SYLLABUS OF

MASTER OF ENGINEERING

(POWER ELECTRONICS)

DEPARTMENT OF ELECTRICAL ENGINEERING

DEPARTMENT OF ELECTRICAL ENGINEERING, SGSITS, INDORE

POs for M.E. (POWER ELECTRONICS)

PO1: An ability to independently carry out research/ investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the areas as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: An ability to function effectively for life-long learning in a team to provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

PO5: Apply the knowledge of science and mathematics in design of power electronics based solutions for real-life problems.

M.E. FIRST YEAR ELECTRICAL ENGINEERING

(SPECIALISATION - POWER ELECTRONICS)

SEMESTER-I

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE 60003	Microprocessor Based System Design	4	-	-	4	-	70	30	-	-	100

PRE- REQUISITE: Basic knowledge about microprocessors.

COURSE OBJECTIVES:

1. Review the concept of 8-bit and 16-bit microprocessors and microcontrollers.

2. Enhance low level programming skill for system design

3. Describe the architecture and interfacing of programmable peripheral devices.

4. Develop the capabilities of design and develop industrial and domestic embedded system using digital techniques.

COURSE CONTENTS:

UNIT:1

Review of 8085/8086 microprocessors – Architecture, pin description, memory interfacing.

UNIT:2

Instruction set, Addressing modes, assembly language programming, interrupts of 8086.

UNIT:3

8051 Microcontroller families - Architecture, Instruction set, on-chip peripherals,

Comparison of different microcontrollers Atmel, Philips, Siemens.

UNIT:4

Peripherals – PIC 8259, DMA Controller 8237, Timer 8254, PPI 8255, USART 8251.

UNIT:5

Application of microcontrollers in PID controller, speed control of DC motors, static VAR systems, stepper motor control.

Text Books:

1. A. K. Ray, K. M. Bhurchandi, “Advanced microprocessors and peripherals architecture, programming and interfacing”, forth reprint, TMH Publishing company Ltd., New Delhi 2004.
2. Douglas V Hall, “Microprocessors, Hardware & Programming”, Glencoe 1992.
3. Mazidi Muhammad Ali “8051 Microcontroller and Embedded Systems”, Second edition Pearson Education, 2008.

Reference Books:

1. Yu Chang Liu and Glenn A. Gibson, "Microcomputer system;The 8086/8088 family Architecture programming and design", Prentice-Hall International 1986.
2. S. K. Mandal, "Microprocessor and Micro controller Architecture Programming and interfacing using 8085, 8086 8051", McGraw Hill 2011.
3. J. Kenneth, "8051 Microcontroller Architecture Programming and Application", Second edition USP 1996.

COURSE OUTCOMES:

Student will able to:

1. **CO1:** Develop program at low level to implement algorithms of engineering problems.
2. **CO2:** Identify and explore architecture of microprocessor and microcontroller for the specific application.
3. **CO3:** Extend capabilities of microprocessor based system using various programmable peripherals devices.
4. **CO4:** Design microprocessor based embedded system for industrial, domestic and social applications.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING

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SEMESTER-I

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr.	Total
EE 60014	Advanced Control System	4	-	-	4	-	70	30	-	-	100

PRE- REQUISITE: Basic knowledge of Mathematics, Network Analysis, Linear Systems and Control Systems.

COURSE OBJECTIVES:

Following are the objectives of the course:

1. Understand major concepts of Control System Applications.

2. Apply Basic Control theory towards assessment of Controllers in Electrical Engineering design.

3. Be capable of applying the Modeling Concepts in solving the real life problems of Engineering, physical systems and Science.

4. Explain the possible failure cases of Stability and Develop Tuning Controllers.

5. Modern Software tools applied in practical understanding of Real Time Control Problems.

COURSE CONTENT:

UNIT:1

Review of Linear Control System: Modelling through differential equations and difference equations, State space method of description and its solution, Discretization of continuous-time state space model, Laplace and z-domain analyses of control systems, Controllability, Observability & Stability, Bode & Nyquist analysis, Root Loci, Effect of load disturbance upon control actions.

UNIT:2

Development of feedback control laws through state space technique, Modal control, Pole placement problem.

UNIT:3

Variable Structure Control and its applications. Examples on variable structure control.

UNIT:4

Control of nonlinear dynamics: Lyapunov based control function, Phase plane technique, Lyapunov Stability analysis.

UNIT:5

Optimal Control: Calculus of variation, Euler-Lagrange equations, Boundary conditions, Transversality condition, Bolza problem, Pontryagin's maximum principle.

Text Books:

1. B. C. Kuo, “Automatic Control Systems”, eight edition, Wiley India 2009.
2. K. Ogata, “Modern Control Engineering”, fifth edition, Prentice-Hall 2010.
3. B. C. Kuo, “Digital Control Systems”, Oxford University Press 1992.

Reference Books:

1. K. Ogata, “Discrete-Time Control Systems”, second edition, Pearson Education 2005.
2. Andrew P. Sage, “Optimum System Control”, Pearson Education Canada, 1977.

COURSE OUTCOMES:

After completing the course, student will able to:

CO1: Demonstrate an understanding of the concepts of Control engineering, various Design mechanisms and physical system Realisation.

CO2: Identify importance of Several Conventional and Soft Tuned Controllers to estimate different parameters for Conventional Control engineering applications and Smart AI and Machine Learning Based Minimum Failure Systems.

CO3: Evolve the Development of complex Control Higher Order systems using ANN and Fuzzy Logic Based Systems.

CO4: Estimate Different Control models for Continuous and Discrete Time Systems using Classical Control mechanisms and State Space Analysis

CO5: Determine the Applications of Optimal Control for Evaluation of different dynamical System.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING

(SPECIALIZATION - POWER ELECTRONICS)

SEMESTER-I

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
MA 60015	Advanced Engineering Mathematics	4	-	-	4	-	70	30	-	-	100

PRE- REQUISITE: Basic knowledge of Matrices, Linear and Non-linear Programming, Graph theory and basics of probability theory is required.

