JALPAIGURI GOVERNMENT ENGINEERING COLLEGE
JALPAIGURI- 735102
(An Autonomous Government College)

COURSE STRUCTURE AND SYLLABUS

M.TECH SYLLABUS
OF
ELECTRICAL ENGINEERING DEPARTMENT

Implemented from 01st July,2021

To be followed by the students who will be admitted in 2021 onwards.

SPECIALIZATION:

POWER ELECTRONICS & DRIVES

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GRADUATE ATTRIBUTES :

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

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

PROGRAM EDUCATIONAL OBJECTIVES

PEO1. Design and develop innovative products and services in the field of Power Electronics & Drives

PEO2. Keep abreast with the latest technology and toolset.

PEO3. Communicate effectively to propagate ideas and promote teamwork

PEO4. Attain intellectual leadership skills to cater to the changing needs of power industry, academia, society and environment

PROGRAM OUTCOMES:

At the end of the program the student will be able to:

PO1-Design and develop power electronic circuits and drive systems

PO2 -Deliver technological solutions in the field of power electronics and drives by assimilating advances in allied disciplines

PO3 -Simulate and experiment in the field of power electronics and drives using modern tools

PO4 -Design renewable energy systems to protect environment and ecosystems

PO5 -Practice professional ethics with social sensitivity

PO6 -Develop innovative and entrepreneurial solutions

PO7 -Develop an attitude to learn with self-motivation

PO8 -Communicate effectively at all levels and demonstrate leadership qualities

PO9 -Pursue research to enhance the existing pool of knowledge

First Semester

A. THEORY							
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours/Week**				**Credits**
			L	**T**	**P**	**Total**	
Core-1	PED-101	Power Electronic Converters	3	0	0	3	03
Core-2	PED-102	Modeling and Analysis of Electrical Machines	3	0	0	3	03
PE-1	Code of the selected papers	Elective-I: One subject to be taken from the pool of elective subjects for PE-1 & PE-2	3	0	0	3	03
PE-2		Elective- II: Second one subject to be taken from the pool of elective subjects for PE-1 & PE-2	3	0	0	3	03
Research	RMI-101	Research Methodology and IPR	2	0	0	2	02
Audit-I	AUD-101	One from the List of Audit subjects	2	0	0	2	00
Total of Theory			**16**	**00**	**00**	**16**	**14**
B. PRACTICAL							
Lab.-I	PED-191	Power Electronics & Drives Laboratory-I	0	0	8	8	04
Total of Practical			00	00	08	08	04
Total of Semester			**16**	**00**	**08**	**24**	**18**

Second Semester

A. THEORY							
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours/Week**				**Credits**
			L	**T**	**P**	**Total**	
Core-1	PED-201	Advanced Power Electronic Circuits	3	0	0	3	03
Core-2	PED-202	Electric Drives System	3	0	0	3	03
PE-3	Code of the selected papers	Elective-I: One subject to be taken from the pool of elective subjects PE-3 & PE-4	3	0	0	3	03
PE-4		Elective- II: Second one subject to be taken from the pool of elective subjects PE-3 & PE-4	3	0	0	3	03
Audit	AUD-201	Second One from the pool of Audit subjects	2	0	0	2	00
Total of Theory			**14**	**00**	**00**	**14**	**12**
B. PRACTICAL							
Lab.-II	PED-291	Power Electronics & Drives Laboratory-II	0	0	8	8	04
Total of Practical			00	00	08	08	04
C. SESSIONAL							
Mini Project	PED-281	Mini Project with Seminar	0	0	4	4	02
Total of Sessional			00	00	04	04	02
Total of Semester			**14**	**00**	**08**	**26**	**18**

Third Semester

A. THEORY							
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours/Week**				**Credits**
			L	**T**	**P**	**Total**	
PE-5	PED-301	Elective-V	3	0	0	3	03
OE	OE-301	One from the pool of Open Elective subjects	3	0	0	3	03
Total of Theory			**06**	**00**	**00**	**06**	**06**
B. SESSIONAL							
Major Project	PED-381	Phase-I Dissertation	0	0	20	20	10
Total of Sessional			00	00	20	20	10
Total of Semester			**06**	**00**	**20**	**26**	**16**

Fourth Semester

A. SESSIONAL							
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours/Week**				**Credits**
			L	**T**	**P**	**Total**	
Major Project	PED-481	Phase-II : Dissertation	0	0	32	32	16
Total of Sessional			00	00	32	32	16
Total of Semester			**00**	**00**	**32**	**32**	**16**

List of Elective Subjects

Elective-I(PE-1) and Elective-II(PE-2): (Any two subjects to be chosen from the following pool of Electives)

PED-103: Optimal and Adaptive Control
PED-104: Power Quality
PED-105: Dynamics of Electrical Machines
PED-106: Static VAR Controllers and Harmonic Filtering
PED-107: PWM converter and Applications
PED-108: Power Semiconductor Devices & Modelling
PED-109: Microcontroller Based System Design
PED-110: Optimization Technique
PED-111: DSP Based System
PED-112: Artificial Neural Network

Elective-III(PE-3) & Elective-IV(PE-4):(Any two subjects to be chosen from the following pool of Electives)

PED-203: .Switched Mode and Resonant Converters
PED-204: Industrial Load Modelling and Control
PED-205: Advanced Digital Signal Processing
PED-206: Soft Computing
PED-207: Advanced Microcontroller Based System
PED-208: Distributed Generation
PED-209: Smart Grids
PED-210: Energy Efficient Motor
PED-211: Nonlinear Dynamics & Chaos
PED-212: Digital Control of Power Electronic and Drive Systems

Elective-V: (Any one subject to be chosen from the following pool of Electives)

PED-301a: SCADA Systems and Applications

PED-301b: FACTS and Custom Power Devices
PED-301c: HVDC
PED-301d: Condition Monitoring of Electrical Equipment.
PED-301e: Modeling and Control of Wind Energy Generation
PED-301f: Advanced Electric Drive
PED-301g: Nonlinear Phenomenon in Power Electronics & Drives
PED-301h: Microgrid

AUD-101& AUD-201: (One subject from the pool to be chosen as AUD-101& a second subject as AUD-201)

a. English for Research Paper Writing
b. Disaster Management
c. Sanskrit for Technical Knowledge
d. Value Education
e. Constitution of India
f. Pedagogy Studies
g. Stress Management by Yoga
h. Personality Development through Life Enlightenment Skills.

OE-301: (Any one subject to be chosen from the following list of Electives)

a. Business Analytics
b. Industrial Safety
c. Operations Research
d. Cost Management of Engineering Projects
e. Composite Materials
f. Waste to Energy

Syllabus:

PED-101: Power Electronic Converters

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03
Course Objectives:

1. To introduce students to the concepts and basic operations of AC to DC, DC to DC converters, Inverters, AC to AC power conversion including power circuit design approaches.
2. To provide strong foundation for further study of steady-state and dynamic analysis of converters along with the applications like solid state drives and power quality.

Syllabus:

Syllabus		
Units	Contents	Hours
1	Analysis of power semiconductor switched circuits with R, L, RL, RC loads D.C. motor load. Battery charging circuit.	6
2	Single-Phase and Three-Phase AC to DC converters. Half controlled configurations-operating domains of three phase full converters and semi-converters. Reactive power considerations.	8
3	Analysis and design of DC to DC converters. Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converters, Cuk converters.	6
4	Single phase and three phase inverters. Voltage source and Current source inverters. Voltage control and harmonic minimization in inverters.	8
5	AC to AC power conversion using voltage regulators. Choppers and cyclo-converters. Consideration of harmonics, introduction to Matrix converters.	8
6	Design aspects of converters, Few practical applications	8

Suggested reading:

1. Ned Mohan, Undeland and Robbin, “Power Electronics: converters, Application and design”, John’s Wiley and sons. Inc, Newyork.
2. M.H.Rashid, “Power Electronics”, Prentice Hall of India 1994.

Course Outcomes:

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

1. Select an appropriate power semiconductor device and design a power converter for the required application.
2. Determine the power circuit configuration needed to fulfil the required power conversion with applicable constraints.
3. Design the control circuit and the power circuit for a given power converter
4. Carry out transient and steady state analysis of different power converters of different types of loads and switching sequences.
5. Improvise the existing control techniques to suit the application

PED102: Modelling and Analysis of Electrical Machines

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03
Course Objectives:

1. To provide concepts for developing mathematical models of different electrical machines.
2. To introduce students a strong foundation on how a machine can be represented as its mathematical equivalent.
3. To make the students competent enough to perform transient analysis on developed mathematical model of AC & DC machines.

Syllabus:

Units	Contents	Hours
1	Principles of Electromagnetic Energy Conversion. General expression of stored magnetic	6

	energy. Co-energy and force/torque, example using single and doubly excited system.	
2	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.	8
3	Three phase symmetrical induction machine and salient pole synchronous machines in phase variable form, Application of reference frame theory to three phase symmetrical induction and synchronous machines. Dynamic direct and quadrature axis model in arbitrarily rotating reference frames.	6
4	Determination of Synchronous machine dynamic equivalent circuit parameters .Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine.	8
5	Special Machines – 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.	8
6	Analysis of Switch Reluctance Motors. Brushless D.C. Motor for space Applications. Recent trends.	8

Suggested reading.

1. Charles Kingsle,Jr., A.E. Fitzgerald, Stephen D.Umans, "Electric Machinery", Tata Mcgraw Hill
2. R. Krishnan, "Electric Motor & Drives: Modeling, Analysis and Control", Prentice Hall of India
3. Miller, T.J.E., "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press
4.P.C.Krause "Analysis of Electric Machine" Wiley IEEE Press 3rd Edition

Course Outcomes:

At the end of the course the student will be able to:
1. perform analysis on dynamic behaviour of rotating machines.
2. understand equivalent circuit of synchronous machines.
3. understand various practical issues of different machines
4. employ electromagnetic energy conversion techniques in system analysis
5. gain competency in modeling asynchronous & synchronous induction machine
6. analyze steady state & dynamic operation of induction machine
7. contrive drive operation as per the industry requirements.

PED-103: Optimal and Adaptive Control

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03
Course Objectives:

1. To provide the concepts on operations of closed and open loop optimal control.
2. To make the students understand the adaptive control strategies.
3. To impart concepts to learn dynamic programming method.

Syllabus:

Units	Contents	Hours
1.	Optimal control problem – fundamental concepts and theorems of calculus of variations– Euler – Language equation and external of functional.	6
2.	Variational approach to solving optimal control problems. Hamiltonian and different boundary conditions for optimal control problem.	8
3.	Linear regulator problem –Pontryagin's minimum principle.	6
4.	Dynamic programming – Principle of optimality and its application to optimal control problem.	8
5.	Hamilton-Jacobi-Bellman equation – model reference adaptive systems (MRAS) – Design hypothesis**.**	8
6.	Introduction to design method based on the use of Liapunov function. Design and simulation of variable structure adaptive model following control.	8

Suggested reading:

1.Donald E. Kirk, "Optimal Control Theory, An introduction", Prentice Hall Inc., 2004
2.A.P. Sage, "Optimum Systems Control", Prentice Hall, 1977
3. HSU and Meyer , "Modern Control, Principles and Applications", McGraw Hill, 1968
4. Yoan D. Landu, "Adaptive Control (Model Reference Approach)", Marcel Dekker.1981
5.K.K.D.Young, "Design of Variable Structure Model Following Control Systems", IEEETransactions on Automatic Control, Vol. 23, pp 1079-1085, 1978.

