Grid Synchronization, Implementation of the PLLs for Grid Synchronization, Current Control, Implementation of the Current Controllers, Maximum Power Point Tracking.

UNIT IV **SMALL WIND ENERGY SYSTEMS** **(7+2 Skill) 9**

Introduction-Generator Selection for Small-Scale Wind Energy Systems- Turbine Selection for Wind Energy- Self-Excited Induction Generators for Small Wind Energy Applications- Permanent Magnet Synchronous Generators for Small Wind Power Applications- Grid-Tied Small Wind Turbine Systems- Magnus Turbine–Based Wind Energy System

UNIT V **DOUBLY-FED INDUCTION GENERATOR-BASED WECS** **(7+2 Skill) 9**

Introduction – modelling of induction machine in machine variable form and arbitrary reference frame, modelling of Doubly-fed Induction Generator.

Total: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Simulation of inverter for PV systems
2. Simulation of WECS with DFIG

List of Open Source Software/ Learning website:

1. https://www.mdpi.com/journal/applsci/topical_collections/Susta_Energy
2. https://www.mathworks.com/help/sps/ug/single-phase-grid-connected-in-pv-system.html
3. https://www.sciencedirect.com/topics/engineering/three-phase-inverter
4. academia.edu/32704493/Wind_Power_Lecture_Notes
5. https://www.syscop.de/files/2018ss/WES/handouts/script.pdf
6. https://www.sciencedirect.com/topics/engineering/wound-rotor-induction-generator

COURSE OUTCOMES:

After the successful completion of this course, the student will be able to

- Review the perspectives of renewable energy systems
- Integrate photovoltaic systems with grid
- Study inverter for PV systems
- Elaborate the working of small wind power systems
- Study the features of induction machine and doubly fed induction machine

TEXT BOOKS:

1. Ahmad Azar, Nashwa Kamal, "Design, Analysis and Applications of Renewable Energy Systems", Academic Press, First Edition, 2021
2. Ahmad Azar, Nashwa Kamal, "Renewable Energy Systems", Academic Press, First Edition, 2021
3. Nabil Derbel, Quanmin Zhu Modeling, "Identification and Control Methods in Renewable Energy Systems" , Springer, First Edition, 2019

REFERENCE BOOKS:

1. Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1st Edition.
2. Wind Electrical Systems, S.N. Bhadra, 2005, Oxford, 7th Impression.
3. Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET, 2nd Edition.
4. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, Frede Blaabjerg, Dan M. Ionel, CRC press, 2017, 1st Edition.

OPEN ELECTIVE

21PCD601	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Understand The Operational Safety
- To Understand The Safety Management

UNIT I ACCIDENT INVESTIGATION AND ANALYSIS 9

Concept of an Accident, reportable and non reportable accidents, reporting to statutory authorities. Principles of accident prevention-accident investigation and analysis-Unsafe act and unsafe condition- Domino sequence-cost of accidents-permanent total disabilities, Permanent partial disabilities, Temporary total disabilities-Calculation of frequency rate and severity rate of accidents.

UNIT II ERGONOMICS AND HUMAN BEHAVIOUR 9

Introduction to ergonomics and its area of application in the work system. Anatomy, Posture and body mechanics-low back pain, risk factors for musculoskeletal disorders in the work place-behavioral aspects of posture - effectiveness. Individual differences, Factors contributing to personality, fitting the man to the job.Motivation -job satisfaction - Frustration and conflicts, reaction to frustration, emotion and frustration. Attitudes - determination of attitudes- changing attitudes.

UNIT III HAZARDS AND THEIR CONTROL 9

Physical hazards-Noise, heat, vibration, ionizing and non-ionizing radiations, and effects. Chemical hazards-dusts, fumes, mist, vapor, fog, gases, types, concentration, exposure Vs dose, TLV. Mechanical hazards. Engineering control methods- use of personal protective equipments.

UNIT IV FIRE PREVENTION AND PROTECTION 9

Fire triangle-principles of fire extinguishing- various classes of fires- A, B, C, D types of fire extinguishers- Industrial fire protection systems. Sprinklers- Fire hydrants- Alarm and detection systems- other suppression systems- CO2 system, foam system and DCP system.

UNIT V SAFETY MANAGEMENT TECHNIQUES, EDUCATION AND TRAINING 9

Incident Recall Technique (IRT), disaster control, Job safety Analysis, Safety survey, safety inspection. Safety training programs, seminars, conferences, competitions- method of promoting safe practice- motivation- creating awareness, awards, celebrations, safety posters, safety displays, safety incentive scheme- domestic safety and training.