COURSE OBJECTIVES:

Following are the objective of the course:

1. To explore various solution of linear systems of equations, eigen values, eigenvectors and Applications of various Eigen-value problems.
2. To explain the different methods for solving non- linear programming problems and various graph theoretic algorithms useful in solving practical problems.
3. To study the basic concepts of the theory of stochastic processes and Marcov chain, most important types of stochastic processes various properties and characteristics of processes, methods for describing and analyzing complex stochastic and Markovian models.
4. To introduce the basic concepts of neural networks and design methodologies for artificial neural networks

COURSE CONTENTS:

Unit 1 Linear system of equations: Basic concepts, rank of matrix, linear independence, solution of linear systems of equations: existence, uniqueness and general form, homogeneous and non-homogeneous equations, Eigen values, Eigen vectors, Matrix Eigen-value problems, Applications of Eigen value problem.

Unit 2 Non-Linear Optimization: Formulation of non-linear programming, general non-linear programming problem, Lagrangean method, Kuhn-Tucker condition, Fibonacci Search, Quadratic Interpolation.

Unit 3 Combinatorial Optimization: Introduction and basic terminology of graphs, path, circuit, Eulerian circuits, Hamiltonian cycles, shortest path problem, Dijkstra's algorithm. Tree, spanning tree, minimum spanning tree algorithms: Kruskal's and Prim's algorithm. Flow augmented paths, Ford-Fulkerson algorithm, Max. Flow min. cut Method theorem.

Unit 4 Elements of Stochastic Process: Random variable, sample space, state space, random process (Stochastic process), Classification of stochastic process, Autocorrelation and auto covariance.

Markov Process: probability vector, stochastic matrix, regular stochastic matrix and their applications, transition matrix, Poisson Process.

Unit 5 Neural Network: Basic Idea, Artificial neural network and its building blocks, Terminologies learning rules, back propagation network and its rule, feedback network, Adaline and madaline network, Neurons as function of single monotocity, Perceptrons, Functional link network and fuzzy logic.

Text Books:

1. Erwin Kreyszig: Adance Engineering Mathematics, John Wiling & Sons, 8th Edition.
2. S. S. Sastry: Engineering Mathematics, Vol II, 2nd Edition, PHI, NewDelhi.

Reference Books:

1. K.K.Vinoth, Neural Network and Fuzzy Logic, 1st Edition, KATSON Book, 2009.
2. Pannerselvam R., Operations Research, Prentice Hall of India Pvt. Ltd, New Delhi, 2004.

COURSE OUTCOMES:

After completing the course, student will able to:

CO1: Identify and Apply algebraic skills essential for the study of systems of linear equations, matrix algebra, eigen values, eigenvectors and analyze Matrix Eigen-value problems and their Applications.

CO2: Critically analyze and construct general non- linear programming problem and solve them through various techniques.

CO3: Understand the fundamental concepts in graph theory and apply some basic graph theoretic algorithms for solving practical problems.

CO4: Explore the basic concepts of stochastic processes and Marcov chain, describe and analyze complex stochastic models.

CO5: Implement the concept of neural network to train and analyze the data.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING
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SEMESTER-I

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE 61004	Power Electronics Devices And Phase Controlled Circuits	4	-	-	4	-	70	30	-	-	100

PRE- REQUISITE: Basic knowledge of basic Electronics, network theory, control system and electrical machines is required.

COURSE OBJECTIVES:
Following are the objective of the course:
1. To introduce with static and dynamic characteristics of different silicon based static switches.
2. Interpret principle of operation, design and synthesis of different line commutated converters and their applications.
3. To provide strong foundation for further study of power converters and its applications.

COURSE CONTENTS:

UNIT 1 : Power Semiconductor requirements, Structures, Static and dynamic characteristics of power semiconductor devices, Series and parallel operation of devices, Device drivers, Cooling of power devices, Device ratings, Protection against dv/dt and di/dt, Device data sheets, interpretations.

UNIT 2 : Different single-phase and three phase line commutated converter configurations, performance analysis with different loads, Effect of source inductance, commutation and overlap, Inverter mode of operation, Gate circuit schemes for phase control.

UNIT 3: Dual phase controlled converter circuit (single and three-phase), principle of operation, practical converters, operation in circulating and non-circulating mode, Comparison, firing schemes.

UNIT 4 : Cyclo-converters, principle of operation, Three-phase dual converter as a cyclo-converter, Cyclo-converter circuits, circulating and non-circulating current mode, load and line harmonics, load commutated cycle-converters, Control schemes.

UNIT 5 : AC voltage controllers, types and principle of operation, on-off control and phase angle control, performance analysis with different loads, their applications for power supplies (solid state tap changing regulator) and AC motor control.

Text Books:

1. N. Mohan, T.M. Undeland and W.P Robbins, "Power Electronics Converters, Applications and Design", third edition, John Wiley & Sons Inc, 2003.
2. M. H. Rashid, "Power Electronics Circuits, Devices and Application", third edition Pearson education 2009.

3. Joseph Vithayathil, “Power Electronics Principles and Applications”, Tata McGraw Hill edition 2010.

Reference Books:

1. B.W. Williams, “Power Electronics, Devices Drivers and Application” Wiley New York 1987.
2. B. R. Pelley, “Thyristor Phase controlled converters and cyclo-converters”, Wiley Inter science, 1971.

COURSE OUTCOMES:

After completing the course, student will able to:

CO1: Define and illustrate the role of static switch, its operating modes and their static and dynamic characteristics**.**

CO2: Show the different topologies of line commutated converters and make use of according to application fields.

CO3: Demonstrate and Analyze performance of cyclo converters and AC voltage controllers for real life applications

CO4: Examine and Evaluate the merits of line commutated converter for industry grade apparatus**.**

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING
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SEMESTER-I

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE61005	Power Electronics Inverter and chopper Circuits	4	-	-	4	-	70	30	-	-	100

PRE-REQUISITE: Basic knowledge of semiconductor devices, power electronics circuits and control system.