Course Outcomes:

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

1. Have knowledge in the mathematical area of calculus of variation so as to apply the same for solving optimal control problems.
2. Apply concepts on problem formulation, performance measure and mathematical treatment of optimal control problems.
3. Acquire knowledge on solving optimal control design problems by taking into consideration the physical constraints on practical control systems.
4. Comprehend optimal solutions to controller design problems taking into consideration the limitation on control energy in the real practical world.

PED-104: Power Quality

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:

1. To know various power quality issues, it causes and effects
2. To understand effects of harmonics due to non-linear load
3. To learn mitigation methods for harmonics
4. To make students learn about the recommended practices by various standard bodies like IEEE, IEC, etc. on voltage & frequency, harmonics
5. To provide concepts on power quality conditioners.

Syllabus:

Syllabus		
Units	Contents	Hours
1	**Overview of Power Quality** - Concern about the Power Quality - General Classes of Power Quality Problems - Transients -Long-Duration Voltage Variations – Short Duration Voltage Variations - Voltage Unbalance - Waveform Distortion – Voltage fluctuation - Power Frequency Variations - Power Quality Terms - Voltage Sags and Interruptions - Sources of Sags and Interruptions - Nonlinear loads	8
2	**Transient over Voltages-** Source of Transient Over Voltages - Principles of Over Voltage Protection - Devices for Over Voltage Protection - Utility Capacitor Switching Transients - Utility Lightning Protection – Load Switching Transient Problems - Computer Tools for Transient Analysis	8
3	**Harmonic Distortion and solutions:** Voltage vs. Current Distortion - Harmonics vs. Transients - Power System Quantities under Non sinusoidal Conditions - Harmonic Indices - Sources of harmonics - Locating Sources of Harmonics - System Response Characteristics - Effects of Harmonic Distortion – Inter harmonics - Harmonic Solutions Harmonic Distortion Evaluation - Devices for Controlling Harmonic Distortion – Harmonic Filter Design - Standards on Harmonics	8
4	**Long Duration Voltage Variations:** Principles of Regulating the Voltage - Device for Voltage Regulation – Utility Voltage Regulator Application - Capacitor for Voltage Regulation - End-user Capacitor Application – Regulating Utility Voltage with Distributed Resources - Flicker	8
5	**Power quality conditioners:-** Shunt and series compensators, Dstatcom-dynamic voltage restorer, unified power quality conditioners.	10

Suggested reading

1. Ghosh Arindam and Ledwich Gerard, 'Power quality enhancement using custom power devices' Springer.

2. Power Quality by C.Sankaran, CRC publication
3. Arrillaga J., Watson N. R. and Chen S., 'Power System Quality Assessment' Wiley.
4. Caramia P, Carpinelli G and Verde P, 'Power quality indices in liberalized markets' – Wiley
5. Angelo Baggini 'Handbook of Power Quality' – Wiley.
6. G.T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007
7. Math H. Bollen, "Understanding Power Quality Problems", IEEE Press, 2000
8. J. Arrillaga, "Power System Quality Assessment", John wiley, 2000

Course Outcomes:
At the end of the course the student will be able to:
1. Implement compensating techniques for a given power quality problem.
2. Acquire knowledge about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads
3. To introduce the student to active power factor correction based on static VAR compensators and its control techniques
4. To introduce the student to series and shunt active power filtering techniques for harmonics.
5. Develop control techniques for compensating devices

PED-105: Dynamics of Electrical Machines

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03
Course Objectives:
1. To learn Performance characteristics of machine.
2. To understand the dynamics of the machine.
3. To understand how to determine stability of machine.
4. To learn the synchronous machine analysis.

Syllabus		
Units	Contents	hours
1	Stability. Primitive 4 Winding Commutator Machine. Commutator Primitive Machine. Complete Voltage Equation of Primitive 4 Winding Commutator Machine.	6
2	Torque Equation. Analysis of Simple DC Machines using the Primitive Machine Equations. The Three Phase Induction Motor. Transformed Equations. Different Reference Frames for Induction Motor Analysis Transfer Function Formulation.	10
3	Three Phase Salient Pole Synchronous Machine. Parks Transformation- Steady State Analysis.	6
4	Large Signal Transient. Small Oscillation Equations in State Variable form Dynamical Analysis of Interconnected Machines.	6
5	Large Signal Transient Analysis using Transformed Equations. DC Generator /DC Motor System.	8
6	Alternator /Synchronous Motor System.	4

Suggested reading:
1. D.P. Sengupta & J.B. Lynn," Electrical Machine Dynamics", The Macmillan Press Ltd. 1980
2. R Krishnan "Electric Motor Drives, Modeling, Analysis, and Control", Pearson Education., 2001
3. P.C. Kraus, "Analysis of Electrical Machines", McGraw Hill Book Company, 1987
4. I. Boldia & S.A. Nasar,,"Electrical Machine Dynamics", The Macmillan Press Ltd. 1992
5. C.V. Jones, "The Unified Theory of Electrical Machines", Butterworth, London. 1967

Course Outcomes
At the end of the course the student will be able to:
1. Formulation of electro-dynamic equations of all electric machines and analyze the performance characteristics
2. Knowledge of transformations for the dynamic analysis of machines

3. Knowledge of determination of stability of the machines under small signal and transient conditions
4. Study about synchronous machine

PED-106: Static VAR Controllers and Harmonic Filtering

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:

1. Understand the various static converters
2. Learn the static converter control strategies
3. Understand the active and reactive power compensation and their control
4. Understand harmonic filtering and its control design.

Syllabus:

Syllabus		
Units	Contents	Hours
1	Fundamentals of Load Compensation. Steady-State Reactive Power Control in Electric Transmission Systems. Reactive Power Compensation and Dynamic Performance of Transmission Systems	6
2	Power Quality Issues: Sags, Swells, Unbalance, Flicker, Distortion. Current Harmonics. Sources of Harmonics in Distribution Systems and Its Effects	6
3	Static Reactive Power Compensators and their control. Shunt Compensators. SVCs of Thyristor Switched and Thyristor Controlled types and their control, STATCOMs and their control. Series Compensators of thyristor Switched and Controlled Type and their Control. SSSC and its Control, Sub-Synchronous Resonance and damping. Use of STATCOMs and SSSCs for Transient and Dynamic Stability Improvement in Power System.	10
4	Converters for Static Compensation. Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM). GTO Inverters. Multi-Pulse Converters and Interface Magnetics. Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM). Multi-level inverters of Cascade Type and their modulation. Current Control of Inverters.	8
5	Passive Harmonic Filtering. Single Phase Shunt Current Injection Type Filter and its Control. Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modelling. Three phase four wire shunt active filters. Hybrid Filtering using Shunt Active Filters. Dynamic Voltage Restorer and its control. Power Quality Conditioner	8
6	Series Active Filtering in Harmonic Cancellation Mode. Series Active Filtering in Harmonic Isolation Mode.	4

Suggested Reading:

1. Ned Mohan et.al, “Power Electronics”,John Wiley and Sons,2006.
2. G. Massobrio, P. Antognet,” Semiconductor Device Modeling with Spice”, McGraw-Hill, Inc.,1988.
3. B. J. Baliga,” Power Semiconductor Devices”,Thomson, 2004
4. V. Benda, J. Gowar, D. A. Grant,” Power Semiconductor Devices. Theory and Applications”,JohnWiley& Sons1994.

Course Outcomes
At the end of the course the student will be able to:
1. Acquire knowledge about the fundamental principles of Passive and Active Reactive Power Compensation Schemes at Transmission and Distribution level in Power Systems.
2. Comprehend various single phase and three-phase Static VAR Compensation schemes and their controls
3. Develop analytical modelling skills needed for modelling and analysis of such Static VAR

PED-107: PWM converter and Applications

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:
1. Understand the concepts and basic operation of PWM converters, including basic circuit operation and design.
2. Understand the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality.

Syllabus:

Syllabus		
Units	Contents	Hours
1	AC/DC and DC/AC power conversion Overview of applications of voltage source converters and current source converters.	6
2	Pulse width modulation techniques for bridge converters Bus clamping PWM. Space vector based PWM. Advanced PWM techniques.	6
3	Practical devices in converter. Calculation of switching and conduction power losses.	4
4	Compensation for dead time and DC voltage regulation. Dynamic model of PWM converter. Multilevel converters. □ Constant V/F induction motor drives	8
5	Estimation of current ripple and torque ripple in inverter fed drives. Line-side converters with power factor compensation.	8
6	Active power filtering. Reactive power compensation. Harmonic current compensation. Selective harmonic elimination PWM technique for high power electric drives.	8

Suggested reading
1. Mohan, Undeland and Robbins, “Power Electronics: Converters, Applications and Design”, John’s Wiley and Sons.
2. Erickson RW, “Fundamentals of Power Electronics”, Chapman and Hall.
3. Vithyathil. J, “Power Electronics: Principles and Applications”, McGraw Hill.

Course Outcomes:
At the end of the course the student will be able to:
1. Grab concepts and basic operation of PWM converters, including basic circuit operation and design
2. Learn the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality
3. Recognize and use the following concepts and ideas:Steady-State and transient modelling and analysis of power converters with various PWM techniques.

PED-108: Power Semiconductor Devices & Modelling

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:

1. To enhance the knowledge of fundamentals of semiconductor physics, power electronics and power computation in circuits.
2. To enhance the knowledge of fundamentals of various semiconductor devices, their operation and characteristics.
3. To explain the design and operation of drive circuits and snubber circuits.
4. To explain the controlling of temperature rise of the semiconductor devices and designing of magnetic components used for the power electronic circuits.

Syllabus:

	Syllabus	
Units	Contents	Hours
1	**Power Electronics:** Introduction, Converter Classification, Power Electronics Concepts, Electronic Switches, Switch Selection, Spice, PSpice and Capture, Representation of switches in Pspice -The Voltage-Controlled Switch, Transistors, Diodes and Thyristors (SCRs). **Power Computations:** Introduction, Power and Energy, Inductors and Capacitors, Energy Recovery, Effective Values, Apparent Power and Power Factor, Power Computations for Sinusoidal AC Circuits, Power Computations for Nonsinusoidal Periodic Waveforms, Power Computations Using Pspice. **Basic Semiconductor Physics:** Introduction, Conduction Processes in Semiconductors pn Junctions, Charge Control Description of pn-Junction Operation, Avalanche Breakdown	8
2	**Power Diodes:** Introduction, Basic Structure and I – V characteristics, Breakdown Voltage Considerations, On –State Losses, Switching Characteristics, Schottky Diodes. **Bipolar Junction Transistors: Introduction**, Vertical Power Transistor Structures, Z-V Characteristics, Physics of BJT Operation, Switching Characteristics, Breakdown Voltages, Second Breakdown, On-State Losses, Safe Operating areas. **Power MOSFETs:** Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Switching Characteristics, Operating Limitations and Safe Operating Areas	10
3	**Thyristors:** Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Switching Characteristics, Methods of Improving di/dt and dv/dt Ratings. **Gate Turn-Off Thyristors:** Introduction, Basic Structure and Z-V Characteristics, Physics of Turn-Off Operation, GTO Switching Characteristics, Overcurrent Protection of GTOs. **Insulated Gate Bipolar Transistors:** Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Latchup in IGBTs, Switching Characteristics, Device Limits and SOAs. **Emerging Devices and Circuits:** Introduction, Power Junction Field Effect Transistors, FieldControlled Thyristor, JFET-Based Devices versus Other Power Devices, MOS-Controlled Thyristors, Power Integrated Circuits, New Semiconductor Materials for Power Devices.	10
4	**Snubber Circuits:** Function and Types of Snubber Circuits, Diode Snubbers, Snubber Circuits for Thyristors, Need for Snubbers with Transistors, Turn-Off Snubber, Overvoltage Snubber, Turn-On Snubber, Snubbers for Bridge Circuit Configurations, GTO Snubber Considerations. **Gate and Base Drive Circuits:** Preliminary Design Considerations, dc-Coupled Drive Circuits, Electrically Isolated Drive Circuits, Cascode-Connected Drive Circuits, Thyristor Drive Circuits, Power Device Protection in Drive Circuits, Circuit Layout Considerations	8
5	**Component Temperature Control and Heat Sinks:** Control of Semiconductor Device Temperatures, Heat Transfer by Conduction, Heat sinks, Heat Transfer by Radiation and Convection. **Design of Magnetic Components:** Magnetic Materials and Cores, Copper Windings, Thermal Considerations, Analysis of a Specific Inductor Design, Inductor Design Procedures, Analysis of a Specific Transformer Design, Eddy Currents, Transformer Leakage Inductance, Transformer Design Procedure, Comparison of Transformer and Inductor Sizes	8