Total: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Evaluate the concept of accident prevention& accident investigation
- Identify the human behavior
- Demonstrate hazards and their control
- Prepare the fire prevention and protection
- Summarize the safety management techniques

TEXT BOOKS:

1. Heinrich.H.W. “Industrial Accident Prevention”, McGraw Hill Company, New York, 1980.

2. John V. Grimaldi and Rollin H. Simonds, “Safety Management” , All India Travellers Book Seller, New Delhi, 1989.

3. E.J.McCormick and M.S. Sanders “Human Factors in Engineering and Design”, TMH, New Delhi, 1982.

4. Hand Book of “Occupational Safety and Health”, National Safety Council, Chicago, 1982.

5. Derek, James, “Fire Prevention Hand Book”, Butter Worths and Company, London, 1986.

REFERENCES:

1. Krishnan.N.V. “Safety Management in Industry”, Jaico Publishing House, Bombay, 1997.

2. Lees, F. P. “Loss Prevention in Process Industries”, Butter Worth publications, London, 2nd Edition, 1990.

3. Dan Peterson, “Techniques of Safety Management”, McGraw Hill Company, Tokyo, 1981.

4. “Accident Prevention Manual for Industrial Operations”, N.S.C. Chicago, 1982.

5. Hunter, Gomos, “Engineering Design for Safety”, McGraw Hill Inc., 1992.

6. Encyclopedia of “Occupational Health and Safety” Vol I and II, Published by International Labour Office, Geneva, 1985.

7. Gupta. R.S., “Hand Book of Fire Technology”, Orient Longman, Bombay, 1977.

21PCS602	BUSINESS ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES :

- Understand the role of business analytics within an organization.
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
- Use decision-making tools/Operations research techniques.
- Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

UNIT I BUSINESS ANALYTICS 9

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT II TRENDINESS AND REGRESSION ANALYSIS 9

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT III ANALYTICS MODELLING AND MINING 9

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.

Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT IV FORECASTING TECHNIQUES 10

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables,

Selecting Appropriate Forecasting Models.

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT V DECISION ANALYSIS 8

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. **TOTAL:45 Periods**

COURSE OUTCOMES:

After the successful completion of this course, the student will be able to

- Demonstrate the knowledge of data analytics.
- Demonstrate the ability of think critically in making decisions based on data and deep analytics.
- Demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
- Demonstrate the ability to translate data into clear, actionable insight. Familiarise the students with the concept of small business
- Ability to devise plans for small business by building the right skills and marketing Strategies
- Identify the funding source for small start ups

REFERENCES:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.

2. Business Analytics by James Evans, persons Education.

21PCM603 IOT FOR SMART APPLICATIONS L T P C

3 0 0 3

Objectives:

- Brief about the interconnection and integration of smart devices with controller/SoC
- Learn the architecture of IoT and its standards
- Give an basic idea about M2M-IoT

UNIT I M2M and IoT- Introduction 9

The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics.

UNIT II M2M AND ioT TECHNOLOGY FUNDAMENTALS 9

Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management.

UNIT III IOT REFERENCE ARCHITECTURE 9

IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model-Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture-Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

UNIT IV SENSORS AND SMART SENSORS 9

Principles, Classification, Parameters, Characteristics, Environmental Parameters (EP), Characterization. Mechanical and Electromechanical Sensors: Introduction, Resistive Potentiometer, Strain Gauge, Resistance Strain Gauge, Semiconductor Strain Gauges, Inductive Sensors- Sensitivity and Linearity of the Sensor, Types- Capacitive Sensors, Electrostatic Transducer, Force/Stress Sensors using Quartz Resonators, Ultrasonic Sensors, Introduction, On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing, Sensors for environmental Monitoring.

UNIT VINTERNET OF THINGS –PRIVACY, SECURITY AND GOVERNANCE 9

Introduction, Overview of Governance, Privacy and Security Issues, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

. **TOTAL: 45 PERIODS**

COURSE OUTCOMES:

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

- Apply IoT technology for smart applications [Apply]
- Analyze the concepts of IoT and its present developments. [Analyze]
- Compare and contrast different platforms and infrastructures available for IoT
- Explain different protocols and communication technologies used in IoT [understand]
- Analyze the big data analytic and programming of IoT [Analyze]
- Implement IoT solutions for smart applications [Create]

REFERENCES:

1. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.
2. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1stEdition, Apress Publications, 2013.
3. CunoPfister, “Getting Started with the Internet of Things”, OReilly Media, 2011.
4. McEwen, H. Cassimally, “Designing the Internet of Things”, Wiley, 2013.
5. Samuel Greenguard, “Internet of things”, MIT Press, 2015.
6. http://www.datamation.com/open-source/35-open-source-tools-for-the-internet-of-things1.html
7. https://developer.mbed.org/handbook/AnalogIn
8. http://www.libelium.com/50_sensor_applications

21PPE604	BIOENERGY FROM WASTE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide the details of types of wastes.
- To illustrate the concept of waste treatment and disposal.
- To outline concepts behind eco-technological alternatives for waste to energy.

UNIT-IINTRODUCTION TO WASTE & WASTE PROCESSING 9

Definitions, sources, types and composition of various types of wastes; Characterization of Municipal Solid Waste (MSW) , Industrial waste and Biomedical Waste (BMW), waste collection and transportation; waste processing-size reduction, separation; waste management hierarchy, waste minimization and recycling of MSW; Life Cycle Analysis (LCA), Material Recovery Facilities (MRF), recycling processes of solid waste.

