STRUCTURE FOR

M.E. ELECTRICAL (POWER ELECTRONICS AND DRIVES) PROGRAMME

UNDER FACULTY OF ENGINEERING

EFFECTIVE FROM JUNE 2013
UNIVERSITY OF PUNE

THE SYLLABUS IS PREPARED BY:

BOS- Electrical Engineering,

University of Pune.

PEER REVIEW BY:

- Prof. Dr. Mrs. G.A. Vaidya, (Chairman)
- Dr. N. Gopalakrishnan, (Academic Expert)
- Dr. J. G. Ghodekar,
  Ex-Dean FOE, Shivaji University, Kolhapur
- Shri Pradeep Kurulkar, (Expert from Industry)
### Structure for M.E. (Electrical) Power Electronics and Drives 2013 Course

#### SEMESTER I

<table>
<thead>
<tr>
<th>CODE</th>
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**List of Elective Subjects**

Note: Select any one subject from module I and one subject from module II for each Elective.

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<th>Elective-III (5 credits)</th>
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<td>1) Project Management</td>
<td>1) Automation in Industrial drives</td>
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<td>2) IPR and Patent Law</td>
<td>2) Embedded system design</td>
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EXAMINATION SCHEME GUIDELINES

A) Compulsory subjects: Credits 4

Total marks: 100

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B) Elective subjects: Credits 5

Total marks: 100

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503301: MODELING AND ANALYSIS OF ELECTRICAL MACHINES

Teaching Scheme
4 Hours / Week
Credits : 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment: 50

Unit I: Generalized Machine Theory:
Elements of generalized circuit theory, basic electrical machine, conventions used, Kron’s primitive machine, leakage flux in machines with more than two windings, voltage equations, matrix form, torque equations, power in AC circuits. (08 Hrs)

Unit II: Linear Transformations in machines:
Linear Transformations in machines: Power invariance, transformations from displaced brush axis, transformations from 3-phase to 2-phase, transformation from rotating axes to stationary axes, Transformed impedance matrix. (08 Hrs)

Unit III: DC Machine:
Separately excited DC motor-steady state and transient state analysis, sudden application of inertia load, transfer function of separately excited DC motor, mathematical model of dc series motor, shunt motor. (08 Hrs)

Unit IV: Modeling of three phase Induction machine
Generalized model in arbitrary frame, Voltage, torque equations, Induction motor models-stator reference frame model, rotor reference frame model, synchronously rotating reference frame model, equations in flux linkages, per unit model, dynamic simulation. (08 Hrs)

Unit V: Modeling of Synchronous Machines
Introduction, voltage equations and torque equation in machine variables, stator voltage equations in arbitrary and rotor reference frame variables, Park’s equations, rotor angle, per unit system, analysis of steady state operation. (08 Hrs)

Unit VI: Linearised machine equations
Linearization of machine equations, Small displacement stability: Eigen values, Eigen values of typical induction machine and synchronous machine. (08 Hrs)

Text Books:
2. P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff, “Analysis of Electrical Machinery and Drive Systems”,

Reference Books:
2. Matrix Analysis of Electric machines, N.N. Hancock, Pergamon Press.
3. Matrix Analysis of Electric machines by Mukhopadhyay
503302: ENERGY MANAGEMENT AND POWER QUALITY IN ELECTRICAL DRIVES

Teaching Scheme
4 Hours / Week
Credits : 4

Unit I: Electric motors
Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis- Energy efficient / high efficient Motors-Case study; Load Matching and selection of motors. Variable speed drives; Pumps and Fans-Efficient Control strategies- Optimal selection and sizing -Optimal operation and Storage; Case study. (08Hrs)

Unit II: Transformer Loading
Efficiency analysis, Feeder/cable loss evaluation, case study. Reactive Power management-Capacitor Sizing-Degree of Compensation-Capacitor losses-Location-Placement-Maintenance case study; Peak Demand controls- Methodologies-Types of Industrial loads-Optimal Load scheduling-case study. (08 Hrs)

Unit III: Power Quality
Introduction to Power Quality, types of power quality disturbances, Causes and effects of power quality disturbances, Voltage sags and interruptions. (08 Hrs)

Unit IV: Transient over voltages
Sources of transient over voltages, overvoltage protection systems, Ferro resonance management, tools for transient analysis. Causes of harmonics generation, harmonic indices, harmonic sources, effect of harmonic distortion, inter harmonics. (08 Hrs)

Unit V: Harmonics
Harmonic distortion evaluation, controlling harmonic distortion, harmonic filter design case study, voltage regulation devices, voltage flicker, Power quality benchmarking, voltage variation indices, power quality state estimations. (08 Hrs)

Unit VI: Power Quality Monitoring
Monitoring considerations, Power quality measuring equipment, application of intelligent systems, power quality monitoring standards. (08 Hrs)

Text Books:

References Books:
3. IEEE Std. 519-1992, IEEE recommended practices and requirements for harmonics control in electrical power system.
10. (www.unescap.org/enrd/energy)
503303: POWER CONVERTERS

Teaching Scheme
4 Hours / Week
Credits: 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment: 50

Unit I: DC to DC Converters
Buck, boost, buck-boost and Cuk converter topologies- continuous and discontinuous modes of operation, Voltage and current commutated choppers, effect of source Inductance, Filter circuits. (06 Hrs)