Suggested reading

1. Power Electronics, Daniel W Hart, McGraw Hill
2. Power Electronics Converters, Applications, and Design Ned Mohan et al Wiley 3rd Edition,2014
3. Semiconductor Device Modeling with Spice G. Massobrio, P. Antognetti, McGraw-Hill 2nd Edition, 2010
4. Power Semiconductor Devices B. Jayant Baliga Springer 2008

Course Outcomes:

1. Discuss power electronic concepts, electronic switches and semiconductor physics.
2. Explain representation of switches in P-spice and power computations.
3. Explain the internal structure, the principle of operation, characteristics and base drive circuits of power semiconductor devices; power diodes, power BJT, power MOSFET.
4. Explain the internal structure, the principle of operation, characteristics and base drive circuits of power semiconductor devices; thyristors, power IGBT, power FET.
5. Design Snubber circuits for the protection of power semiconductor devices.
6. Design gate and base drive circuits for power semiconductor devices
7. Design a heat sink to control the temperature rise of semiconductor devices
8. Design magnetic components inductors and transformers used in the power electronic circuits

PED-109: Microcontroller Based System Design :

Course Objectives:

1. To understand the architecture of microcontrollers
2. To understand the applications of these controllers
3. To get basic introduction to FPGA.

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03
Syllabus:

	Syllabus	
Units	Contents	Hours
1	Introduction – embedded systems and their characteristics, review of micro – processors, MPU design options, Instruction sets – CISC and RISC – instruction pipelining, the microcontroller – its applications and environment.	8
2	16 bit microcontroller – Intel 8096 CPU structure, register file – assembly language overview – addressing modes –Instruction set – simple programs , Introduction, PIC microcontrollers PIC 16 C6x/7x, architecture, register file structure and addressing modes, Instruction set, simple programs	10
3	Peripheral functions of PIC 16C6x/7x - Interrupts -Interrupts constraints – Interrupt servicing – Critical regions – External Interrupts – Use of Timers in interrupt Handling – Compare and capture mode – PWM outputs, I/O port expansion – Synchronous serial port module– State machines and key switches LCD display – I2C bus operations and subroutine – serial EEPROM	10
4	Analog to Digital converter: Characteristics and use UART : Initialization – Data Handling circuitry and USE	8
5	Special Features of PIC – Reset Alternatives Low power operation – Serial programming – parallel slave port Application of Micro controller in Power Electronics, Drives, control system and instrumentation	8

Course Outcomes

Students will be able to:

1. To learn how to program a processor in assembly language and develop a processor based system

2. To learn configuring and using different peripherals in a digital system
3. To compile and debug a Program
4. To generate an executable file and use it

PED-110: Optimization Technique:

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

COURSE OBJECTIVES:

- Enumerate the fundamental knowledge of Linear Programming and Dynamic Programming problems.
- Learn classical optimization techniques and numerical methods of optimization.
- Know the basics of different evolutionary algorithms.
- Explain Integer programming techniques and apply different optimization techniques to solve various models arising from engineering areas

Syllabus:

	Syllabus	
Units	Contents	Hours
1	**Introduction to Optimization:** Engineering Applications of Optimization, Classification of Optimization Problems, Optimization Techniques, Solution of Optimization Problems Using MATLAB Classical Optimization Techniques: Single-Variable& Multivariable Optimization, Convex Programming Problem.	5
2	**Linear Programming**: Simplex Method, MATLAB Solution of LP Problems, Revised Simplex Method, Decomposition Principle, Transportation Problem, Karmarkar's Interior Method, Quadratic Programming, MATLAB Solutions.	4
3	**Nonlinear Programming**: One-Dimensional Minimization Methods, Unimodal Function, ELIMINATION METHODS, INTERPOLATION METHODS,INDIRECT SEARCH (DESCENT) METHODS, Constrained **Optimization Techniques**-DIRECT METHODS, INDIRECT METHODS, MATLAB Solution	5
4	**Geometric Programming**: Polynomial, Unconstrained Minimization Problem and solutions, Constrained Minimization and solution.	4
5	**Dynamic Programming**: Multistage Decision Processes, Concept of Sub-optimization and Principle of Optimality, Computational Procedure in Dynamic Programming, Example Illustrating the Calculus Method of Solution, Example Illustrating the Tabular Method of Solution, Continuous Dynamic Programming, applications. INTEGER LINEAR PROGRAMMING: Graphical Representation, Gomory's Cutting Plane Method, Balas' Algorithm for Zero – One Programming Problems.	5
6	**INTEGER NONLINEAR PROGRAMMING**: Conversion of a Zero – One Polynomial Programming Problem into a Zero – One LP Problem, Branch-and-Bound Method, Sequential Linear Discrete Programming ,Generalized Penalty Function Method, Solution of Binary Programming Problems Using MATLAB.	4
7	**Stochastic Programming**: Stochastic Linear Programming ,Stochastic Nonlinear Programming, Stochastic Geometric Programming.	4
8	**Optimal Control and Optimality Criteria Methods**: Optimality Criteria Methods.	4
9	**Modern Methods of Optimization**: Introduction, computation, algorithms and application of Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization, Optimization of Fuzzy Systems,	4
10	**Practical Aspects of Optimization**: Reduction of Size of an Optimization Problem,Fast Reanalysis Techniques, Derivatives of Static Displacements and Stresses, Derivatives of Eigenvalues and Eigenvectors, Derivatives of Transient Response, Sensitivity of Optimum Solution to Problem Parameters, Multilevel Optimization, Parallel Processing, Multi-objective Optimization, Solution of Multi-objective Problems Using MATLAB. Application of Optimization Technique in Power Electronics, Drives, control system and instrumentation	5

Suggested Books:

1. Engineering Optimization: Theory and Practice, Singiresu S. Rao, John Wiley & Sons, Inc.,
2. Reference:

3. S.S.Rao, Engineering Optimization, 3rd Edition, New Age International (P) Ltd.
4. 2. Genetic Algorithm – D.E.Goldberg
5. 3. Principle of soft computing by S.N.Sivanandam & S.N. Deepa
5. Soft computing Technique and its application in electrical Engineering by Chaturvedi,
6. Optimization on Power system Operation by Jizhong Zhu Wiley-IEEE Press.
7. An Introduction to Optimization, 3rd Edition by K.P. Chong, Stanislaw H. Zak.

COURSE OUTCOMES:
Upon completion of the subject, students will be able to:
1. Explain the fundamental knowledge of Linear Programming and Dynamic Programming problems.
2. Use classical optimization techniques and numerical methods of optimization.
3. Describe the basics of different evolutionary algorithms.
4. Enumerate fundamentals of Integer programming technique and apply different techniques to solve various optimization problems arising from engineering areas.

PED-111:DSP Based System:

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03
Syllabus:

	Syllabus	
Units	Contents	Hours
1	Introduction to Signal Processing: Review of Laplace transform, Z transform, Fourier transform. Discrete Fourier transform, Fast Fourier transform, Algorithms and complexity, Introduction to linear optimal filtering	8
2	Digital Filter: Definition and anatomy of a digital filter, Frequency domain description of signals and systems, Typical application of digital filters, Replacing analog filters with digital filters, Filter categories: recursive and non-recursive	10
3	Digital Filter Structures: The direct form I and II structures, Cascade combination of second order sections, Parallel combination of second order sections, Linear- phase FIR filter structures, Frequency sampling structure for the FIR filter	10
4	Effect of Word Length: Round off error, Truncation error, Quantization error, Limit cycle	8
5	Introduction to DSP Hardware: Application of DSP in Power Electronics, Drives, control system and instrumentation	8

Suggested Readings:
1. S. K. Mitra, Digital Signal Processing,
2. J. C. Proakis, and D. G. Maniolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall.
3. Oppenheim, and R. W. Shaffer, Discrete Time Signal Processing, Prentice Hall, 1992.
4. J. Johnson, Digital Signal Processing, Prentice Hall.
5. B. Venkata Ramani, and M. Bhaskar, Digital Signal Processors, New Delhi: Tata McGraw Hill.

COURSE OUTCOMES:
Upon completion of the subject, students will be able to:
1. Know basic discrete-time signal and system types, convolution sum, impulse and frequency response concepts for linear, time-invariant (LTI) systems, difference equation realization of LTI systems and discrete-time Fourier transform and basic properties of these.
2. Understand periodic sampling of analog signals and the relation between Fourier transforms of the sampled analog signal and the resulting discrete-time signal.
3. Grasp z and inverse z transform, region of convergence concepts and their properties, performs simple transform calculations, understands the system function concept with its relations to impulse and frequency responses.
4. Understand the basic properties of system functions and frequency responses of LTI systems, minimum-phase, all-pass and linear-phase systems.

5. Understand signal flow graph and block diagram representations of difference equations that realize digital filters: (i) Learns direct forms 1 and 2 for IIR filter realization. (ii) Learns direct form for FIR filter realization.
6. Understand definitions and basic properties of forward and inverse discrete Fourier transform and their computation by fast algorithms.
7. Learn basic digital filter design methods: (i) Learns analog Butterworth and Chebyshev filters transformed to yield digital IIR filters, (ii) impulse-invariance and bilinear transformation methods for IIR filter design and (iii) FIR filter design methods based on windowing.

PED-112: Artificial Neural Network:

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:

1. To **introduce** basic concept and state-of-the- art techniques of artificial intelligence.
2. To learn how to design and program with Python.
3. To provide basic understanding about Artificial Neural Network.

Syllabus:

Unit No.	Contents	Hours
1	Overview of Artificial Intelligence, AI Programming Language: Python.	6
2	Knowledge Representation Techniques; Propositional logic, First order logic; Forward and Backward Chaining; Object-Oriented Representations, Matching Techniques; Uncertainties, Probabilistic Reasoning.	8
3	General Problem solving; Control Strategies: Uninformed search techniques, Heuristic search techniques, Problem Reduction search techniques, Constraint Satisfaction Problems, Min-Max algorithm, Alpha-Beta pruning, Additional Refinements; Knowledge Organization and Management.	12
4	Overview of: Fuzzy Logic, Expert Systems, Natural Language Processing, Pattern Recognition.	6
5	Artificial Neural Networks (ANN): Typical applications of ANNs : Classification, Clustering, Vector Quantization, Pattern Recognition, Function Approximation, Control, Optimization; Basic Approach of the working of ANN - Training, Learning and Generalization. Application of ANN in Power Electronics, Drives, control system and instrumentation.	12

Recommendation:

- For better in-depth concept about Python, students may opt for AICTE sponsored NPTEL MOOCS programs on Python.