COURSE OBJECTIVES:
1. Introduce students to different inverter and chopper circuit topologies, principle of operations, design and their applications.
2. Develop understanding of various modulation techniques and control methods applicable to inverter and chopper circuits.
3. Familiarize students with basic applications of inverters and DC/DC converters, like multi-level inverters and power supply applications.

COURSE CONTENTS:

UNIT:1

Inverter principles, Inverter topologies for single phase and three phase inverters, Push pull, half bridge and full bridge single-phase inverters, Quasi square wave inverters, Three-phase six step and current controlled inverters, current source single & Three-phase inverters.

UNIT:2

Voltage and frequency control techniques for inverters. 120^o and 180^o mode of operation of three-phase inverters, basic concepts of switch mode inverter, PWM with bipolar and unipolar switching. Push Pull inverters, switch utilization, Effect of blanking time, space vector modulation, phase sequence control, selective harmonics elimination techniques.

UNIT:3

Multi-level inverters, concept, advantages of multilevel inverters, types and principle of operation, Diode clamped multilevel inverter and cascaded multilevel inverters.

UNIT:4

Principles and classification of chopper circuits, Analysis of practical choppers for single, two and four quadrant operation, Device selection, duty cycle range of practical choppers, Design consideration for RL and RLE loads, Multiphase Choppers, thyristor choppers, Switching control circuits for chopper converters.

UNIT:5

Switch mode power supplies, buck. Boost and buck-boost converters, Control of DC-DC converters, Continuous and discontinuous conduction mode, Effect of patristic elements, Converter comparison.

Text Books:

1. N. Mohan, T. M. Undeland and W.P Robins, “Power Electronics Converters, Application and Design”, third edition, John Wiley India 2003.
2. M. H. Rashid, “Power Electronics Circuits, Devices and Applications”, third edition Prentice-Hall 2004.
3. L. Umanand, “Power Electronics Essentials and Applications”, Wiley India 2009.

4. Joseph Vithayathil, “Power Electronics principle and Applications”, Tata McGraw Hill 2010.
5. D.W. Hart, “Power Electronics”, Tata McGraw Hill edition 2011.

Reference Books:

1. K. Thorborg, “Power electronics”, Prentice Hall, UK 1988.
2. E. R. Hnatek, “Design of Solid-State Power Supplies”, Van Nostrand Reinhold New York 1989.
3. T. Kenjo, “Power Electronics for the Microprocessor Age”, Oxford University Press New York 1990.
4. R. Bausiere, F. Labrique and G. Seguier, “Power Electronics Converters: DC-DC Conversion”, Springer-Verlag, 1993.

COURSE OUTCOMES:

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

CO1: State, differentiate and analyze the various single phase and three phase inverter topologies.
CO2: Classify and compare the various control methods and modulation techniques effecting the performance of inverter and chopper circuits.
CO3: Apply the basics of two/three level inverter circuits to develop understanding of multi-level inverters.
CO4: Examine, discuss and analyze different chopper topologies for practical, industrial applications.
CO5: Identify and compare the performance of DC-DC converter topologies with consideration of switch mode power supply (SMPS) applications.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALIZATION -POWER ELECTRONICS)
SEMESTER -I

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE-61451	LAB -I	-	-	4	-	4	-	-	40	60	100

COURSE OBJECTIVES:

1. Establish familiarity with MATLAB toolboxes and be able use the tool boxes for specialized technology
2. Evolve capability to develop computational algorithms ranging from elementary functions to more sophisticated functions.
3. Promote the students towards mathematical modelling of electrical and real life systems, so that they can model and verify the accuracy of the models through simulation.

LIST OF EXPERIMENTS

1. Learning of basic MATLAB operations.
2. Development of code to determine Fibonacci Series.
3. Plotting of 2-D and 3-D functions.
4. Solving system of algebraic and differential equations.
5. Plotting triangular wave and evaluation of its harmonic series.
6. Find the step response for R-L and R-L-C circuit and plot the response.
7. Design and analysis of single-phase DC-DC converter (buck, boost and buck-boost).
8. Study of closed loop performance of buck type DC-DC converter.
9. Simulation of AC-DC half-controlled and fully-controlled rectifiers.
10. Development of mathematical model for Solar cell.
11. Estimate the value of pi using Monte Carlo Simulation.
12. EMI filter design for DC-DC converters using bode plots.
13. Development of mathematical model for separately excited DC motor.
14. Controller design for speed control of separately excited DC motor.
15. Minor Project

MINOR PROJECT TOPICS

Any other project based on emerging field of power electronics/ other fields in consultation with course coordinator.

Note:

The project work comprises following activities

- Literature survey
- Schematic diagram of the work
- Simulation model of the project
- Simulation result analysis and discussion

- Detailed design of the each component used in project including specifications of passive elements, semiconductor switches, heat sink design
- Prototype
- Experimental results and analysis
- Seminar
- Report writing

COURSE OUTCOMES:

Student will be able to

CO-1. Recongnize, relate and apply the tool boxes of MATLAB for simulation verification of converter circuits and other mathematical and engineering applications.

CO-2. Summarize the mathematical, data, equations and functions through visual representations.

CO-3. Develop mathematical models of real life systems and evaluate the correctness of the models through simulation.

CO-4. Conclude the analytical and simulation results through practical verification of hardware circuits. This will involve software-hardware integration.

COURSE ASSESSMENT:

Students will be assessed on
(a) Continuous evaluation through lab report assessments (10%), mid semester and end semester internal submissions (10%). It includes class attendance (5%) as well as report questions based on lab experiments (5%). The minor project will be submitted at the end of semester and its outcome will be assessed by an internal examiner (10%). Total (40% marks)

(b) The end-term practical examination. (The student is asked to perform the given laboratory task based on experimentation done during the semester. The student is allowed to perform experiment and take observation and justify the obtained results. The exam will be conducted by external and internal examiners. Total (60% marks)

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALIZATION -POWER ELECTRONICS)
SEMESTER -I

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE-61452	LAB -II	-	-	4	-	4	-	-	40	60	100

COURSE OBJECTIVES:

- Show awareness about operating behaviour of various static switches used in converters
- Understand the basic requirements in design of power converters.
- Analyse performance parameters of various power converters

LIST OF EXPERIMENTS

1. To understand the switching characteristics of controlled power semiconductor devices such as SCR, GTO, TRIAC, BJT, MOSFET and IGBT as a power electronic switch. Design of heat sink for these devices.