Unit II: AC to DC Converters
1-phase and 3-phase half controlled and Fully controlled bridge converters with RLE loads, freewheeling diodes, Dual Converter, sequence control of converter-inverter operation, Effect of source inductance on commutation, Harmonic analysis of source current. (08Hrs)

Unit III: Inverter-Generic Topology
General topology of 1-phase and 3-phase voltage source and Current source inverters, Selection of switching frequency & switching device. (08 Hrs)

Unit IV: PWM Inverters
1-phase VSI –sine-triangle PWM. 3-phase VSI sine-triangle PWM: under modulation and over modulation, region of operation. Other Inverter Switching schemes: Programmed harmonic elimination, Current regulated modulation (Hysteresis control), Space vector modulation: brief overview. (09 Hrs)

Unit V: Resonant Converters
Classification, basic resonant circuit concepts, loads resonant converters, ZVS, Soft switching concepts. (08 Hrs)

Unit VI: AC-AC Converters
1-phase and 3-phase AC controllers, Principle of operation, single phase and three phase cycloconverters, harmonics, power factor. (09 Hrs)

Text Books:

Reference Books:
1. Power Electronics by M.D.Singh and Khanchandani.
503304: RESEARCH METHODOLOGY

**Teaching Scheme**
Lectures: 4 Hours / Week
Credits: 4

**Examination Scheme**
In Semester Assessment: 50
End Semester Assessment: 50

**Unit I:**

[8 Hrs]

**Unit II:**
Research Formulation – Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis. Summarizing a Technical Paper - summary template
Online tools - Google, CiteSeer, ACM Digital Library, IEEE, The on-line Computer Science bibliography, Searching patents

[8 Hrs]

**Unit III:**
Research design, sampling design and scaling techniques – Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design, basic principles of experimental designs, implications of sample design, steps in sample design, criteria of selecting sampling procedure, characteristics of good sampling design, different types of sample design. Scaling techniques: measurement scales, sources of error, technique of developing measurement tool, important scaling techniques, scale construction techniques.

[8 Hrs]

**Unit IV:**
Data Collection and analysis:- Observation and Collection of primary and secondary data - Methods of data collection, processing operations, types of analysis, statistics in research, measures of central tendency, measures of dispersion, measures of asymmetry, measures of relationships, simple regression analysis, multiple correlation and regression, partial correlation.

[8 Hrs]

**Unit V:**

[8 Hrs]
Unit VI:
Types of technical papers - Journal papers, Conference papers, Survey papers, Poster papers, Review papers

Text Books:
1. Kothari, C.R., Research Methodology: Methods and Techniques. New Age International
3. Suresh Sinha, Anil K Dhiman, Research Methodology, ESS Publications, Volumes 2
5. Wadehra, B.L. Law relating to patents, Trade Marks, copyright designs and geographical indications. Universal Law Publishing.

Reference Books:
503305: (ELECTIVE- I)

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Teaching Scheme
Lectures: 4 Hrs./Week
Credits: 4

Examination Scheme
In-Semester Examination: 25 Marks
End Semester Examination: 50 Marks

Prerequisite: Fourier series, Fourier transform, Z transform

Unit I: Discrete Signals and systems
Sampling of continuous time signals, quantization, aliasing, Sampling Theorem, Elementary discrete-time signals, classification, sequence operations, Discrete-time systems and Classification, impulse response, linear convolution and its properties, Z transform: basics, properties, inverse Z transform using power series and partial fraction. (08Hrs)

Unit II: Frequency response of discrete time systems
Discrete-time systems described by difference equations, Analysis of LTI discrete systems using z transform, frequency response of first order and second order systems, transfer function, steady state and transient response, phase and group delays, ideal filters and their pole zero locations, zero phase and linear phase transfer functions. (08Hrs)

Unit III: Frequency analysis of discrete time signals
Exponential representation of Fourier series and Fourier transform of continuous time signals, The Fourier series for discrete-Time periodic signals (only concept), The Fourier transform of discrete-time a periodic signals (only concept), Discrete Fourier Transform, Properties: periodicity, linearity, and symmetry properties, Circular convolution, Linear convolution using circular convolution, Fast Fourier Transform: Radix 2 DIT and DIF algorithms. (08Hrs)

Unit IV: IIR filters
Advantages and disadvantages of digital filter over analog filters, classification of digital filters: FIR and IIR, design of analog low pass Butterworth filter, Chebyshev filter, design of IIR filters from analog filters using bilinear transformation, impulse invariance. Realization of IIR filters: direct form I, direct form II, cascade and parallel. (08Hrs)

Unit V: FIR filters
Comparison between FIR and IIR filters, symmetric and anti-symmetric FIR filters, design of linear phase FIR filters using windows method and frequency sampling method, Realization of FIR filters by direct form, cascade form and parallel form. (08Hrs)

Unit VI: Applications of DSP
Application of DSP in rotating Electric Machines - speed control and condition Monitoring, Application of DSP in transmission line protection, Transformer protection. Harmonic analysis. (08 Hrs)

Text Books:

Reference Books:

503305 M1 (ii) : DATA ACQUISITION AND SIGNAL CONDITIONING

Teaching Scheme
Lectures: 4 Hrs./Week
Credits: 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination: 50 Marks