Reference Books:

1. Introduction to Artificial Intelligence and Expert Systems by D.W. Patterson
2. Artificial Intelligence: A Modern Approach - 3rd edition by Stuart Russell & Peter Norvig
3. Introduction to Artificial Neural Networks by J. M. Zurada, (Indian edition) Jaico Publishers, Mumbai.
4. K. Mehrotra, C.K. Mohan and Sanjay Ranka, Elements of Artificial Neural Networks, MIT Press, 1997 - [Indian Reprint Penram International Publishing (India), 1997].

Course Outcomes:

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

1. **Perform** data analysis problems using Python.
2. **Identify** different control and search strategies of artificial intelligence.

3. **Apply** artificial intelligence in respective research works.
4. **Demonstrate** clustering, pattern recognition, optimization in ANN applications.
5. **Comprehend** fuzzy logic for signal processing.
6. **Acquire** knowledge about the foundation of Machine learning and Deep learning.

RMI-101: Research Methodology and IPR

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Syllabus:

Unit No.	Contents	Hours
1	**Unit 1:** Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	8
2	**Unit 2:** Effective literature studies approaches, analysis Plagiarism, Research ethics,	6
3	**Unit 3:** Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	8
4	**Unit 4:** Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	6
5	**Unit 5:** Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	6
6	**Unit 6:** New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	8

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Course Outcomes:

At the end of this course, students will be able to

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

AUD-101 (one subject from the List in 1st semester) & AUD-201 (a second subject in 2nd semester): Audit course 1 & 2:

AUD-101a/AUD-201a: English for Research Paper Writing

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03
Course objectives:
1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
Ensure the good quality of paper at very first-time submission

Syllabus:

	Syllabus	
Units	Contents	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	10
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	10
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	10
4	Key skills needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	14

Suggested Studies:
1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books) Model Curriculum of Engineering & Technology PG Courses [Volume-I]
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's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

AUD-101(b)/AUD-201(b): Disaster Management

Course Objectives:
1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Syllabus:

	Syllabus	
Units	Contents	Hours
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And	4

	Magnitude.	
2	**Repercussions Of Disasters And Hazards**: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	4
3	**Disaster Prone Areas In India** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	4
4	**Disaster Preparedness And Management** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	4
5	**Risk Assessment** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	4
6	**Disaster Mitigation** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	4

AUD-101c/AUD-201c: Sanskrit for Technical Knowledge

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03
Course Objectives

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects
4. enhancing the memory power
5. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Syllabus:

1. Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences
2. Order Introduction of roots Technical information about Sanskrit Literature
3. Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Suggested reading:

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Outcome:

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

AUD-101d/AUD-201d: Value Education

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives
1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

Syllabus:

1. Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgments.

2. Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature ,Discipline.

3. Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

4. Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence ,Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

Suggested reading:
1.Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

Course outcomes:
Students will be able to
1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

AUD-101e/AUD-201e: Constitution of India

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:
Students will be able to:
1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Syllabus:
1. **History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working)
2. **Philosophy of the Indian Constitution:** Preamble Salient Features
3. **Contours of Constitutional Rights & Duties:** Fundamental Rights Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy Fundamental Duties.

4. **Organs of Governance:** Parliament Composition Qualifications and Disqualifications Powers and Functions Executive President, Governor Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions
5. **Local Administration:** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments),Village level: Role of Elected and Appointed officials, Importance of grass root democracy
6. **Election Commission:** Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. tate Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP]under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

AUD-101f/AUD-201f: Pedagogy Studies

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:

Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Syllabus:

1. **Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.
2. **Thematic overview**: Pedagogical practices are being used by teachers informal and informal classrooms in developing countries. Curriculum, Teacher education.
3. **Evidence on the effectiveness of pedagogical practices:** Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.
4. **Professional development**: Alignment with classroom practices and follow up support. Peer Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes
5. **Research gaps and future directions:** Research design, Contexts Pedagogy Teacher education Curriculum and assessment, Dissemination and research impact.

   Suggested reading:

   1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
   2.Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36

3.Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Outcomes
Students will be able to understand:
1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

AUD-101g/AUD-201g: Stress Management by Yoga

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives
1. To achieve overall health of body and mind
2. To overcome stress

Syllabus:
1. Definitions of Eight parts of yog. (Ashtanga)
2. Yam and Niyam, Do`s and Don't's in life.i) Ahinsa, satya, astheya, bramhacharya and aparigrahaii) Shaucha, santosh, tapa, swadhyay, ishwar pranidhan
3. Asan and Pranayami) Various yog poses and their benefits for mind &bodyii)Regularization of breathing techniques and its effects-Types of pranayama.

Suggested reading:
1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama(Publication Department), Kolkata

Course Outcomes:
Students will be able to:
1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

AUD-101h/AUD-201h: Personality Development through Life Enlightenment Skills

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives
1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Syllabus:
1. Neeti-satakam-Holistic development of personality, Verses- 19,20,21,22 (wisdom), Verses- 29,31,32 pride & heroism), Verses- 26,28,63,65 (virtue), Verses- 52,53,59 (dont's), Verses- 71,73,75,78 (do's),

2. Approach to day to day work and duties. Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,. Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, . Chapter 18-Verses 45, 46, 48.
3. Statements of basic knowledge. Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68. Chapter 12 -Verses 13, 14, 15, 16,17, 18. Personality of Role model. ShrimadBhagwadGeeta:Chapter2-Verses 17, Chapter 3-Verses 36,37,42,. Chapter 4-Verses 18, 38,39. Chapter18 – Verses 37,38,63.

Suggested reading;

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication2. Department), Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P. Gopinath,
3. Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

PED-191: POWER ELECTRONICS & DRIVES LABORATORY-I

List of experiments for PED-191 and PED-291 are as follows: Selection of experiments will be monitored by the department and the semester wise list of experiments will be finalized as deemed fit.

List of Experiments :

A.

1. Study of Thyristor controlled D.C Drive.
2. Study of Chopper Fed DC Motor.
3. Study of A.C single phase motor speed control using TRIAC.
4. PWM inverter fed three phase induction motor control using PSPICE/MATLAB/PSIM software.
5. VSI/CSI fed induction motor drive analysis using MATLAB/PSPICE/PSIM software.
6. Study of V/f control operation of three phase induction motor.
7. Study of permanent magnet synchronous motor drive fed by PWM inverter using software.
8. Regenerative/ Dynamic breaking operation for DC motor study using software.
9. Regenerative/ Dynamic breaking operation for AC motor study using software.
10. PC/PLC based AC/DC motor control operation.

B.

1. Load test on dc shunt motor to draw speed – torque and horse power – efficiency characteristics.
2. Field Test on dc series machines.
3. Speed control of dc shunt motor by armature and field control.
4. Swinburne's Test on dc motor.
5. Retardation test on dc shunt motor.
6. Regenerative test on dc shunt machines.
7. Load test on three phase induction motor.
8. No load and Blocked rotor test on three phase induction motor to draw (i) equivalent circuit and (ii) circle diagram. Determination of performance parameters at different load conditions from (i) and (ii).
9. Load test on induction generator.
10. Load test on single phase induction motor to draw output versus torque, current, power and efficiency characteristics.
11. Conduct suitable tests to draw the equivalent circuit of single phase induction motor and determine performance parameters.
12. Conduct an experiment to draw V and _ curves of synchronous motor at no load and load conditions.

C.

1. To study the effect of non linear loads on power quality.
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 non linear 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 equipments.
12. To obtain the current harmonics drawn by power electronics interface using PSCAD software

D.

1. To study V-I characteristics of SCR and measure latching and holding currents.
2. To study UJT trigger circuit for half wave and full wave control.
3. To study single-phase half wave controlled rectified with (i) resistive load (ii) inductive load with and without freewheeling diode.
4. To study single phase (i) fully controlled (ii) half controlled bridge rectifiers with resistive and inductive loads.
5. To study three-phase fully/half controlled bridge rectifier with resistive and inductive loads.
6. To study single-phase ac voltage regulator with resistive and inductive loads.
7. To study single phase cyclo-converter.
8. To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor.
9. To study operation of IGBT/MOSFET chopper circuit.
10. To study MOSFET/IGBT based single-phase series-resonant inverter.
11. To study MOSFET/IGBT based single-phase bridge inverter.

E.

1. Write a program to multiplication and division using MUL and DIV instructions.
2. Write a program to transfer a block of data from internal memory to external memory.
3. Write a program to exchange two set of eight-byte data.
4. Write a program to find the sum of two numbers in decimal.
5. Write a program to convert decimal number to hexadecimal.
6. Write a program to add a number n, m number of times.
7. Write program to find the largest from a set of n numbers.
8. Write program for sorting the given set of numbers.

F.

1. Write an assembly language program for generating a triangular wave.
2. Write a program to find the largest from a set of ten numbers and display it usingLEDs.
3. Write a program to for displaying the decimal numbers in 7 Segment display.
4. Write a program to read the DIP switches for displaying the reading using 7 Segmentdisplay.

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5. Write a program to rotate the given motor in clockwise direction.
6. Write a program to rotate the given motor in anticlockwise direction.
7. Write a program to generate a square wave.
8. Write a program to display a message in LCD display.

Digital Signal Processing Lab

1.Introduction to Code Composer Studio-I
2.Introduction to Code Composer Studio-II
3.Introduction to the Addressing Modes
4. FFT and Bit Reversal Operation
5. FFT and its Applications
6. Audio Codec and its Applications
7. Real Time Data Exchange
8. IR filtering by interfacing Matlab with Code Composer Studio
9. Introduction to Interrupts
10. Digital communication using Binary Phase Shift Keying

Course outcomes:

1. Study of different Power Electronic devices
2. Study for simulation of different Power Electronic devices

3. Design the control circuit and the power circuit for different Power Electronic Circuits
4. Verify the compliance of spectral performance of different Power Electronic Circuits
5. Compare various options available for the drive circuit requirements different Power Electronic Circuits
6. Design the control circuit and the power circuit for different Power Electronic Circuits based Drives
7. Verify the compliance of spectral performance of different Power Electronic Circuits based Drives
8. Compare various options available for the drive circuit requirements different Power Electronic Circuits based Drives
9. Recognize possible modes of failure of a circuit - troubleshoot and repair
10. Understand the architecture and addressing modes of the µC, µP,DSP etc.
11. Use the instruction set of the µC, µP,DSP etc. for writing programs
12. Use the Event Manager of the µC, µP,DSP etc. for PWM generation
13. Configure the Interrupts and use the digital I/Os - ADC and DAC of the µC, µP,DSP etc.
14. Modeling and simulation of different Electrical Machines
15. Modeling and simulation of different Power Electronic Circuits based Drives
16. Modeling and simulation of real systems
17. Modeling and simulation of different Power Electronic Circuits in Nonlinear modes
18. Modeling and simulation of different Power Electronic Circuits based Drives in Nonlinear modes

PED-201: Advanced Power Electronic Circuits

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course objectives:
Students will be able to:
1. Understand the operation of advanced power electronic circuit topologies.
2. Understand the control strategies involved.
3. Learn few practical circuits, used in practice.