2. Design a relaxation oscillator circuit using Uni-junction Transistor (UJT) to be used as a firing circuit for single-phase phase controlled rectifiers.

3. Evaluate the performance of single-phase AC voltage controller using TRIAC-DIAC combination. Record the waveforms of input supply voltage, output voltage, TRIAC voltage, DIAC voltage and capacitor voltage under different firing angles.

4. Observe the performance of a TCA-785 based triggering circuit used for single phase controlled converter.

5. Design and evaluate the performance of switching aid circuits (Turn-Off and Turn-On). Obtain the trace of device voltage and currents during turn-on time and turn-off time with and without switching aid circuits. Comment on rating of passive elements used in switching-aid circuits.

6. Evaluate the performance of single-phase controlled rectifiers with R and RL loads. Trace the waveforms of input AC voltage, input current, output voltage, output current, switch voltage and current with different rectifier configurations and determine form factor, ripple factor, and displacement power factor. Also plot a graph V0 v/s firing angle.

7. Analyze the performance of step down chopper with R-L loads. Plot for the output voltage, output current, switch voltage and current, diode voltage and current. Study the effect on peak-peak ripple current under change in switching frequency and load inductance.

8. Design of current commutation circuit for SCRs used in forced commutated inverters and choppers. Trace the waveforms of voltage and currents of main and auxiliary SCR, inductor current etc.

9. Design the voltage commutation circuit for SCR used in forced commutated inverters and choppers. Trace the device voltage, capacitor voltage, device current with on different RC combinations.

10. Design of Single-phase Half bridge inverter with R and RL loads. Trace the waveforms of device voltage, load voltage, load current and device currents.

11. Minor Project (for the group of two students)

MINOR PROJECT TOPICS

- Design and development of a single phase line commutated rectifier feeding a 0.25kW separately excited DC motor.
- Design and development of single phase AC voltage controller for feeding 80W ceiling fan load.
- Design and development of step down chopper feeding 0.25kW separately excited DC motor.
- Design and development of single phase inverter feeding RL Loads.
- Design and development of single phase Cyclo-converter feeding 80W ceiling fan load.
- Any other project based on emerging field of power electronics in consultation with course coordinator.

Note:

The project work comprises following activities

- literature survey
- Schematic diagram of the work
- Simulation model of the project
- Simulation result analysis and discussion
- Detailed design of the each component used in project including specifications of passive elements, semiconductor switches, heat sink design
- Prototype
- Experimental results and analysis
- Seminar
- Report writing

COURSE OUTCOMES:

Student will be able to

1. Show testing procedure and select proper instruments to evaluate performance characteristics of static switches and power converters and analyse their operation under different loading conditions.

2. Make use of wiring and device connections keeping in mind technical, economical, safety issues.

3. Apply professional quality textual and graphical presentations of laboratory data and computational results, incorporating accepted data analysis and synthesis methods, mathematical software, and word- processing tools.

4. Team based laboratory activities for designing power converters to demonstrate the creativity, ability to interact effectively on a social and interpersonal level, divide up and share task responsibilities to complete assignments.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through lab report assessments (10%), mid semester and end semester internal submissions (10%). It includes class attendance (5%) as well as report questions based on lab experiments (5%). The minor project will be submitted at the end of semester and its outcome will be assessed by an internal examiner (10%). Total (40% marks)

(b) The end-term practical examination. (The student is asked to perform the given laboratory task based on experimentation done during the semester. The student is allowed to perform experiment and take observation and justify the obtained results. The exam will be conducted by external and internal examiners. Total (60% marks)

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALIZATION - POWER ELECTRONICS)
SEMESTER-I and II

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE61500/ EE61900	Comprehensive Viva	-	-	-	-	-	-	-	-	-	Grade

COURSE OBJECTIVE:
The objective of comprehensive viva-voce is to assess the overall knowledge of the student.

COURSE OUTCOMES:

CO1: Test the overall theoretical and practical knowledge of the student in the relevant field.

CO2: Judge their expertise and research orientation in solving practical problems

CO3: Present their design and analytical capabilities through the use of real life/ industry oriented problems. (PO5)

CO4: Examine their expertise and research orientation in solving practical problems. (PO1 and PO3)

CRITERIA & RUBRICS:

Student will be judged using following criteria and rubrics:

1. Technical Knowledge – 4 Marks (CO1, CO2, CO3, CO4)

2. Analytical Capabilities – 3 Marks (CO1, CO2, CO3, CO4)

3. General Awareness – 2 Marks (CO1, CO2, CO3, CO4)

4. Confidence – 1 Marks (CO1, CO2, CO3, CO4)

M.E. FIRST YEAR ELECTRICAL ENGINEERING

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SEMESTER-II

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE60505	Digital Signal Processing	4	-	-	4	-	70	30	-	-	100

PRE-REQUISITE: Basic knowledge of Mathematics, Network Analysis, Analog/Digital Communication and Linear Systems.

COURSE OBJECTIVES:

Following are the objectives of the course:

1. Understand the Extensive Concepts of Digital Signal Processing Applications.
2. Apply linear system theory using Analog and Digital means towards assessment of Sampling requirements and Avoidance of Aliasing.
3. Be capable of applying the Various Transforms in Analyzing LTIV and Minimum/Non-Minimum Phase Systems.
4. Explain the various possible cases of Filter options available for several structures with windowing concept.
5. Modern Digital Signal Processors applied in practical understanding of Real Time applications of Conventional and Smart /Intelligent systems.