UNIT-II WASTE TREATMENT AND DISPOSAL 9

Aerobic composting, incineration, different type of incineration; medical and pharmaceutical waste incinerations- land fill classification, types, methods and sitting consideration, layout and preliminary design of landfills: composition, characteristics, generation, movement and control of landfill leachate and gases, environmental monitoring system for land fill gases.

UNIT-IIIENERGY FROM WASTE-THERMO CHEMICAL CONVERSION 9

Sources of energy generation, incineration, pyrolysis, gasification of waste using gasifiers, briquetting, utilization and advantages of briquetting, - environmental and health impacts of incineration; strategies for reducing environmental impacts.

UNIT-IV ENERGY FROM WASTE- BIO-CHEMICAL CONVERSION9

Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, anaerobic digestion bio gas production, land fill gas generation and utilization, present status of technologies for conversion of waste into energy, design of waste to energy plants for cities, small townships and villages.

UNIT-VENVIRONMENTAL AND HEALTH IMPACTS-CASE STUDIES 9

Environmental and health impacts of waste to energy conversion, case studies of commercial waste to energy plants, waste to energy- potentials and constraints in India, eco-technological alternatives for waste to energy conversions – Rules related to the handling, treatment and disposal of MSW and BMW in India.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Classify different types of waste.
- Implement the waste disposal & energy conversion techniques.
- Apply the strategies for reducing environmental impacts.
- Design the waste to energy plants

REFERENCES:

1. Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, by Gary C. Young, ISBN:9780470539675, Publisher: John Wiley & Sons, Publication Date: June 2010.
2. Recovering Energy from Waste Various Aspects Editors: Velma I. Grover and Vaneeta Grover, ISBN 978-1-57808-200-1; 2002
3. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000.
4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987.
5. Waste-to-Energy by Marc J. Rogoff, DEC-1987, Elsiever, ISBN-13: 978-0-8155-1132-8, ISBN-10: 0-8155-1132-9.
6. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.
7. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997.
8. Bhide A. D., Sundaresan B. B., Solid Waste Management in Developing Countries, INSDOC, New Delhi, 1983.
9. Robert Green, From Waste to Energy, Cherry Lake Pub. ISBN: 1602795096, 2009.
10. G. Evans, Biowaste and Biological Waste Treatment, 2005
11. Biogas from waste and renewable resources, by Dieter D. And Angelika S. Wiley-Vch Publication 2010

21PSE605	SMART CITY TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students understand the core challenges relating to the foundation of sustainable smart cities
- To impart knowledge on understanding, and critical thinking related to smart, sustainable urban development.
- To explore issues relating to the development and deployment of new and emerging technologies, that will create a thorough understanding of smart processes and systems of the present and future

UNIT I INTRODUCTION TO SMART CITIES **9**

Introduction, Definition, Drivers, barriers and benefits of smart cities, characteristics and factors of Smart cities, understanding Livability, Affordability and Inequality, Development standards, Fundamentals of smart city rankings, emerging trends and technologies.

UNIT II SMART CITIES FRAMEWORK **9**

Smart city responsibilities: Built environment, Energy, Telecommunications, Transportation, Health and human services, Water and wastewater, Smart city enablers: instrumentation and control, connectivity, security, privacy and data management.

UNIT III SMART AND SUSTAINABLE URBAN DEVELOPMENT **9**

Principles of sustainable development and smart growth, low carbon and renewable energy technologies, pollution prevention, climate adaptation, environmental systems management, smart buildings infrastructure

UNIT IV SMART TECHNOLOGIES **9**

Concepts of Big Data Analytics: big data platforms and cloud computing, urban informatics, GIS and spatial analysis, measuring impact and data visualization Smart Technologies: Internet of things, remote sensing and communication technologies.

UNIT V INDIAN INITIATIVES TOWARDS SMART CITIES **9**

ICT initiatives in Indian Cities, Institutional frame work, selection of cities for suitability to become a smart city, e- governance, identification parameters for smart city fund allocation, Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the students will be able to

- Explain the concepts of smart cities.
- Describe the framework of smart cities.
- Analyze the principles of sustainable development.
- Apply Big data analytics and smart technologies in creating smart cities
- Evaluate the smart city projects implemented in India

REFERENCE BOOKS:

1. Jesse Berst, Liz Enbysk and Christopher Williams Smart Cities Readiness Guide – The planning manual for building tomorrow"s cities today, Smart Cities Council, 2014.
2. Joy Sen, Sustainable Urban Planning, The Energy and Resources Institute, New Delhi, 2013. (ISBN 978-81-7993-324-4).
3. Anthony M. Townsend, SMART CITIES Big Data, Civic Hackers, and the Quest for a New Utopia, W. W. Norton & Company, Inc., 2013.(ISBN-13: 978-0393082876)
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