Syllabus:

1. Boost type APFC and control.
2.Three phase utility interphases and control-Buck, Boost, Buck-Boost SMPS Topologies.
3. Modes of operation –Push-Pull and Forward Converter Topologies – Voltage Mode Control. Half and Full Bridge Converters.
4. Flyback Converter. Introduction to Resonant Converters. Load Resonant Converter. Zero Voltage Switching Clamped Voltage Topologies.
5. Resonant DC Link Inverters with Zero Voltage Switching. High Frequency Link Integral Half Cycle Converter.
6. Modeling and design of DC-DC Converters for various renewable energy conversion. Few power electronic circuits used in practice for controlling electric drives.

Suggested reading:
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.

Course Outcomes:
Students will be able to:
1: Knowledge about analysis and design of Load Commutated CSI and PWM CSI
2: Learn analysis and design of series Inverters.
3: Acquire knowledge about analysis and design of Switched Mode Rectifiers,APFC, DC-DC converters &Resonant converters

PED-202: Electric Drive System

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:
1. Understand Basic electrical drives and their analysis.
2. Learn Design of controller for drives.
3. Understand Scalar control of electrical drives.

Syllabus:

1. Dynamics of Electric Drives: Fundamentals of torque equation. Speed torque convention and multi-quadrant operation, components of load torques.
2. Classification of load torques steady state stability. Load equation, Speed control and drive classification. Close loop control of drives.
3. DC motor Drives-Modeling of DC machines. Steady state characteristics with armature and speed control. Phase controlled DC motor drives, chopper controlled DC motor drives.
4. Poly-phase induction machines- Dynamic modeling of induction machines. Small signal equations, control characteristics of induction machines. Phase-controlled induction machines. Stator voltage control. Slip energy recovery scheme, frequency control and vector control of induction motor drives.
5. Traction motor: Starting. Speed-Time characteristics. Braking. Traction motors used in practice.
6. Industrial Drives-Digital Control of Electric Drives. Stepper motor. Servo motor and their Applications.

Suggested reading
1. G.K, Dubey, "Power semiconductor controlled Drives", Prentice Hall international, New Jersey, 1989.
2. R.Krishanam, “Electric motor drives modeling, analysis and control”, PHI-India-2009.
3. G. K. Dubey,“Fundamentals of electric Drives, Narosa Publishing House”, 2nd edition, 2011.
4. W. Leonhard, “Control of Electrical drives”, Springer, 3rd edition, 2001.
5. P.C. Krause –, “Analysis of Electric Machine”, Wiley-IEEE press 3rdedition.
6. K. Bose, “Modern Power Electronics and AC Drives”, Prentice Hall publication, 1st edition, 2001.

Course Outcomes:
Students will be able to:
1. Model and simulate electric drive systems
2. Design modulation strategies of power electronics converters, for drives application
3. Design appropriate current/voltage regulators for electric drives
4. Select and implement the drives for Industrial Process
5. Implement various variable speed drives in Electrical Energy Conversion System

PED-203: Switched Mode and Resonant Converters

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:
1. To understand different types of converters
2. To understand different switch mode topologies & control methods
3. To understand different resonant converter topologies.

Syllabus:

	Syllabus	
Units	Contents	Hours
1	➢ Buck, Boost, Buck-Boost SMPS Topologies. ➢ Basic Operation-Waveforms - modes of operation -switching stresses. ➢ Switching and conduction losses. Optimum switching frequency. ➢ Practical voltage, current and power limits - design relations. ➢ Voltage mode control principles. ➢ Push-Pull and Forward Converter Topologies - Basic Operation, ➢ Waveforms.	6

	➢ Flux Imbalance Problem and Solutions	
2	➢ Transformer Design. Output Filter Design. Switching Stresses and Losses. ➢ Forward Converter Magnetics. Voltage Mode Control. ➢ Half and Full Bridge Converters. Basic Operation and Waveforms. ➢ Magnetics, Output Filter, Flux Imbalance, Switching Stresses and Losses, ➢ Power Limits, Voltage Mode Control.	8
3	➢ Classification of Resonant Converters. Basic Resonant Circuit Concepts. ➢ Load Resonant Converter, Resonant Switch Converter, Zero. ➢ Voltage Switching Clamped Voltage Topologies. ➢ Resonant DC Link Inverters with Zero Voltage Switching. ➢ High Frequency Link Integral Half Cycle Converter. ➢ Fly back Converter- discontinuous mode operation, waveforms, control. ➢ Magnetics- Switching Stresses and Losses, Disadvantages - Continuous ➢ Mode Operation, waveforms, control, design relations.	6
4	➢ Voltage Mode Control of SMPS- Loop Gain and Stability Considerations. ➢ Error Amp– frequency Response and Transfer Function. ➢ Trans-conductance Current Mode Control of SMPS. ➢ Current Mode Control Advantages, Current Mode Vs Voltage Mode.	8
5	➢ Current Mode Deficiencies. ➢ Slope Compensation. ➢ Study of a typical Current Mode PWM Control IC UC3842. Modeling of ➢ SMPS. ➢ Small Signal Approximation- General Second Order Linear Equivalent ➢ Circuits. ➢ Study of popular PWM Control ICs (SG 3525,TL 494,MC34060 etc.)	8
6	➢ DC Transformer, Voltage Mode SMPS Transfer Function. ➢ General Control Law Consideration. ➢ EMI Generation and Filtering in SMPS - Conducted and Radiated ➢ Emission Mechanisms in SMPS. ➢ Techniques to reduce Emissions, Control of Switching Loci. ➢ Shielding and Grounding, Power Circuit Layout for minimum EMI. ➢ EMI Filtering at Input and Output, Effect of EMI Filter on SMPS Control ➢ Dynamics. Introduction to Resonant Converters.	8

Suggested reading

1. Abraham I Pressman, "Switching Power Supply Design,". McGraw Hill Publishing Company,2001.
2. Daniel M Mitchell,"DC-DC Switching Regulator Analysis," McGraw Hill Publishing Company-1988.
3. Ned Mohan et.al, "Power Electronics," John Wiley and Sons 2006.

Course Outcomes

1. Acquire knowledge about the principles of operation of non-isolated and isolated hard-switched DC-DC converters.
2. Acquire knowledge on various loss components in a switched mode converter and choice of switching frequency with a view towards design of such converters.

PED-204: Industrial Load Modelling and Control

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:

Students will be able to:

1. To understand the energy demand scenario
2. To understand the modeling of load and its ease to study load demand industrially
3. To know Electricity pricing models

4. Study Reactive power management in Industries

Syllabus:

	Syllabus	
Units	Contents	Hours
1	➢ Electric Energy Scenario-Demand Side Management-Industrial Load Management. ➢ Load Curves-Load Shaping Objectives-Methodologies. ➢ Barriers; Classification of Industrial Loads- Continuous and Batch processes -Load Modeling.	6
2	➢ Electricity pricing – Dynamic and spot pricing –Models. ➢ Direct load control- Interruptible load control. ➢ Bottom up approach- scheduling- Formulation of load models- Optimization and control algorithms - Case studies.	8
3	➢ Reactive power management in industries-controls-power quality impacts application ➢ of filters Energy saving in industries.	6
4	➢ Cooling and heating loads- load profiling- Modeling. ➢ Cool storage-Types- Control strategies. ➢ Optimal operation-Problem formulation- Case studies.	8
5	➢ Captive power units- Operating and control strategies- Power Pooling-Operation models. ➢ Energy banking-Industrial Cogeneration	8
6	➢ Selection of Schemes Optimal Operating Strategies. ➢ Peak load saving-Constraints-Problem formulation- Case study. ➢ Integrated Load management for Industries	8

Suggested reading

1. C.O. Bjork “Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands,1989.
2. C.W. Gellings and S.N. Talukdar, “Load management concepts,” IEEE Press, New York, 1986, pp. 3-28.
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981.
4. H. G. Stoll, "Least cost Electricity Utility Planning”, Wiley Inter-science Publication, USA, 1989.
5. I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, New Delhi, 1995.
6. IEEE Bronze Book- “Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities”, IEEE Inc, USA.

Course Outcomes:

Students will be able to:
1. Knowledge about load control techniques in industries and its application.
2. Different types of industrial processes and optimize the process using tools like LINDO and LINGO.
3. Apply load management to reduce demand of electricity during peak time.
4. Apply different energy saving opportunities in industries.

PED-205: Advanced Digital Signal Processing

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:

1. To know about in-depth analysis of discrete time signals.
2. To **demonstrate** design and realization of digital filters
3. To introduce different parameters like errors, scaling etc. in A/D conversion.

4. To **discuss** optimization techniques of linear filters.

Course Outcomes:
After completion of the course, students will be able
1. **Apply** the principles of discrete-time signal analysis to perform various signal operations
2. **Acquire** knowledge about the finite word length effects in implementation of digital filters.
3. **Perform** statistical analysis for real time signal processing in research works.
4. **Analyze** power spectrum estimation for random and deterministic signals.
5. Optimize filters for best performance.
6. **Identify** different A/D conversion problems in advanced sampling method of continuous signals.

Prerequisites: Undergraduate concepts of Digital Signal Processing, Signals and Systems.

Syllabus:

Units	Contents	Hours
1	Overview on discrete time signals: Linear shift invariant systems-Stability and causality; Sampling of continuous time signals; Properties of different transforms: Z-transform, Discrete Time Fourier Transform; Discrete Fourier series; Discrete Fourier transform;	8
2	Linear and circular convolution using DFT; overlap save and overlap add methods; Computation of DFT Design of IIR digital filters from analog filters: Impulse invariance method; Bilinear transformation method;	8
3	FIR filter design using window functions; Comparison of IIR and FIR digital filters; Basic IIR and FIR filter realization structures; Signal flow graph representations; Quantization process and errors; Coefficient quantisation effects in IIR and FIR filters	8
4	A/D conversion noise: Arithmetic round-off errors; Dynamic range scaling; Overflow oscillations and zero Input limit cycles in IIR filters; Linear Signal Models	8
5	All pole, All zero and Pole-zero models; Power spectrum estimation: Spectral analysis of deterministic signals; Estimation of power spectrum of stationary random signals	6
6	Optimum linear filters; Optimum signal estimation; Mean square error estimation; Optimum FIR and IIR Filters.	6

Reference books:

1. Digital Signal Processing – S Salivahanan. A Vallavaraj C. Gnanapriya –TMH – 2nd reprint 2001.
2. Sanjit K Mitra, "Digital Signal Processing: A computer-based approach ",TataMc Grow-Hill Edition 1998
3. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and Adaptive Signal Processing", Mc Grow Hill international editions .-2000
4. Foundations of Signal Processing, Vetterli M., Kovacevic J., Goyal V.K., Cambridge University Press, 2014.

PED-206 :Soft Computing

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Syllabus:

Neural Networks: Supervised Learning Neural Networks – Perceptrons - Adaline – Back propagation Multilayer Perceptrons – Radial Basis Function Networks – Unsupervised Learning Neural Networks – Competitive Learning Networks Hebbian Learning.

Fuzzy Set Theory: Introduction to Neuro– Fuzzy and Soft Computing – Fuzzy Sets –Basic Definition and Terminology – Set-theoretic Operations – Member Function

Formulation and Parameterization – Fuzzy Rules, Introduction to Fuzzy Reasoning –Extension Principle and Fuzzy Relations

Genetic Algorithm: Difference between Traditional Algorithms and GA, The basicoperators, Schema theorem, convergence analysis, stochastic models, applications in search and optimization. Encoding, Fitness Function, Reproduction, Cross Over, Mutation, Application of Genetic Algorithm.