COURSE CONTENTS:

UNIT:1

Discrete time signals: Sequences & systems, linear time invariant systems & their properties. Difference equations. Frequency domain representations of discrete time signals & systems. Discrete time Fourier transform of (DTFT).

UNIT:2

Sampling of continuous time signals., Freq. domain representation of sampling, reconstruction of a band-limited signal from its samples, discrete time processing of continuous time signals, continuous time processing of discrete time signals, changing the sampling rate using discrete time processing.

UNIT:3

Z-transform – properties of Z-transform, properties of the region of coverage for the Z-transform, inverse Z-transform using contour integration, complex convolution theorem, parseval's relation, unilateral Z-transform. Transform analysis of linear time invariant systems- - Frequency response of LTIV systems, systems functions frequency response for rational system functions, relationship between magnitude & 1-phase, All-pass systems, Minimum phase system.

UNIT:4

Structures of discrete time systems: Signal flow graph representation of linear constant coefficient difference eqn. Basic structures of FIR & IIR systems. Design of FIR filters by windowing, Kaiser window. Design of IIR filters from contentious time filter.

UNIT:5

Discrete Fourier Transform (DFT) & its properties, linear convolution using DFT decimation in time FFT algorithm, implementation of the DFT using convolution. Discrete Hilbert transformer.

Text Books:

1. Alan V. Oppenheim & Ronald W. Schafer, "Discrete-Time Signal Processing", second edition Prentice-Hall of India, Pvt., Ltd 2007.
2. L. R. Rabiner & B. Gold, "Theory and Application of Digital Signal Processing", Prentice-Hall Englewood Cliffs 1975.
3. Proakis, "Digital Signal Processing", fourth edition Pearson education 2009.

Reference Books:

1. S.K Mitra, "Digital Signal Processing", fourth edition Tata McGraw Hill, 2011.
2. Vallavaraj and Salivahanan, "Digital Signal Processing", Tata McGraw Hill, 2007.
3. Monson H. Hayes, "Schaum's Outlines of Digital Signal Processing", McGraw Hill Professional 1999.

COURSE OUTCOMES:

After completing the course, student will able to:

CO1: Demonstrate an understanding of the concepts of Digital Signal Processing, Various Architectures and Discrete Time System Realization.

CO2: Identify importance of Continuous and Discrete time systems to estimate different Amplitude and Phase Spectrums of Real Time and Random Signals.

CO3: Evolve the Development of complex Discrete Time systems with Realization of Causal and Non-Causal systems.

CO4: Estimate Different Methodologies for Discrete Time Systems using Signal flow Graph Concept and State Space Analysis

CO5: Determine the Applications of FFT/DFT Algorithms as well Evaluation of DSP Processors for Conventional and Smart Systems.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING

(SPECIALISATION - POWER ELECTRONICS)

SEMESTER-II

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE61507	Power Electronics Application to Power Systems	4	-	-	4	-	70	30	-	-	100

PRE-REQUISITE: Power System, Power Electronics

COURSE OBJECTIVES:

1. Understand the basics of formation of bus admittance matrix, modeling of transmission line, and analyze the load flow.
2. Teach the analysis of sensitivity and the basics of power system security.
3. Explain the voltage stability, proximity indicators and participation factors.
4. Familiarize with FACT systems for controlling the power and configuration of various FACT devices.
5. Introduce the thyristor controlled series capacitor, its analysis, different modes of operation and various models.

COURSE CONTENTS:

UNIT:1

Power System components models formation of bus admittance matrix, algorithm for formation of bus impedance matrix, Reactive power capability of an alternator, transmission line model and loadability, Reactive power transmission and associated difficulties, Regulated shunt compensation, Models of OLTC and Phase shifting transformer, load flow study.

UNIT:2

Sensitivity analysis: Generation shift distribution factors, line outage distribution factors, Compensated shift factors. Power system security levels, contingency selection and evaluation, security constrained economic dispatch. Pre-contingency corrective rescheduling.

UNIT:3

Voltage stability: Proximity indicators e.g. slope of PV-curve, Minimum Eigen value of reduced load flow Jacobian, participation factors based on modal analysis and application.

UNIT:4

Flexible ac transmission systems, Reactive power control, Brief description and definition of FACT's controllers, Shunt compensators, Configuration and operating characteristics of TCR, FC-TCR, TSC, Comparison of SVCs.

UNIT:5

The Thyristor-controlled series capacitor (TCSC), Advantages of the TCSC, Basic principle and different mode of operation, Analysis, Variable-reactance model and transient stability model of TCSC.

Text Books:

1. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, Tata McGraw Hill 2011.
2. A. J. Wood and B. F. Wollenberg, “Power generation, operation and control”, second edition John Wiley and Sons 1996.
3. N. G. Hingorani and L. Gyugyi, “Understanding facts: Concepts and Technology of flexible AC transmission systems”, Wiley Press 2000.

Reference Books:

1. P. Kundur, “Power System Stability and control”, McGraw-Hill edition 2008.
2. R. M. Mathur and R. K. Varma, “Thyristor Based FACTS Controllers for electrical Transmission systems”, John Wiley and sons 2002.

COURSE OUTCOMES:

After completing the course, student will able to:

CO1 : Create the bus admittance matrx, describe the reactive power of transmission line, model the tansmission line, define the model of OLTC and analyse the load flow of lines.

CO2 : Analyze the sensitivity of different distribution factors, explain the power system security, and select and evaluate the contingency.

CO3 : Determine the voltage stability, proximity indicators and participation factor based on model analysis.

CO4: Describe the FACT’s controllers for power system and configure various FACT devices.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING

(SPECIALISATION - POWER ELECTRONICS)

SEMESTER-II

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE61602	Power Electronics Supply System & Design	4	-	-	4	-	70	30	-	-	100

PRE-REQUISITE: Basic knowledge of semiconductor devices, power electronics circuits and control system.