Unit I: Transducers & Data Acquisition
Data Acquisition Systems (DAS) - Introduction. Objectives of DAS. Block Diagram Description of DAS - General configurations - Single and multichannel DAS - Transducers for the measurement of motion, force, pressure, flow, level, dc and ac voltages and currents (CTs, PTs for supply frequency as well as high frequency, Hall Effect Current Sensors, High Voltage Sensors, Optosensors, Rogowski Coil, Ampflex Sensors etc.) (08 Hrs)

Unit II: Signal Conditioning

Unit III: Filtering and Sampling
Review of Nyquist's Sampling Theorem - Aliasing. Need for Prefiltering - First and second order filters - classification and types of filters - Low-pass, High-pass, Band-pass and Band-rejection and All Pass: Butterworth, Bessel, Chebyshev and Elliptic filters. Opamp RC Circuits for Second Order Sections - Design of Higher Order Filters using second order sections using Butterworth Approximation - Narrow Bandpass and Notch Filters and their application in DAS. Sample and Hold Amplifiers . (08 Hrs)

Unit IV: Signal Conversion and Transmission

Unit V: Digital Signal Transmission and Interfacing
DAS Boards - Introduction. Study of a representative DAS Board, Interfacing Issues with DAS Boards, I/O vs Memory Addressing, Software Drivers, Virtual Instruments, Modular Programming Techniques for Robust Systems, Bus standard for communication between instruments - GPIB (IEEE-488bus) - RS-232C - USB-4-to-20mA current loop serial communication systems. Communication via parallel port. Interrupt-based Data Acquisition. (08 Hrs)

Unit VI: Software Design Strategies
Hardware Vs Software Interrupts - Foreground/ background Programming Techniques - Limitations of Polling Circular Queues. (08 Hrs)
Text Books:

Reference Books:
1. John Uffrenbeck, "The 80x86 Family, Design, Programming, and Interfacing", Pearson Education, Asia,
3. G.B. Clayton, Operational Amplifiers, Butterworth and Co,
503305 M2 (i) : PROJECT MANAGEMENT

Teaching Scheme
Lectures: 1 Hr./Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit I:
Project Scheduling: Gantt chart and its application, AOA (Activity on Arrow diagram), AON (Activity on Node) Diagram, Precedence diagramming methods (PDM), Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT), GERT (Graphical Evaluation and Review Technique), Resource allocation, Line of Balancing and crashing the network.

Project Quality Management: The processes of project quality management, Quality planning, assurance and control, Quality of procured items, Techniques of quality assurance and control, project execution and control, International Project Management. [9Hrs]

Unit II:
Project Risk Management: Introduction, Managing risks in projects, Measurement and assessment of risk, Sources of risks. Risk: - Adjusted discount rate method, certainly equivalent method, correlation coefficient, portfolio risks, diversible & non-diversible risks, CAPM (Capital Asset pricing model) case studies of project management, computer aided project management. [5Hrs]

Text Books:
3. Rosy Burke, “Project Management: planning and control technique”, Wiley India, 2003

Reference Books:
Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination: 25 Marks

Unit I:

Unit II:
Copyright: CEN-CENELEC copyright policy, piracy. Industrial design rights
Trademarks: Geographical indication, Protected designation of origin, Trade dress.
Other types: Database right, Fashion law, Indigenous intellectual property, Industrial design rights (or registered designs), Intellectual rights to magic methods, Internet domain name, Know how, Mask work (or Integrated circuit layout design protection), Open-source software, Orphan drug rights, Personality rights, Plant breeders' rights Patent law by region or country: Indian patent law, Australian patent law, Canadian patent law, Patent law of the People's Republic of China, European patent law, Japanese patent law, United States patent law. [7 Hrs]

Text Books:

Reference books:
www.cen.eu
www.cenelec.eu
www.cencenelec.eu
http://ipindia.nic.in/
http://ipindia.nic.in/ipr/patent/patents.htm
http://www.cipo.ic.gc.ca (Canadian patent office)
http://www.epo.org(European patent office)
http://www.cas.go.jp/jp/seisaku/hourei/data/PA.pdf
http://nopr.niscair.res.in/bitstream/123456789/12687/1/JIPR%2016%285%29%20377-384.pdf
Teaching Scheme
Lectures: 1 Hr./Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit I:
Effective Presentation Strategies
Define the purpose of presentation, Analyzing audience and locale, organizing contents, Preparing an Outline, Visual Aids, Understanding the nuance of delivery, sample speech and practice the presentation [3Hrs]

Listening techniques
Types of listening, listening with a purpose, barriers to listening, listening comprehension, effective listening strategies, listening in conversational interaction, team listening [2Hrs]

Speech techniques
Conversation and oral skills, strategies for good conversation, techniques to develop effective word accent, word stress, primary and secondary stress, use of correct stress pattern, developing voice quality, developing correct tone [2Hrs]

Unit II:
Writing technical reports, research papers, dissertation, thesis and research proposals. Important parts of reports like abstract, results, conclusion. Supplementary parts like list of symbols, list of tables, annexure, references etc. Making title page, writing mathematical equations, including graphics, making tables and writing references using LaTeX/ MiKTeX.
Assignment for one technical proposal, one research paper and one technical report should be submitted using LaTeX/MikTeX for in semester assessment. [7 Hrs]

Text books
1) Technical Communication-Principals and Practice, Meenakshi Raman, Sangeeta Sharma, OXFORD university Press.
2) Effective Technical Communication, M Ashraf Rizvi, TATA McGRAW HILL

Reference books
Teaching Scheme
Lectures: 1 Hr. /Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit I:
Need of Synchrophasor Measurements, Phasor Measurement Unit: Architecture, Functions, Optimal Placement of PMUs, phasor data concentrators and associated communication system. Visualization tools to enhance visibility and control within transmission system, PMU measurements and sampling rates. State Estimation & observability by using PMU, phasor data use for real-time operation, frequency stability monitoring and trending, power oscillation, voltage monitoring and trending. Alarming and setting system operating limits. Dynamic line rating and congestion management, outage restoration. Application of PMU for wide area monitoring and control.