Neuro Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference Systems – Architecture – Hybrid

Learning Algorithm – Learning Methods that Cross-fertilize ANFIS and RBFN – Coactive

Neuro Fuzzy Modeling – Framework Neuron Functions for Adaptive Networks – Neuro-Fuzzy Spectrum.

Application of Soft Computing in Power Electronics, Drives, control system and instrumentation

Text Books:

1.M. Mitchell, An Introduction to Genetic Algorithms, Prentice-Hall, 1998.
2.D. E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley, 1989.
3.S. V. Kartalopoulos, Understanding Neural Networks and Fuzzy Logic: Basic Concepts and Applications, IEEE Press - PHI, 2004.
4.S. Rajasekaran & G. A. VijayalakshmiPai, Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, PHI, 2003.
5.S. N. Sivanandam & S. N. Deepa, Principles of Soft Computing, Wiley - India,2007

PED-207: Advanced Microcontroller based System

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:

Students will be able to:
1. To understand the architecture of advance microcontrollers
2. To understand the applications of these controllers
3. To get some introduction to FPGA.

Syllabus:

	Syllabus	
Units	Contents	Hours
1	➢ Basic Computer Organization. ➢ Accumulator based processes-Architecture-Memory ➢ Organization-I/O Organization	6
2	➢ Micro-Controllers-Intel 8051, Intel 8056- Registers, Memories. ➢ I/O Ports, Serial Communication. Timers, Interrupts, Programming.	8
3	➢ Intel 8051 – Assembly language programming-Addressing-Operations- Stack & Subroutines, Interrupts-DMA.	6
4	➢ PIC 16F877- Architecture Programming. ➢ Interfacing Memory/ I/O Devices, Serial I/O and data communication	8
5	➢ Digital Signal Processor (DSP) - Architecture – Programming, ➢ Introduction to FPGA	8
6	➢ Microcontroller development for motor control applications. ➢ Stepper motor control using micro controller.	8

Suggested reading

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”, Penram International 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 RTOS with the PIC18F Series”, Elsevier, 2008.
7. Microchip datasheets for PIC16F877.

Course Outcomes

Students will be able to:

1. To learn how to program a processor in assembly language and develop an advanced processor based system
2. To learn configuring and using different peripherals in a digital system
3. To compile and debug a Program
4. To generate an executable file and use it

PED-208: Distributed Generation

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:
Students will be able to:
1. To understand renewable energy sources.
2. To gain understanding of the working of off-grid and grid-connected renewable energy generation schemes.

Syllabus:

	Syllabus	
Units	Contents	Hours
	➢ Need for Distributed generation. ➢ Renewable sources in distributed generation and current scenario in Distributed Generation.	6
	➢ Planning of DGs. ➢ Sitting and sizing of DGs optimal placement of DG sources in distribution systems. ➢ Grid integration of DGs Different types of interfaces, Inverter based DGs and rotating machine based interfaces. ➢ Aggregation of multiple DG units.	8
	➢ Technical impacts of DGs. ➢ Transmission systems Distribution Systems De-regulation Impact of DGs upon protective relaying. ➢ Impact of DGs upon transient and dynamic stability of existing distribution systems, Steady-state and Dynamic analysis	6
	➢ Economic and control aspects of DGs Market facts. ➢ Issues and challenges Limitations of DGs, Voltage control techniques. ➢ Reactive power control, Harmonics Power quality issues, Reliability of DG based systems.	8
	➢ Introduction to micro-grids. ➢ Types of micro-grids: autonomous and non-autonomous grids Sizing of micro-grids. ➢ Modeling & analysis of Micro-grids with multiple DGs. ➢ Micro-grids with power electronic interfacing units.	8
	➢ Transients in micro-grids, Protection of micro-grids, Case ➢ studies, Advanced topics.	8

Suggested reading
1. H. Lee Willis, Walter G. Scott, “Distributed Power Generation – Planning and Evaluation”, Marcel Decker Press.
2. M. Godoy Simoes, Felix A.Farret, “Renewable Energy Systems – Design and Analysis with Induction Generators”, CRC press.
3. Stuart Borlase. “Smart Grid: Infrastructure Technology Solutions” CRC Press

Course outcomes:
Students will be able to:

1. To understand the planning and operational issues related to Distributed Generation.
2. Acquire Knowledge about Distributed Generation Learn Micro-Grids

PED-209: Smart Grids

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:
Students will be able to:
1. Understand concept of smart grid and its advantages over conventional grid.
2. Know smart metering techniques.
3. Learn wide area measurement techniques.
4. Understanding the problems associated with integration of distributed generation & its solution through smart grid.

Syllabus:

	Syllabus	
Units	Contents	Hours
1	➢ Introduction to Smart Grid, Evolution of Electric Grid. ➢ Concept of Smart Grid, Definitions, Need of Smart Grid. ➢ Concept of Robust &Self-Healing Grid, Present development & International policies in Smart Grid	6
2	➢ Introduction to Smart Meters, Real Time Prizing, Smart Appliances. ➢ Automatic Meter Reading (AMR). ➢ Outage Management System (OMS). ➢ Plug in Hybrid Electric Vehicles(PHEV). ➢ Vehicle to Grid, Smart Sensors. ➢ Home & Building Automation, Smart Substations, Substation Automation, ➢ Feeder Automation	8
3	➢ Geographic Information System (GIS). ➢ Intelligent Electronic Devices (IED) & their application for monitoring & ➢ protection, Smart storage like Battery, SMES, Pumped Hydro. ➢ Compressed Air Energy Storage. ➢ Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU).	6
4	➢ Concept of micro-grid, need & applications of micro-grid. ➢ Formation of micro-grid, Issues of interconnection. ➢ Protection & control of micro-grid. ➢ Plastic & Organic solar cells, Thin film solar cells. ➢ Variable speed wind generators, fuel-cells, micro-turbines. ➢ Captive power plants, Integration of renewable energy sources.	8
5	➢ 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	8
6	➢ Advanced Metering Infrastructure (AMI), Home Area Network (HAN). ➢ Neighbourhood Area Network (NAN), Wide Area Network (WAN). ➢ Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication. ➢ Wireless Mesh Network. Basics of CLOUD Computing &Cyber Security for Smart Grid.	8

	➢ Broadband over Power line (BPL). IP based protocols	

Suggested reading

1. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE,2011.
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press, 2009.
Model Curriculum of Engineering & Technology PG Courses [Volume-I]
3. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, "Smart Grid: Technology and Applications",Wiley 2012.
4. Stuart Borlas'e, "Smart Grid: Infrastructure, Technology and solutions "CRC Press.
5. A.G.Phadke , "Synchronized Phasor Measurement and their Applications", Springer.

Course Outcomes

Students will be able to:
1. Appreciate the difference between smart grid & conventional grid.
2. Apply smart metering concepts to industrial and commercial installations.
3. Formulate solutions in the areas of smart substations, distributed generation and wide area measurements.
4. Come up with smart grid solutions using modern communication technologies

PED-210:Energy Efficient Motor:

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Syllabus:

1. Introduction : Energy efficiency and its impacts on social life.
2. Energy-Efficient Motors: Standard Motor Efficiencies for various motors, Why More Efficient Motors?, What Is Efficiency? What Is an Energy-Efficient Motor?, Efficiency Determination. Motor Efficiency Labeling, NEMA Energy-Efficient Motor Standards
3. Fundamentals of Electric Motor Drives, Power electronic devices, electric motor drives, controlled rectifier, phase controlled AC controller, DC motor control using DC-DC converter.
4. Power Factor and its definition under various practical conditions, Power Factor and its definition for ideal sinusoidal system. Improvement of factor : Reasons and methods. The Power Factor with Nonlinear Loads, Harmonics and the Power Factor, Power Factor Motor Controllers.
5. Energy efficient induction motor under different input parameters and applications, Varying Duty Applications, Voltage Unbalance ,Voltage Variation, Poly-phase Induction Motors Supplied by Adjustable-Frequency Power Supplies.
6. Adjustable-Speed Drives their Advantages and Benefits from Efficiency Point of View. The Impact of Motor Efficiency, Advantages of Variable-Speed Motors. Adjustable-Speed Drive Applications.
7. Induction Motor Variable Seed Drive System a Case Study .
8. Brushless DC motor Drive a Case Study.
9. Switched Reluctance Motor Drives a Case Study .
10. Permanent Magnet Synchronous Motor Drive a Case Study.

Suggested Readings:

[1] Ali Emadi "Energy efficient electric motors" 3rd Edition, revised and expanded, MarcelDekker, 2005.
[2] John C. Andreas "Energy-Efficient Electric Motors Selection and Application" MarcelDekker, 1982.
[3] Wei Tong "Mechanical Design of Electric Motors" CRC Press, 2014.
[4] B.N. Chaudhari and B.G. Fernandes, "Permanent magnet synchronous motor forgeneral purpose energy efficient drive,"IEEE Power Engineering Society WinterMeeting, 2000, vol.1, pp.213-218.
[5] P. Pillay, "Practical considerations in applying energy efficient motors in thepetrochemical industry," 42nd AnnualPetroleum and Chemical Industry ConferenceIndustry Applications Society, 1995, pp.197-207.
[6] A. H. Bonnett, "Quality and reliability of energy efficient motors,"IEEEIndustryApplications Magazine, vol.3, no.1, pp.22-31, 1997.
[7] Kao Chen, "The impact of energy efficient equipment on system power quality," IEEEIndustry Applications Conference, 2000, vol.5, no., pp.3240-3247.

PED-211: NONLINEAR DYNAMICSAND CHAOS:

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Objective of the Course: To introduce the Nonlinear Dynamics and Chaos theory to the students. Many equations are not solvable, so in this course we learn how to extract the information about the solution of the equations without solving the equation. The students will learn about the Deterministic Chaos.

Syllabus:

Dynamics in State Space of One and Two Dimensions : Introduction, State Space, Systems Described by First-Order Differential Equations, The No-Intersection Theorem , Dissipative Systems and Attractors One-Dimensional State Space, Taylor Series Linearization Near Fixed Points, Trajectories in a One-Dimensional State Space, Two-Dimensional State Space, Dynamics and Complex Characteristic Values, Dissipation and the Divergence Theorem, The Jacobian Matrix for Characteristic Values, Limit Cycles, Poincare Sections and the Stability of Limit Cycles, Bifurcation Theory .

Three-Dimensional State Space and Chaos: Overview, Routes to Chaos, Three-Dimensional Dynamical Systems, Fixed Points in Three Dimensions, Limit Cycles and Poincare Sections, Quasi-Periodic Behavior,

The Routes to Chaos: Period-Doubling, Quasi-Periodicity, Intermittency and Crises, Chaotic Transients and Homoclinic Orbits, Homoclinic Tangles and Horseshoes, Lyapunov Exponents and Chaos.

Iterated Maps: Introduction, Poincare Sections and Iterated Maps, One-Dimensional Iterated Maps, Bifurcations of Smooth Maps, Pitchfork Bifurcation, Saddle-Node Bifurcation, Period-Doubling Bifurcation, Neimark Bifurcation, Chaos, Lyapunov Exponents, Qualitative Universal Behavior: The U-Sequence, Feigenbaum Universality , Tent Map, Shift Maps and Symbolic Dynamics The Gaussian Map, Two-Dimensional Iterated Maps, The Smale Horseshoe Map.

Quasi-Periodicity and Chaos: Introduction, Quasi-Periodicity and Poincare Sections, Quasi-Periodic Route to Chaos, Universality in the Quasi-Periodic Route to Chaos, Frequency-Locking, Circle Map, The Devil's Staircase and the Farey Tree, Continued Fractions and Fibonacci Numbers, Chaos and Universality.