COURSE OBJECTIVES:

1. Develop in depth knowledge of Power Electronic circuits.
2. Mature the analytical skills to be able to develop mathematical models of the converter topologies.
3. Have thorough understanding of power supply design procedures and control algorithms.
4. Be familiar with the power supply safety, standards, regulations, agencies and marks.

COURSE CONTENTS:

UNIT:1

Review of basic power electronics principles, Introduction to various power electronics supplies. Performance parameters for power electronics supplies and their measurement.

UNIT:2

DC to DC converters: Analysis and design of cuk converters, two quadrant and full bridge non-isolated converters, Isolated converters, i.e., flyback, forward, push-pull, half- bridge, full bridge Zeta, and SEPIC topology, block diagram of converter control, modeling such as averaged model, linearized and state space model Design of DC inductor, Concept of integrated magnetic.

UNIT:3

Soft switching DC to DC converters, zero current switching topologies, zero voltage switching topologies, generalized switch cell, ZCT and ZVT DC converters, design and simulation.

UNIT:4

Pulse width modulation rectifiers, properties of ideal rectifiers, Realization of near deal rectifiers, CCM boost converter, DCM flyback converters, control of current waveforms, AC Choppers: Modeling and analysis of AC choppers, harmonics control using symmetrical and asymmetrical waveform pattern, design and simulation.

UNIT:5

Static un-interruptible power supply, on-line, off-line and line interactive UPS, modes of operation, batteries and converters selection and design for UPS, performance evaluation of UPS, power factor correction techniques, control of UPS.

Text Books:

1. Issa Batarseh, "Power Electronics Circuits", John Wiley & Sons Inc 2004.
2. Ned Mohan, "Power Electronics: Converters, Applications, and Design", John Wiley & Sons Inc 2003.
3. M. H. Rashid, "Power Electronics Circuits, Devices and Applications", third edition Pearson Education India, 2009.
4. L. Umanand, "Power Electronics Essential and Applications", Wiley India 2009.

Reference Books:

1. R. W. erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2013.
2. Y.S Lee, "Computer Aided Analysis and Design of Switch Mode Power Supplies", Marcel Dekker, New York 1993.
3. D. C. Griffith, "Uninterruptible Power Supplies", Marcel Dekker Inc, New York 1993.
4. K. Billing, "Switch Mode Power Supply Handbook", third edition McGraw Hill, Boston 2010.

COURSE OUTCOMES:

At the end of the course, student will,

CO1: Demonstrate adequate understanding of power electronics concepts. Be able to classify DC-DC and AC/DC power electronic converters as per the performance requirement of Power Supplies.

CO2: Analyse and design conventional DC-DC converter topologies and be capable of developing their mathematical models aiding the steady state and transient analysis.

CO3: Enumerate the various soft switching techniques and modify the conventional DC-DC converter topologies to introduce the concept of soft switching. The student will be able to evaluate and anticipate the modified outcome in converter efficiency.

CO4: Develop understanding of conventional AC/DC converter topologies and be able to classify and design them based on their power stages, control aspects and other issues like source current quality control etc.

CO5: Able to classify the different layouts of uninterruptible power supplies, compare the applicable control strategies and identify the various standards followed in this area.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALIZATION -POWER ELECTRONICS)
SEMESTER -II

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE 61603	Modeling and Simulation of Drives	4	-	-	4	-	70	30	-	-	100

PRE-REQUISITE:
Basic knowledge of the power electronic converters- single phase and three phase, basic knowledge of electrical machines- AC and DC, basics of controller design.

COURSE OBJECTIVE:
1. To understand the basics of drives and its requirements.
2. To understand the transformations of parameters from stationary reference frame to rotating reference frame and vice versa.
3. To expose students to the operation, application and control of power conversion systems employed in electric drives to cater to industrial needs.
4. To impart knowledge on performance of the fundamental control practices associated with AC and DC machines using power electronic devices.
5. To understand the design and simulation of control systems suitable for an electric drive according to the dynamics of motor.

COURSE CONTENTS:
UNIT:1
Mathematical modeling of electrical machines, Reference frame theory, Transformations of variables between reference frames, Park and Clarke Transformation, Calculating machine parameters based on frame of reference used, Analysis of A.C. and D.C. machines, Linearized equations of AC and DC machines.

UNIT:2
Modeling and simulation of rectifier and chopper fed DC drives, current limit control, field weakening control, two quadrant and four quadrant DC drives, closed loop control, PLL control, sensor-less control, Application based control designing and simulation, design problems.

UNIT:3
Modeling and simulation of synchronous machine drives, self-control and true synchronous mode, Scalar control, vector control, direct torque control, LCI fed drive, VSI and CSI fed closed loop control drives, sensor-less control, Application based control designing and simulation , design problems.

UNIT:4
Generalized operation of induction motor with impressed voltage and non-sinusoidal waveform, Analysis using equivalent circuit, harmonics losses, Analysis of VSI and CSI fed induction motor drive, Scalar control, field oriented control and direct torque control speed estimation algorithm, Application based control designing and simulation, design problems.

UNIT:5

Modeling of permanent magnet brushless DC motor drive,control scheme, converter topologies, sensor-less control of PMBLDC drives, modeling of Switch reluctance motor, converters, closed loop control, choice of motor for particular application, application based control designing and simulation, design problems.

Text Books:

1. B.K. Bose, "Power Electronics and Motor Drives", Elsevier 2015.
2. H. Buyse and I.J. Robert, "Electrical machines and converters: Modeling and simulation", North Holland, digitized 2007.
3. R. Krishnan, " Electric Motor Drives Modeling Analysis and Control", Prentice -Hall of India2001.
4. P.S. Bhimra," Generalized Theory of Electrical Machines", Khanna Publisher.

Reference Books:

1. P.C. Sen, "Thyristor DC Drives", John Wiley & Sons 1981.
2. G. K. Dubey," Fundamental of Electrical Drives", CRC Press , 2002.
3. P.C. Krause, "Analysis of Electrical Machine", third edition IEEE Press John Wiley &Sons, 2013.
4. I. Boldea and S.A. Nasar," Electric Drive", second edition CRC 2006.