[9Hrs]

Unit II:

[5Hrs]

Text Books

Reference Books
1. “Power System State Estimation”, Mukhtar Ahmad
3. “SMART GRID Infrastructure & Networking”, KRZYSZTOF INIEWSKI, TATA McGRAW-HILL EDITION.
A minimum of eight experiments should be performed under Lab Practice – I. Out of which minimum six experiments should be from the list below. Minimum six experiments should be based on compulsory subjects. A list of experiments that may be performed under various subjects of semester - I is given below as a guideline:

**List of Experiments**

1. Modeling and simulation of three phase Induction machine and to study the dynamic behavior of the machine for change in load torque.

2. Modeling and simulation of separately excited DC motor and to study the dynamic behavior of the machine for change in load torque.

3. Analysis of harmonics of three phase Induction motor.

4. Analyze THD in inverter output using Harmonic analyzer.

5. To study the harmonic analysis of CFL, electronic fan regulator, electronic choke of tube, computer and remedy for the same.


7. Simulation & analysis of Buck/Boost converters with RLE load.

8. Simulation & analysis of three phase PWM inverter with RLE load.

9. FFT analysis of three phase converter.


Unit I: Converter Fed DC Drives:
Single phase and three phase drives - separately excited and series motor drives - semi converter and full converter fed drives - General analysis - Evaluation of performance parameters - Dual converter fed drives. (8Hrs)

Unit II: Chopper Fed DC Drives
Single quadrant chopper controlled drives - evaluation of performance parameters for separately excited and series motor drives - Two quadrant and four quadrant chopper controlled drives. (8Hrs)

Unit III: Closed Loop Control of AC Drives
Voltage and current source inverter - inverter control-six step and PWM operation, Control of Induction motor drive: Stator voltage control, V/F control, slip regulation, static Kramer’s drive. (8Hrs)

Unit IV: Vector Control of Induction Motor
Principle of field oriented control, rotor flux oriented control, stator flux oriented control, Rotor flux estimation, Magnetizing flux - oriented control of induction machines. (08Hrs)

Unit V: Special Drives
Brushless DC motor, stepper motor and variable reluctance motor drives. (08Hrs)

Unit VI: Time response Analysis of Motor drive systems
Transfer function and time response analysis using Bode plot and root locus methods for Separately excited DC motor and three phase induction motor. (08Hrs)

Text Books:

Reference Books:
1. Peter Vas, "Vector control of Ac machines", Oxford University Press, 1990
2. Bose, B.K.et.al."Microcomputer control of power electronics and drives", IEEE Press,
# 503308: DESIGN OF POWER ELECTRONIC SYSTEMS

<table>
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<td>4 Hours / Week</td>
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<td>End Semester Assessment: 50</td>
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## Unit I: Modeling of Basic devices
Modeling of basic power electronic devices, modeling of 1-ϕ and 3-ϕ converters. (07 Hrs)

## Unit II: Modeling of Converter
Modeling of DC-DC converters and Inverters. (07 Hrs)

## Unit III: Thermal Design
Thermal design and modeling, Heat sink design and selection of heat sink. (08 Hrs)

## Unit IV: Magnetic Design
Magnetic component design – Magnetic materials and cores, Copper windings, Thermal considerations, special inductor design and procedure, transformer design procedure and K-factor transformer design. (09 Hrs)

## Unit V: Design of Power Electronic circuit
Design of soft starters, design of converters, design of inverters. (08 Hrs)

## Unit VI: Design of snubber & drive circuits
Snubber circuits: Types of Snubber circuits, need of Snubber circuit, Snubber for bridge circuit configurations, GTO -Snubber circuit. Gate and basic drive circuits: Design Consideration, De-coupled drive circuits, Electrically isolated drive circuits, cascade connected drive circuits, Power device protection in drive circuits, circuit layout considerations. (09 Hrs)

## Text Books:
2. J P Agarwal, “Power Electronics Converters Applications & Design”.

## Reference Books:
5. Power Electronics handbook by M.H.Rashid, CRC Press.
503309: ADVANCED CONTROL SYSTEMS

Teaching Scheme
4 Hours / Week
Credits: 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment: 50

Unit I:
Review of classical and modern control concepts: PID control and tuning approaches, State space method, analysis and design of control system in state space, pole placement, state observer, design of control system with Luenberger observer. (6 hrs)

Unit II:
Optimal control:
Parameter optimization and optimal control problems, quadratic performance index, analysis and design of finite and infinite time Linear Quadratic Regulators, Introduction to Linear Quadratic Gaussian approach (8 hrs)

Unit III:
Robust Control:
Concept of robust control, description and categorization of system uncertainties. System and signal norms, small gain theorem, robust stability, design of robust control, Introduction to $H_{\infty}$ control. (8 hrs)