Intermittency and Crises: Intermittency, The Cause of Intermittency, Quantitative Theory of Intermittency, Types of Intermittency, Crises.

Quantifying Chaos: Introduction, Time-Series of Dynamical Variables, Lyapunov Exponents, Universal Scaling of the Lyapunov Exponent, Invariant Measure, Fractal Dimension(s), Correlation Dimension.

Bifurcations in Piecewise-Smooth Maps: Normal Form, Bifurcations in the One-Dimensional Normal Form, Border Collision Pair Bifurcation, Border-Crossing Bifurcations, Bifurcations in the Two-Dimensional Normal Form, Classification of Border Collision Bifurcations, Border Collision Pair Bifurcation, Border-Crossing Bifurcations, Nonstandard Bifurcations in Discontinuous Maps.

Control of Chaos: The OGY Method, Review of the OGY Method, Pyragas Methods, A Combination of OGY and Pyragas Methods, Controlling Border-Collision Bifurcations, Time-Delay Control of Chaos, TDAS for the Current-Mode Boost Converter.

Suggested Readings:

1. Chaos and Nonlinear Dynamics:An Introduction for Scientists and Engineers Second Edition, Robert C. Hilborn, Oxford University Press.
2. Nonlinear Dynamics And Chaos: With Applications To Physics, Biology, Chemistry, And Engineering (Studies in Nonlinearity) ,Steven H. Strogatz.
3. NONLINEAR PHENOMENA IN POWER ELECTRONICS :Attractors, Bifurcations, Chaos, and Nonlinear Control, Soumitro Banerjee, George C. Verghese, Wiley.
4. CHAOS: An Introduction to Dynamical Systems, by Kathleen T. Alligood,Tim D. Sauer,James A. Yorke, Springer.
5. DIFFERENTIAL EQUATIONS,DYNAMICAL SYSTEMS, AND AN INTRODUCTION TO CHAOS by Hirch, Smale, Devaney, Elsavier.
6. An Introduction to Chaotic Dynamical System, 2nd Edition, byDevaney, Addison Wiseley.
7. Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields by John Guckenheimer , Philip Holmes , Springer.
8. Elements of Applied Bifurcation Theory,Second Edition by Yuri A. Kuznetsov, Springer.
9. Introduction to Applied Nonlinear Dynamical Systems and Chaos by Stephen Wiggins**, Springer.**
10. Controlling Chaos: Suppression, Synchronization and Chaotification by Huaguang Zhang, Derong Liu, Zhiliang Wang, Springer.

Learning Outcomes

After completing the course the student will have an understanding of the basic classes of nonlinear systems and will be able to analyse them using analytic and diagrammatic methods. Based on these skills he/she will be able to solve

these systems also numerically (although numerical methods will be in minor role in this course). The student will have an understanding of how and why a dynamical system becomes chaotic. He/she will understand fundamental characteristics of chaotic systems and how they are modelled.

PED-212: Digital Control of Power Electronic and Drive Systems

Contact Hours/Week: L-T-P: 3-0-0
Credits: 03

Course Objectives:
Students will be able to:
1. To understand different control strategies
2. To understand state space modeling of different converters
3. To perform simulation of different power converters

Syllabus:

	Syllabus	
Units	Contents	Hours
1	➢ Review of numerical methods. ➢ Application of numerical methods to solve transients in D.C. ➢ Switched R, L, R-L, R-C and R-L-C circuits. Extension to AC circuits.	6
2	➢ Modelling of diode in simulation. ➢ Diode with R, R-L, R-C and R-L-C load with AC supply. ➢ Modelling of SCR, TRIAC, IGBT and Power Transistors in simulation. ➢ Application of numerical methods to R, L, C circuits with power electronic switches. ➢ Simulation of gate/base drive circuits, simulation of snubber circuits.	8
3	➢ State space modelling and simulation of linear systems. ➢ Introduction to electrical machine modelling: induction, DC, and ➢ synchronous machines, simulation of basic electric drives, stability aspects.	6
4	➢ Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers. ➢ Converters with self-commutated devices- simulation of power factor ➢ correction schemes.	8
5	➢ Simulation of converter fed DC motor drives. ➢ Simulation of thyristor choppers with voltage. ➢ Current and load commutation schemes. ➢ Simulation of chopper fed DC motor.	8
6	➢ Simulation of single and three phase inverters with thyristors and self commutated ➢ devices. ➢ Space vector representation. ➢ Pulse-width modulation methods for voltage control. ➢ Waveform control. Simulation of inverter fed induction motor drives.	8

Suggested reading
1. Simulink Reference Manual, Math works, USA

Course Outcomes
Students will be able to:
1. To provide knowledge on modelling and simulation of power simulation circuits and systems.
2. The candidate will be able to simulate power electronic systems and analyse the system response.
3. Evaluate the output of a digital system for a given input.
4. Describe the dynamics of a Linear, Time Invariant and Causal digital systems through difference equations
5. Analyze digital systems using the Z-transformation

6. Design digital controllers for Power Electronic Systems

AUD-201: AUD-101 (one subject from the pool in 1st semester) & AUD-201 (a second subject in 2nd semester):

PED-281: Mini Project with Seminar

Mini Project will be carried out by the students and they have to deliver seminar on the it.

PED-291: Power Electronics & Drives Laboratory -II

List of experiments for PED-191 and PED-291 are as follows: Selection of experiments will be monitored by the department and the semester wise list of experiments will be finalized as deemed fit.

List of experiments for PED-191 and PED-291 are incorporated in the block of PED-191

PED-301(a) : SCADA Systems and Applications

Course Objectives:

Students will be able to:

1. To understand what is meant by SCADA and its functions.
2. To know SCADA communication.
3. To get an insight into its application.

1 . Introduction to SCADA: Data acquisition systems, Evolution of SCADA, Communication technologies.

2. Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA

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

4. SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture –IEC 61850.

5. SCADA Communication: various industrial communication technologies -wired and wireless methods and fiber optics. open standard communication protocols.

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

Suggested reading: 1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, 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. Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power",PennWell 1999.

PED-301(b): FACTS and Custom Power Devices

1. 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. Reactive

power compensation. Shunt and Series compensation principles – Reactive compensation at transmission and distribution level .

2. 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.

3. 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.

4. SSR and its damping Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPF. Basic Principle of P and Q control- Independent real and reactive power flow control- Applications.

5. Introduction to interline power flow controller. Modeling and analysis of FACTS Controllers – Simulation of FACTS controllers 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.

6. Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners- IEEE standards on power quality.

Suggested reading:

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- Modeling and Control",SpringerVerlag, Berlin,
3. N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible ACTransmission 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, Newyork, 1982.

Course Outcomes: At the end of the course, the student will be able to

CO1: Distinguish the performance of Transmission line with and without FACTS Devices
CO2: Compare the SVC and STATCOM
CO3: Understand the operation and control of various Static Series Compensators
CO4: Understand the operation and control of Unified Power Flow Controller
CO5: Distinguish various power quality issues and how are they mitigated by various FACTS Devices

PED-301(c): HVDC

1 Development of HVDC Technology, DC versus AC Transmission, Selection of converter configuration.

2 Rectifier and Inverter operation, Digital Simulation of converters, Control of HVDC converters and Systems.

3 Individual phase control, Equidistant firing controls, Higher level controls. Characteristics and non-characteristics harmonics filter design. Fault development and protection.

4 Interaction between AC-DC power systems. Over voltages on AC/DC side, multi-terminal HVDC systems, control of MTDC systems.

5 Modeling of HVDC systems, per unit system, Representation for power flow solution, representation for stability studies.

6 Introduction to relevant national and international standards, safe clearances for HV, Study regulations for HV tests, Digital techniques in HV measurements.

Suggested reading:

1. J. Arrillaga, "High Voltage Direct Transmission", Peter Peregrinus Ltd. London, 1983.
2. K. R. Padiyar, "HVDC Power Transmission Systems", Wiley Eastern Ltd., 1990.
3. E. W. Kimbark, "Direct Current Transmission", Vol. I, Wiley Interscience, 1971.
4. Erich Uhlmann, "Power Transmission by Direct Current", B.S. Publications, 2004.

Course Outcomes:

CO1: Proficiency in HVDC converter systems design.
CO2: Know-how of operation of Power electronics in HVDC system.
CO3: Competency in designing filters & DC link control for HVDC System.
CO4: Acquaintance with MTDC system & its open challenges.

PED-301(d): CONDITION MONITORING OF ELECTRICAL EQUIPMENTS

Course Objectives:

1. To understand typical failure modes associated with Transformers and Rotating Machines.
2. To model and analyze health assessment of HV equipments.
3. To acquire knowledge about the international standards of machine parameters.

Course Outcomes:

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

1. **Comprehend** different aspects of maintenance management.
2. **Predict** how the condition monitoring tools help in predetermining the faults can develop in electrical machineries.
3. **Explain** and **analyze** the impact of these techniques used in industries.
4. **Derive** basic mathematical analysis for their application in diagnosis.
5. Understand the interpretation of different test results.
6. **Apply** statistical signal processing tools in condition assessment.

Syllabus:

Unit	Contents	Hours
1	**Introduction:** Review of today's industry and role of condition monitoring.	1
2	**Maintenance Management and Applied Strategies:** Maintenance Management Systems; Basic Principals of Maintenance Strategies; Structure of the Maintenance Management System.	3
3	**Condition Monitoring and Diagnostics of Transformer:** Introduction, Transformer Diagnostics, Transformer Maintenance: Dissolved Gas Analysis; Physical / Chemical Tests of Oil; Age Test on Insulation; Dielectric Response Measurement; Polarisation and Depolarisation Current (PDC) Measurement; PDC Measurement; Frequency Domain Spectroscopy (FDS); Visual Inspection.	15
4	**Condition Monitoring of Rotating Electrical Machines:** Introduction; Construction, operation and failure modes of electrical machines; Structure of electrical machines and their types; Insulation ageing mechanism; Insulation Failure modes: General, Stator winding insulation, Stator winding faults, Rotor winding faults; Instrumentation requirements: Introduction, Temperature measurement, Vibration measurement; Temperature Monitoring; Vibration monitoring; Electrical techniques: current, flux and power monitoring; Generator rotor faults; Motor rotor faults.	15
5	**Recent developments in the field of Condition Monitoring**: Use of statistical methods; Digital Signal Processing and data processing tools in condition assessment and health monitoring of electrical equipments.	10

Reference Books:

1. Zhaklina Stamboliska, Eugeniusz Rusinski, Przemyslaw Moczko, "Proactive Condition Monitoring of Low-Speed Machines", Springer International Publishing Switzerland 2015.
2. Hydroelectric Research and Technical Services Group, "Facilities Instructions, Standards, and Techniques (FIST) Volume 3-31, Transformer Diagnostics", United States Department of the Interior, Bureau of Reclamation, June 2003.
3. Peter Tavner, Li Ran, Jim Penman, Howard Sedding, "Condition Monitoring of Rotating Electrical Machines", The Institution of Engineering and Technology, London, United Kingdom, 2008.
4. Hamid A. Toliyat, Subhasis Nandi, Seungdeog Choi, Homayoun Meshgin-kelk "Electric Machines Modeling, Condition Monitoring and Fault Diagnosis", CRC Press, Taylor & Francis Group.
5. Kulkarni S. V. and Khaparde S. A., "Transformer Engineering – Design, Technology and Diagnostics" 2nd Edition, CRC Press, New York.