COURSE OUTCOMES:

At the end of the course, student must be able to,

1. **CO1:** Develop primitive mathematical model for machines, design the parameters of machines according to the frame of reference being considered.
2. **CO2:** Combine the concepts of previously learnt courses such as, electrical machines, control and power electronics to understand the need of drive in real-life scenarios.
3. **CO3:** Understand and apply the basic principles of power electronics in drives using switch-mode converters and different pulse width modulation techniques to synthesize the voltages in dc and ac motor drives.
4. **CO4:** Design, configure and justify new power conversion schemes for implementing alternative solutions considering the major issues.
5. **CO5:** Study and design and torque, speed and position controller of motor drives.

COURSE ASSESSMENT:

Students will be assessed on

(c) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.

(d) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALISATION - POWER ELECTRONICS)
SEMESTER-II (ELECTIVE-I)

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE-61701	Reliability Engineering	4	-	-	4	-	70	30	-	-	100

PRE- REQUISITE: Basic knowledge of Mathematics is required**.**

COURSE OBJECTIVES:

Following are the objective of the course:

1. Understand major concepts of reliability prediction.
2. Apply reliability theory to assessment of reliability in engineering design.
3. Be capable of applying the analytical skills in solving real life problems of engineering and science.
4. Explain the possible causes of poor reliability and suggest appropriate reliability tests and the associated failure analysis methods.
5. Modern simulation tools aiding in reliability analysis.

COURSE CONTENTS:

UNIT-1

Reliability definition, requirement, methods of enhancement. Reliability importance and allocation, concept of random variable, distribution functions. Distribution functions of function of a single random variable.

UNIT-2

Failure density function e.g. Exponential, Weibull, Normal, Hypoexponential, Hyper exponential etc. Hazard function, Reliability function and inter relationship, safety and reliability. Effect of Wear-in-period on reliability. Effect of preventive maintenance. Reliability evaluation with component replacement.

UNIT-3

Network methods of reliability evaluation. Event-space method, Decomposition method, Tie-set method and cut set method. Random number generators, Generation of random variants from failure distributions e.g. Exponential, Normal, Rayleigh etc. Montecarlo simulation based network reliability evaluation. Convergence using coefficient of variation and confidence intervals. Standby systems and load sharing systems. Multistate models.

UNIT-4

Markov modeling, state equations, MTTF calculations. Steady state and time dependent state probabilities. System availability and unavailability. Concept of frequency and durations. State enumeration method for frequency, MUT, MDT calculations.

UNIT-5

Load, capacity and reliability evaluation. Normal distribution of load and capacity. Estimation of parameters of failure laws e.g. exponential and normal.

Text Books:

1. R. Billinton, R. N. Allan, “Reliability evaluation of engineering system: concept and techniques”, second edition Springer US 1992.
2. C. E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill 2004.
3. E. E. Lewis, “Introduction to Reliability Engineering”, second edition Wiley 1995.

Reference Books:

1. David J. Smith, “Reliability, Maintainability and risk”, fourth edition Elsevier 2013.
2. Joel A. Nachlas, “Reliability Engineering: Probability Model and maintenance methods”, Taylor and Francis 2005.

COURSE OUTCOMES:

After completing the course, student will able to:

CO1: Demonstrate an understanding of the concepts of reliability engineering and various failure mechanisms.

CO2: Identify importance of statistical distributions for modelling failure data and the physical meanings of different parameters.

CO3: Evolve the efficacy to develop reliability models of complicated systems and be able to analyse and interpret the data to infer reliability indices from the data.

CO4: Estimate model mean time to failure and demonstrate an understanding of steady state and time-dependent probabilities.

CO5: Estimate reliability and parameters for failure laws from the test data.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALISATION - POWER ELECTRONICS)
SEMESTER-II (ELECTIVE-I)

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE61702	Measurement ,Instrumentation & Protection Of Power Electronics Equipments	4	-	-	4	-	70	30	-	-	100

PRE- REQUISITE: Basic knowledge of measurement & instrumentation.

COURSE OBJECTIVES:
Following are the objective of the course:
1. Develop the understanding of measuring instruments used for power electronics equipment.
2. Knowledge development about EMI and its effects on measuring instruments.
3. To develop the control skills applied on power electronics equipment.
4. To provide information related to faults on power electronics equipment.

COURSE CONTENTS:

UNIT:1
Elements of measuring instruments, Transducers and displays, recording instruments.

UNIT:2
FFT analyzer, Effect of non-sinusoidal waveforms on the measuring instruments, Transducers, cables, EMI and its measurement and effect on instrumentation. EMI improvements and compatibility.

UNIT:3
Enunciations in power electronics equipment's, Nature of faults and pronunciation techniques, recording of order of consequent faults.

UNIT:4
Control of power electronics equipments by the plant computer, Signal processing deadbands and resolutions, Process optimization, interfacing of control electronics with process computer, Electrical and optical communication.

UNIT:5
Faults on power electronics equipment's, Non-destructive and destructive faults. Electronics protection, Limitations and advantages. Fuses in power electronics, Characteristics, Selection and location of fuses. Circuit breakers, Types and selection, Methods of limiting the severity of faults, Surge protection.

Text Books:

1. C. M. Pauddar, "Semiconductor Power Electronics", Jain Brothers Publication, New Delhi first edition 1999.
2. D. Patranabis, "Instrumentation and control", PHI Learning Private Limited, New Delhi 2011.

Reference Books:

1. Badri Ram and D. N. Vishwakarma, "Power System Protection and Switchgear", second edition Tata McGraw-Hill Education, 2011.
2. Krishna Kant and Vineeta Agarwal, "Power Electronics", BPB Publications, 2005.

COURSE OUTCOMES:

After completing the course, student will able to:

CO1: Define and illustrate the role of different measuring instruments in power electronics.

CO2: Observe and analyze the effects of EMI on power electronics equipment.

CO3: Interface between control equipment with process computer.

CO4: Find the faults on power electronics equipment.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.