Unit IV:
Nonlinear Control:

Unit V:
Sliding mode control
Notion of variable structure system and variable structure control, Introduction to sliding mode control, features of sliding mode control, sliding mode control design, concept of sliding surface, control design using reaching laws, stability analysis. (8 hrs)

Unit VI:
Applications to power system/power electronics:
Transfer functions of various power electronic devices like converters (switching model, averaging model), Applications of control theory for control of converters, renewable systems, distribution generation, power quality devices. (10 hrs)

Text Books:

Reference Books:
# 503310: (ELECTIVE- II)

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<td>503310 M2(i)</td>
<td>Electric Vehicles</td>
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<td>Embedded system design</td>
<td>503310 M2(ii)</td>
<td>Fundamentals of Cyber Security</td>
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<td>503310 M2(iii)</td>
<td>Disaster Management</td>
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<td>503310 M2(iv)</td>
<td>Communication protocols in SCADA System</td>
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Teaching Scheme
Lectures: 4 Hrs./Week
Credits: 4

Unit I: Introduction
Definition, Types of loads, steady state & transient stability of Drive, state of art of power electronics and drives, selection of motor rating. (08Hrs)

Unit II: D.C. Drives
Review of braking and speed control of D.C. motors, multi-quadrant operation, loss minimization in adjustable speed drives. Mathematical modeling of dc drives, stability analysis, modern control techniques: variable structure, adaptive control. (08Hrs)

Unit III: Induction Motor Drives
Review of braking and speed control of induction motors. constant V/F, constant air gap flux, controlled voltage, controlled current and controlled slip operation. (08Hrs)

Unit IV: Modeling and stability analysis
Mathematical modeling of induction motor drives, transient response and stability analysis Introduction to cycloconverter fed induction motor drive. (08Hrs)

Unit V: Synchronous Motor Drives
Adjustable frequency operation, voltage fed drive, current fed self-controlled drive. (08Hrs)

Unit VI: Automation Using Drives
Introduction, various components of automation, different sensors used in automation, PLC introduction and ladder programming, industrial application of automation, sensor less vector control and DTC drive, Recent trends in automation and case studies. (08Hrs)

Text Books:
1. Dubey G.K., Power Semiconductor Controlled Drive, Prentice Hall, New Jersey
2. Sen P.C., Thyristor Controlled DC Drives, Wiley, New York
3. Murphy J.M.D. and Turnbull F.G., Power Electronics Control of AC Motors, Franklin Book

References:
1. Bose B.K., Power Electronics and AC Drives, Prentice Hall, New Jersey
Teaching Scheme
Lectures: 4 Hrs./Week
Credits : 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Unit I: Introduction to Embedded System
An embedded system, processor, hardware unit, software embedded into a system, Example of an embedded system, Real time and embedded OS. Structural unit in a processor processor selection for embedded systems. (08Hrs)

Unit II
AVR system - AVR family processors, Architecture, Addressing modes, Instruction overview, Branch, Call, and Time Delay Loop, AVR I/O Port Programming. (08Hrs)

Unit III
Assembly level programming, Higher level language programming, AVR Programming in C, Timer Programming, Interrupt Programming. (08Hrs)

Unit IV
AVR LCD and Keyboard Interfacing, ADC, DAC, and different Sensor Interfacing, Relay, Opt isolator interface. (08Hrs)

Unit V
Stepper Motor Interfacing, Servo motor interfacing, PWM Programming, RTC, PC interface, data acquisition system. (08Hrs)

Unit VI
Case studies
DC motor control, Induction Motor control ( VSI and CSI fed ) , UPS Applications , Special Machine control ( PMBLDC). (08Hrs)

Text Books:

Reference Books:
UNIT-I
History and development of on-road Electric Vehicles (EV). Different configurations of hybrid EVs with block diagram representation, merits & demerits of different configurations in view of vehicle efficiency and energy storage system. [7 Hrs]

UNIT-II
Energy storage systems – Basics of EV batteries, specifications, power density, Energy density, Charging & Discharging cycle and recommended methodologies for charging. Recommended drives for EV and converter topology used in EVs. [7 Hrs]

Text Books:
1] Ron Hodkinson & John Fenton, Light Weight Electric/ Hybrid Vehicle design, Butterworth Publications, Heinemann
2] H. A. Kiehne, Battery Technology Handbook, MARCEDLE KKEIRN,C

Reference books :
1] Sandeep Dhameja , Electric vehicle battery systems , Butterworth–Heinemann
503310 M2(ii) : FUNDAMENTALS OF CYBER SECURITY

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit I: Introduction cyber security

Security principles, threats and attack techniques
Introduction to security, Information security, Security triad: Confidential, Integrity, Availability, Focus of control, Security threats and attacks, Security management [2 Hrs]

Authentication and access control
Identification, Authentication, Authentication by passwords, Protecting passwords, Access control structures, Types of access control [2 Hrs]

Unit II: Lattice and reference monitors
Security levels and categories, Lattice diagram, Reference monitors, Security kernel, Hardware security features, protecting memory [2 Hrs]

Security models
Bell-LaPadula, Biba, Non-deducibility, Non-interference, Other models [2 Hrs]

Cryptography
Cryptographic mechanisms, Digital signatures, Encryption, Certificates [2 Hrs]