PED-301(e): Modeling and Control of Wind Energy Generation :

Electricity Generation from Wind Energy- Wind Farms , Wind Energy-generating Systems , Wind Turbines , Wind Turbine Architectures , Wind Generators Compared with Conventional Power Plant, impacts, Grid Code Regulations for the Integration of Wind Generation ,

Power Electronics for Wind Turbines: Soft-starter for FSIG Wind Turbines, Voltage Source Converters (VSCs), Application of VSCs for Variable-speed Systems, VSC with a Diode Bridge,
Modeling of Synchronous Generators, Generator Equations in thedqFrame, control.
Fixed-speed Induction Generator (FSIG)-based WindTurbines.FSIG Model as a Voltage Behind a Transient, Dynamic Performance of FSIG Wind Turbines, Small Disturbances, performance.
Doubly Fed Induction Generator (DFIG)-based Wind Turbines: Configuration, Characteristics, Control Strategies for a DFIG, Steady-state, Control for Optimum Wind Power Extraction, Dynamic Performance Assessment, Fully Rated Converter-based (FRC) Wind Turbines, FRC Induction Generator-based (FRC-IG) Wind Turbine.
Influence of Rotor Dynamics on Wind Turbine Operation: Blade Bending Dynamics , derivation, example, assessment.
Influence of Wind Farms on Network DynamicPerformance, Dynamic Stability and its Assessment .

Books:
WIND ENERGY GENERATION: Modeling and Control, Olimpo Anaya-Lara, University of Strathclyde, Glasgow, UK, Nick Jenkins, Cardiff University, UK, JanakaEkanayake, Cardiff University, UK, Phill Cartwright, Rolls-Royce plc, UK, Mike Hughes, Consultant and Imperial College London, UK, A John Wiley and Sons, Ltd., Publication,

Course Outcomes:
CO1: Aptitude & proficiency in grid interconnection requirements for wind farms.
CO2: Ability of integrating power electronics device with Renewable Energy Sources.
CO3: Know-how of Wind Power Control.
CO4: Skill in developing MPPT techniques.

PED-301(f): Advanced Electric Drives

Control of Separately Excited DC-motor Drive:
Introduction - Review of DC-motor drives - Speed control of a Separately excited DC motor drive with controlled rectifiers and choppers - Review of controllers - need for anti-windup feature for integral controllers - Speed control of a separately excited DC drive with inner current loop and outer speed loop - Design of current loop with pole-zero cancellation - Design of speed loop with symmetrical optimization technique - Simulation studies
Control of IM drives :
Review of power pole - 4-quadrant operation of drives and switching devices - objectives of modulation - Introduction to PWM schemes for 1-Ph VSI and 3-Ph VSI - Practical implementation of sine-triangle PWM technique for a V/Hz controlled IM drive - Space Vector modulation along with over modulation technique - Implementation of SVM for 3-Ph VSI along with Kim-Sul algorithm - Comparison of SVM and sine-triangle modulation - Practical implementation of SVPWM technique with DSP 320LF2407 processor - simulation studies
Control of IM drives:
Implementation of V/f control with slip compensation scheme -Review of dq0 model of 3-Ph IM with simulation studies - Principle of vector control of IM - Direct vector control - Indirect vector control with feedback - Indirect vector control with feed-forward - Indirect vector control in various frames of reference - Decoupling of vector control with feed forward compensation - Direct Torque Control of IM - Introduction to emerging technologies: Multilevel inversion with Open-end winding induction motor drive - simulation studies
Vector control of PMSM drives Types of PM Synchronous motors - Torque developed by PMSM - Model of PMSM - Implementation of vector control for PMSM – introduction to BLDC drives

Reading:
1. Modern Power Electronics & AC Drives – B.K. Bose - Pearson, First edition
2. Electric Motor Drives: Modeling, Analysis and Control – R. Krishnan – Prentice Hall Reference
Books:
1. Vector Control of Electric Drives: Peter Vas, Oxford Publishers
2. High-power Converters and AC Drives: Bin-Wu, IEEE Press, John Wiley & Sons
3. Papers from journals

Course Outcomes:

CO1 Design controllers for closed-loop operation of a separately excited DC motor drive with symmetrical optimization technique
CO2 Implement sine-triangle and Space Vector PWM techniques on analog and digital platforms
CO3 Understand the power circuit topologies and the sine triangle PWM technique for 3-level NPC, FC, HB inverters
CO4 Understand and simulate the behavior of high performance induction Motor drives using the principles of Vector Control and DTC
CO5 Understand and apply the concept of vector control to PMSM drives

PED-301(g): Nonlinear Phenomenon in Power Electronics & Drives 3-0-0-3:3

OBJECTIVES :
- To understand the non linear behavior of power electronic converters.
- To understand the techniques for investigation on non linear behavior of power electronic converters.
- To analyse the non linear phenomena in DC to DC converters.
- To analyse the non linear phenomena in AC and DC Drives.
- To introduce the control techniques for control of non linear behavior in power electronic systems.

UNIT I: BASICS OF NONLINEAR DYNAMICS 9 Basics of Nonlinear Dynamics: System, state and state space model, Vector field- Modeling of Linear, nonlinear and Linearized systems, Attractors , chaos, Poincare map, Dynamics of Discrete time system, Lyapunov Exponent, Bifurcations, Bifurcations of smooth map, Bifurcations in piece wise smooth maps, border crossing and border collision bifurcation.
UNIT II : TECHNIQUES FOR INVESTIGATION OF NONLINEAR PHENOMENA
Techniques for experimental investigation, Techniques for numerical investigation, Computation of averages under chaos, Computations of spectral peaks, Computation of the bifurcation and analyzing stability.
UNIT III: NONLINEAR PHENOMENA IN DC-DC CONVERTERS
Border collision in the Current Mode controlled Boost Converter, Bifurcation and chaos in the Voltage controlled Buck Converter with latch, Bifurcation and chaos in the Voltage controlled Buck Converter without latch, Bifurcation and chaos in Cuk Converter. Nonlinear phenomenon in the inverter under tolerance band control
UNIT IV: NONLINEAR PHENOMENA IN DRIVES
Nonlinear Phenomenon in Current controlled and voltage controlled DC Drives, Nonlinear Phenomenon in PMSM Drives.
UNIT V CONTROL OF CHAOS:
Hysteresis control, Sliding mode and switching surface control, OGY Method, Pyragas method, Time Delay control. Application of the techniques to the Power electronics circuit and drives.

REFERENCES:
1. George C. Vargheese, July 2001 Wiley – IEEE Press S Banerjee, Nonlinear Phenomena in Power Electronics, IEEE Press
2. Steven H Strogatz, Nonlinear Dynamics and Chaos, Westview Press
3. C.K.TSE Complex Behaviour of Switching Power Converters, CRC Press, 2003

PED-301(h): Microgrids 3-0-0-3:3

Course objectives:
Advanced modeling, control, resilience and security technologies useful for the grid modernization from a unique angle of microgrid design, analysis and operation. Smart inverters, microgrid architectures, distributed energy resources modeling, microgrid hierachical control, microgrid stability, fault management, resilient microgrids through programmable networks, reliable networked microgrids, and cyber security.

Topic 1: Introduction – Power systems resilience – The concept of microgrids
Topic 2: Microgrid Modelling and Analysis – Distributed energy resources (DERs) modelling : PV system, MPPT, and grid-tied interface – Distributed energy resources modelling , Microturbine, energy storage and other DERs – Microgrid inverter structures – Distribution power flow – Stability modelling and computation
Topic 3: Microgrid Control – Centralized control – Hierarchical principle: Primary, secondary and tertiary control – Distributed control
Topic 4: Enhanced Microgrid Power Flow – Microgrid power flow – Networked microgrid power flow 1

Topic 5: Resilient Microgrids through Software Defined Networking – SDN-enabled control and communication architecture – Distributed regulation of networked microgrids – Hardware-in-the-loop test bed
Topic 6: Formal Analysis of Networked Microgrids Dynamics– Formal analysis of microgrid dynamics – Stability margin analysis on networked microgrids
Topic 7: Active Fault Management for Networked Microgrids – Fault ride through – Multi-functional Active Fault Management (AFM)
Topic 8: Cyber Security in Microgrids – Introduction to cyber attacks – Active detection of cyber attacks Topic 9: DC Microgrids – Overview of DC microgrids – Stability of DC microgrids
Topic 10: Future Perspectives

Learning Outcomes L By the time the course is completed, students will have acquired knowledge and skills with microgrids which include the ability to:
* Understand the concepts of microgrids, and networked microgrids;
* Model PV power systems and standard grid-tied inverter;
* Analyze distribution grid power flow;
* Understand centralized control and distributed control in microgrids, especially primary, secondary and tertiary control;
* Conduct power flow analysis for droop-control-based microgrids and networked microgrids;
* Use RTDS for real-time simulation of microgrids;
* Understand fault ride-through and active fault management for microgrids;
* Understand basics of cybersecurity in microgrids and active defense strategy

OE-301(a): Business Analytics

Course objective
1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

(a) Unit1: Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview.

Unit 2: Trendiness and Regression Analysis: Modeling 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 3: 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 Modeling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modeling, nonlinear Optimization.

Unit 4: 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 5: Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Unit 6: Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Reference:

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.

COURSE OUTCOMES

3. 1. Students will demonstrate knowledge of data analytics.
4. 2. Students will demonstrate the ability of think critically in making decisions based on data
5. and deep analytics.
6. 3. Students will demonstrate the ability to use technical skills in predicative and prescriptive
7. modeling to support business decision-making.
8. **4.** Students will demonstrate the ability to translate data into clear, actionable insights.

OE-301(b): Industrial Safety

Unit-I: Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.
Unit-II: Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.
Unit-III: Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.
Unit-IV: Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, iv. Electrical motors, Types of faults in machine tools and their general causes.
Unit-V: Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Reference:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

OE-301(c): Operations Research

Unit 1: Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models
Unit 2 Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method sensitivity analysis - parametric programming
Unit 3: Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT
Unit 4: Scheduling and sequencing - single server and multiple server models - deterministic inventory models-probabilistic inventory control models - Geometric Programming.
Unit 5: Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008

4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5.Pannerselvam, Operations Research: Prentice Hall of India 2010

Course Outcomes: At the end of the course, the student should be able to
1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

OE-301(d): Cost Management of Engineering Projects

Cost Management of Engineering Projects: Introduction and Overview of the Strategic Cost Management Process Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity. cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities.Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts.Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.
References:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4.Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

OE-301(e): Composite Materials

UNIT–I: INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.
UNIT – II: REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.
UNIT – III: Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.
UNIT–IV: Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.
UNIT – V: Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygro thermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.
TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

References:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

OE-301(f): Waste to Energy

Unit-I: Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors
Unit-II: Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.
Unit-III: Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.
Unit-IV: Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.
Unit-V: Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion . Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

References:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. Were Ko-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

PED-381: Major Project Phase-I Dissertation

Project work will be done by the students. At the end of the semester a seminar is to be given on the progress of project work.

Course outcomes:

CO1 -Recognize and formulate a problem to analyze, synthesize, evaluate, simulate and create a power electronic converter and/or a drive system.
CO2 - Carryout modeling and simulation studies pertaining to the system and prepare a presentation

Fourth Semester:

PED-481: Major Project Phase-II Dissertation

Given project work is to be completed and there will be a seminar after the completion of the project work.

Course outcomes:

CO1 -Build the hardware to demonstrate the principle of working
CO2 -Correlate the analytical, simulation and experimental results
CO3-Deduce conclusions and draw inferences worthy of publication

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