Reference Books

WEBSITES:
1) www.cert.org
2) www.microsoft.com/security/
3) www.sans.org
4) www.us.cert.gov
503310 M2 (iii): DISASTER MANAGEMENT

Teaching Scheme
Lectures: 1 Hr/Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit I: Disaster, Hazards and Vulnerability
Concept of disaster, different approaches, concept of risk, levels of disasters Disaster phenomena and events, Natural and man-made hazards; response time, frequency and forewarning levels of different hazards, Characteristics and damage potential of natural hazards; hazard assessment, dimensions of vulnerability factors; vulnerability assessment, Vulnerability and disaster risk, Vulnerabilities to flood and earthquake hazards. [7 Hrs]

Unit II: Disaster management mechanism and Planning
Concepts of risk management and crisis management, Disaster management cycle Response and Recovery, Development, Prevention, Mitigation and Preparedness Planning for relief, Strategies for disaster management planning, Steps for formulating a disaster risk reduction plan, Disaster management Act and Policy in India, Organizational structure for disaster management in India, Preparation of state and district disaster management plans. [7 Hrs]

- Students shall submit a detailed case study report on any disaster, prevention and preparedness.

Text books :

References:
2. Disaster Management in India, Ministry of Home Affairs, Government of India, New Delhi, 2011.
5. http://nidm.gov.in/ - National Institute of Disaster Management (NIDM) (Ministry of Home Affairs, Govt. of India) website
503310 M2 (iv) : COMMUNICATION PROTOCOLS IN SCADA SYSTEM

Teaching Scheme
Lectures: 1 Hr./Week
Credit: 1

Examination Scheme
In-Semester Examination: 25 Marks

Unit I:
SCADA Systems: Introduction and definitions of SCADA,
Basic SCADA system Architecture: Human Machine Interface, Master Terminal Unit, Remote Terminal Unit Communications for SCADA systems, Configuration of SCADA systems, SCADA system applications, SCADA systems in operation and control of interconnected power systems, Functions of SCADA systems, Common features of SCADA systems, Automatic substation control, SCADA configuration, Energy management system, system operating states, system security, State estimation.
(7 Hrs)

Unit II:
Communication in power systems: Inductive coordination, Voice communication, carrier systems, Power line carrier systems, Microwave systems, co axial cable and optical fiber system, two way mobile radio systems.
(7 Hrs)

Text Books:

Reference books:
1. Gordan Clark, Deem Reynders, “Practical Modern SCADA Protocols”
503311: LAB PRACTICE II

Teaching Scheme
4 Hrs / Week
Credits : 4

Examination Scheme
Term Work : 50 Marks
Oral Exam. : 50 Marks

A minimum of eight experiments should be performed under Lab Practice – II. Out of which minimum six experiments should be from the list below. Minimum six experiments should be based on compulsory subjects. A list of experiments that may be performed under various subjects of semester -II is given below as a guideline:

**List of Experiments**
1. Modeling and simulation of Chopper fed DC drive.
2. To study the performance characteristics of vector controlled three phase Induction motor.
3. To study the performance characteristics of BLDC motor drive.
4. To study the performance characteristics of Switched Reluctance motor.
5. Modeling and analysis of solar photovoltaic system.
6. MPPT of wind turbine using MATLAB.
7. Simulation of three phase voltage regulator.
8. Design and analysis of snubber circuit.
10. To develop AVR based data acquisition system.
11. To develop AVR based motor control system.
12. To develop AVR based variable DC supply.
15. Design and simulation of finite time Linear Quadratic Regulator (LQR).
16. Design and simulation of sliding mode control for double integrating system.
17. Design and simulation of H-∞ controller.
18. Analysis of closed loop control of converter based system.
503312 : SEMINAR– I

Teaching Scheme
4 Hrs/Week
Credits: 4

Examination Scheme
Term Work: 50 Marks
Oral/Presentation : 50 Marks

Seminar I shall be on state of the art topic of student’s own choice based on relevant specialization approved by an authority. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute.
603301: POWER ELECTRONICS APPLICATIONS

Teaching Scheme
4 Hours / Week
Credits: 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment: 50

Unit I: Power System Applications
Power system components and characteristics, Power flow controllers-types, Need of power flow controllers, types of it, role of power electronics in power systems, future scope. (08 Hrs)

Unit II: Renewable Energy Systems
Block diagram and components of wind energy systems, Generator control, Power factor improvement, PV conversion system, Synchronized operation with grid. Case study of solar PV system (08 Hrs)

Unit III: HVDC System
Need of HVDC system, comparison between EHVAC & HVDC system, HVDC substation, Use of converters in HVDC system, Analysis of 6 and 12 pulse converters, harmonics and filters. (08 Hrs)

Unit IV: Compensation Techniques
Modeling and control of Thyristorised controlled series compensators. Static VAR Compensation - Basic concepts, Thyristor controlled reactor (TCR), Thyristor switched reactor (TSR), Thyristor switched capacitor, Active filter (08 Hrs)

Unit V: FACTS and its Applications

Unit VI: Utility Applications
Switched Mode Power Supplies, UPS and Battery charging system, applications of Power Electronics in Heating & Welding, Illumination application, Electronic Ballast, AC-DC electric locomotives systems, Hybrid vehicle system (08 Hrs)

Text Book:

Reference Books:

603302: POWER ELECTRONICS IN SMART GRID

<table>
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Unit I: Introduction
Introduction to smart grid, electricity network, local energy networks, electric transportation, low carbon central generation, fundamental problems of electrical power systems, power flow control, distributed generation and energy storage, attributes of the smart grid, alternate views of a smart grid. (08 Hrs)

Unit II: Power Control and Quality Problems
Introduction, general problems and solutions of power control, power quality and EMC, power quality issues, monitoring, legal and organizational regulations, mitigation methods, and EMC related phenomena in smart system, EMC cases in distributed power system. (08 Hrs)

Unit III: High frequency AC Power Distribution Platform
Introduction, high frequency in space applications, telecommunications, and computer and commercial electronics systems, automotive and motor drives, micro grids. (08 Hrs)

Unit IV: Integration of Distributed Generation with Power System
Distributed generation past and future, interconnection with a hosting grid, integration and interconnection concerns, Interconnected Grid system and relative problems. (08 Hrs)

Unit V: Communication Technology in Smart Grid
Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Wide Area Network (WAN), Bluetooth, ZigBee, GPS, Wi-Fi based communication, Basics of CLOUD computing and Cyber security for Smart Grid. (08 Hrs)

Unit VI: Active Power Controllers
Dynamic static synchronous controllers, D –STATCOM, Dynamic static synchronous series controllers, dynamic voltage restorer, AC/AC voltage regulators. (08 Hrs)

Text Book:
2. Jean Claude “Smart Grid”, Wiley Blackwell
3. Peter Fox Penner-“ Smart Power- Climate changes the smart grid and the future of electric utility”, Island Press 2010 edition

Reference Books:

### 603303: (ELECTIVE - III)

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<td>Artificial Intelligence in Electrical drives</td>
<td>603303 M2(i)</td>
<td>Artificial Intelligent tools</td>
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<td>603303 M1(ii)</td>
<td>Industrial Automation</td>
<td>603303 M2(ii)</td>
<td>Intelligent Sensors and instrumentation</td>
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<td>603303 M2(iii)</td>
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<td>Green building design</td>
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<td>603303 M2(v)</td>
<td>Biomedical Instrumentation</td>
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Teaching Scheme
Lectures: 4 Hrs./Week
Credits : 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Unit I: Artificial Intelligent Based Systems
Natural language system – perception system for vision speech and touch - expert or knowledge based system – knowledge acquisition – knowledge of representation – inference strategy – expert controller.

(08Hrs)

Unit II: Artificial Intelligence
Definition, problem solving methods, searching techniques, knowledge representation, reasoning methods, predicate logic, predicate calculus, multivalue logic.

(08Hrs)

Unit III: Fuzzy Logic
Concepts, fuzzy relations, membership functions, matrix representation, de-fuzzification methods

(08Hrs)

Unit IV: Artificial Neural Network
Introduction, multi-layer feed forward networks, back propagation algorithms, radial basis function and recurrent networks.

(08Hrs)

Unit V: Evolutionary Techniques
Introduction and concepts of genetic algorithms and evolutionary programming

(08Hrs)

Unit VI: VLSI Implementation of Neural Networks
Analog and digital techniques – hybrid systems – special purpose VLSI chips- neuro-fuzzy control system.

(08Hrs)

Text Books:

Reference Books:
603303 M1(ii) : INDUSTRIAL AUTOMATION

Teaching Scheme
Lectures: 4 Hrs./Week
Credits : 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Unit I:
Introduction: Introduction, structure of automated process control system, Introduction to automation tools PLC, DCS, HMI, SCADA, Hybrid DCS/PLC. Benefits and inconveniences of automation

Unit II

Unit III:
Programmable Logic Controllers: Introduction of Advanced PLC programming, Selection of PLC Input/output modules, Interfacing of Input/output devices, concept of Object linking and embedding for Process (OPC), Control, study of SCADA, PLC SCADA Interfacing.

Unit IV:
Types of communication interface, Communication Protocols Introduction to Open System Interconnection (OSI) model, Modbus (ASCII/RTU), Functions of Transmission control protocol TCP/IP protocol, DNP3 protocol, IEC61850, Control and Information Protocol (CIP), DeviceNet, ControlNet, EtherNet/IP, Process Field bus (Profibus)

Unit V:
Distributed Control System (DCS): Architecture, Specifications, configuration of DCS blocks for different applications, Interfacing of protocol based sensors, actuators and PLC systems, Plant wide database management, Security and user access management, Enterprise Resources Planning (ERP) Interface.

Unit VI:

Text Book:
1. Gary Dunning, ‘Introduction to Programmable logic Controllers’, (Delmar Publisher)
2. Webb & Reis, ‘Programmable logic Controllers’, (Prentice Hall of India)
3. Jose A. Romagnoli, Ahmet Palazoglu, ‘Introduction to process Control’ (CRC Tylor and Francisgroup)

Reference Books:
2. B.G. Liptak ‘Handbook of Instrumentation- Process Control’
3. Installation and user manuals of different DCS, PLC Vendors.
603303 M2(i) : ARTIFICIAL INTELLIGENT TOOLS

Teaching Scheme
Lectures: 1 Hr/Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit I: Fuzzy Logic System
Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Case studies and assignment based on applications of fuzzy logic.

[ 7Hrs ]

Unit II Genetic Algorithm
Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems. GA application to power system optimization problem, Case studies: based on use of GA for optimization.

[ 7Hrs ]

Text Books:
1) M. Ganesh “Introduction to Fuzzy Sets and Fuzzy Logic”, Prentice Hall, India.

Reference Books:
Teaching Scheme
Lectures: 1 Hr./Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit I : Introduction
Sensors: primary sensing principles and measurement variables, sensor performance characteristics and
terminology. Instrumentation: transducer measurement circuit, signal conditioning circuit, Data conversion:
DAC, ADC, virtual instrumentation with Lab View. [7 Hrs]

Unit II : Smart Sensors
Primary sensors; excitation; compensation; information coding/ processing; data communication; standards
for smart sensor interface. Recent trends in sensor technologies: Introduction; film sensors (thick film
sensors, thin film sensors); semiconductor IC technology standard methods; Micro Electro-Mechanical
Systems (micro-machining, some application examples); nanosensors. [7 Hrs]

Text books:

Reference Book:
Teaching Scheme
Lectures: 1 Hr./Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit I:
**Human Rights – Concept, Development, Evolution**
- Philosophical, Sociological and Political debates
- Benchmarks of Human Rights Movement.

**Human Rights and the Indian Constitution**
- Constitutional framework
- Fundamental Rights & Duties
- Directive Principles of State Policy
- Welfare State & Welfare Schemes

**Human Rights & State Mechanisms**
- Police & Human Rights
- Judiciary & Human Rights
- Prisons & Human Rights
- National and State Human Rights Commissions

Unit II:
**Human Rights of the Different Sections and contemporary issues**
- Unorganized Sector,
- Right to Environment.
- Globalization and Human Rights
- Right to Development,

**Citizens’ Role and Civil Society**
- Social Movements and Non-Governmental Organizations
- Public Interest Litigation
- Role of Non Government organizations in implementation of Human rights.
- Right to Information

**Human Rights and the international scene** –Primary Information with reference to Engineering Industry.
- UN Documents
- International Mechanisms (UN & Regional)
- International Criminal Court

**References:**
1) Study material on UNESCO,UNICEF web site
2) HUMAN RIGHTS IN INDIA A MAPPING, Usha Ramanathan
   Available at: http://www.ielrc.org/content/w0103.pdf
Teaching Scheme
Lectures: 1 Hr./Week
Credit: 1

Examination Scheme
In-Semester Examination: 25 Marks

Unit I: Sustainability and Building design
Sustainability, objectives of sustainable development, Sustainable aspects of habitat design, sustainable buildings, principles, approaches and characteristics, climate data, climate parameters and zones, comparative analysis of various climatic zones, site planning recommended check list for identifying site characteristics, site development and layout. Efficient water management and waste water treatment, solid waste management. [7 Hrs]

Unit II: Energy efficiency:
Solar passive techniques in building design to minimize load on conventional system i.e. heating, cooling, ventilation and lighting. Designing Energy efficient lighting and HVAC systems. Use of renewable energy system to meet part of building load. Green building certification. Overview various green building in India. Policy and regulatory mechanism. [7 Hrs]

Text Book:
Seven wonders of Green Building Technology- Karen Sirvaitis, Twenty first century books.

References:
2. Energy Efficient Buildings in India, TERI, New Delhi
3. Sustainable Building Design Manual, Volume 1, TERI, New Delhi
UNIT-I
Basics of bio cell: cell potential, and its measurement. Electrode-Electrolyte interface, half-cell potential l, Polarization- polarisable and non- polarisable electrodes, Ag/AgCl electrodes, Electrode circuit model; motion artifact. Body Surface recording electrodes for ECG, EMG, and EEG. Internal Electrodes- needle and wire electrodes. Micro electrodes- metal microelectrodes, Electrical properties of microelectrodes. Electrodes for electric stimulation of tissue, Selection & specifications for the bio transducers to measure parameters, biosensors. [7 Hrs]

UNIT-II
Cardiovascular System: Heart Structure, Cardiac Cycle, ECG Theory, ECG Electrodes, Electrocardiograph, Vector cardiograph, General block diagram representing ECG measurement. Amplifiers, Transient Protection, Interference Reduction, Movement Artifact Circuits. [7 Hrs]

Reference Books
Seminar II shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned guide and head of the Department/Institute.
603305: PROJECT STAGE - I

Teaching Scheme
08 Hrs/Week
Credits: 08

Examination Scheme
Term Work: 50 Marks
Oral Exam. : 50 Marks

Project work Stage – I is an integral part of the project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation (Mathematical Model/block diagram/ PERT chart, etc.) and Layout & Design of the hardware Set-up. As a part of the progress report of Project work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic.

The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department / Institute.
603306: SEMINAR– III

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<tr>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
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<tr>
<td>5 Hrs / week</td>
<td>Term work : 50 Marks</td>
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<tr>
<td>Credits: 05</td>
<td>Oral/ Presentation: 50 Marks</td>
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Seminar III shall preferably be an extension of seminar II. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned guide and head of the Department/Institute.
603307 : PROJECT WORK STAGE - II

Teaching Scheme
20Hrs / week
Credits: 20

Examination Scheme
Term work : 150 marks
Oral: 50 Marks

In Project Work Stage – II, the student shall complete the remaining part of the project which will consist of simulation & fabrication of hardware set up required for the project work station, conducting experiments and taking results, analysis & validation of results and conclusions (Simulation and Hardware implementation required).

The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.