(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALISATION - POWER ELECTRONICS)
SEMESTER-II (ELECTIVE-I)

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE61703	Components in Power Electronics Equipments	4	-	-	4	-	70	30	-	-	100

PRE- REQUISITE: Basic knowledge of electronics, magnetics, and electrical components.

COURSE OBJECTIVES:
Following are the objective of the course:
1. Provide information about the different components used in power electronics equipment.
2. Develop the knowledge of magnetics applied in the different type of transformer.
3. Get familiar with various amplifier and oscillators.
4. Ability to develop component selection skill for given application.

COURSE CONTENTS:
UNIT:1
Devices - Power Switches, Characteristics, ratings, data sheets, trigger devices, different types of diodes, transistors, Ics, Driver circuits, interfacing with PCs. Microprocessors and microcontrollers, present status, capabilities, Peripheral Ics, Interfacing hardware, software introduction.

UNIT:2
Magnetics- Power transformers, high frequency power transformer, pulse Transformer, modeling performance, air cored and iron cored inductors, transformer sheets use of hanna curves, ferrites characteristics, transformers and inductors usually ferrites stray inductances.

UNIT:3
a) Capacitors, types, dielectrics, dielectric losses, high frequency operation, unipolar and bipolar capacitors.
b) Resistances, types, power resistors.
c) Laminates, PCBs, component lay out, SMDs, multi layer boards.
d) Transmission - Cables, wires, high frequency limitations, optical fiber, interfacing, terminal transducers.
e) Transducers for non electrical quantities such as pressure, temperature, flow etc.
f) Filters, passive filters, active filters, filter components.
g) EMI, effects, suppression, EMI compatibility noise.
h) Fuses, circuit breakers, coordination, surges and surge suppressors

UNIT:4
Review of electronic circuits such as amplifiers, oscillators, operational amplifiers, digital circuits oscillators, counters, A/D and D/A converters, Mixers, comparators, hysteresis, dead band. Power supplies, CVTs, linear and switches. Heat sinks-types, air, forced-air and water cooling.

UNIT:5

Component selection, specifying components, testing the components, burn in test. Reliability, Quality management, efficiency of heat removal, assessment of reliability.

Text Books:

1. N. Mohan, T. M. Undeland and W. P Robbins, "Power Electronics Converters, Applications and Design", third edition, John Wiley & Sons Inc, 2003.
2. M. H. Rashid, "Power Electronics Circuits, Devices and Application", third edition Pearson education 2009.
3. Joseph Vithayathil, "Power Electronics Principles and Applications", Tata McGraw Hill edition 2010.

Reference Books:

1. B. W. Williams, "Power Electronics, Devices Drivers and Application" Wiley New York 1987.
2. C. M. Pauddar, B. M. Singhi, "Elements of Power Electronics"", Jain Brothers, New Delhi, 2013.
3. J. P. Agrawal, "Power Electronics Systems – Theory and Design", Pearson Education, New Delhi, 2004.
4. Manufacturers Datasheets, Manuals and Catalogue.

COURSE OUTCOMES:

After completing the course, student will able to:

CO1: Illustrate different aspects related to components used in power electronics equipment.

CO2: Analyze magnetic properties of various types of transformer used in power electronics equipment.

CO3: Apply the knowledge of component used in power electronics equipment.

CO4: Design and develop the power electronic component based equipment.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALISATION - POWER ELECTRONICS)
SEMESTER-II (ELECTIVE-I)

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE61704	Computer Aided Power Electronics Analysis & Design	4	-	-	4	-	70	30	-	-	100

PRE - REQUISITE: Basic knowledge of power electronics and simulation tools.

COURSE OBJECTIVES:
Following are the objective of the course:
1. Develop the skill of simulation applied in power electronics.
2. Provide knowledge of different tools used for simulation work.
3. Understand the advance computation techniques used in simulation.
4. To develop the ability to know the practical aspect, this makes simulation real time.

COURSE CONTENTS:

UNIT:1
Introduction to Power Electronics simulation, Methods of analysis and formulation of system equation.

UNIT:2
Modelling of power electronics system element. Computer formulation of power electronics systems equation and state equations, Review of graph theory.

UNIT:3
Introduction to Pspice, Auto sec, Simulink for power electronics converter analysis. Introduction to design optimization, Sequential methods of simulation.

UNIT:4
Advance techniques for efficient computation, Creation of data files for power semi-conductors, magnetic and capacitors.

UNIT:5
Modelling of stray inductance, Capacitances and connections, Thermal modelling and heat flow design. Analysis under abnormal fault conditions and design of protection circuits.

Text Books:

1. Venkatachari Rajagopalan, “Computer-Aided Analysis of Power Electronic Systems”, CRC Press 1987.
2. B. K. Bose, “Modern Power Electronics and AC Drives”, Prentice Hall PTR, 2002.

Reference Books:

1. JMD Murphy & FG Turnbull, “Power Electronic Control of AC Motors”, Franklin Book Company, 1988.
2. Ferraz/ Prague/Siemens, Manufacturers Catalogue Rectifiers GE, West code/International.

COURSE OUTCOMES:

After completing the course, student will able to:

CO1: Develop the computer simulation of power electronics circuits.

CO2: Apply different modelling techniques used for the simulation work.

CO3: Use the knowledge of different software tools to develop simulation.

CO4: Examine and evaluate the effects of stray components, faults and their remedies.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.

(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALISATION - POWER ELECTRONICS)
SEMESTER-II (ELECTIVE-I)

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE61705	Neural Computing Systems and Applications	4	-	-	4	-	70	30	-	-	100

PRE- REQUISITE: Basic knowledge of algorithm development and optimization methods.

COURSE OBJECTIVES:
Following are the objective of the course:
1. To develop understanding of basic building block about neural computing.
2. To create ability to prepare algorithm used for neural computing.
3. To provide the knowledge of neural networks and their architecture.
4. To give the information about model development for artificial neuron.

COURSE CONTENTS:

UNIT:1

Introduction: Basic Model of Neuron, Characteristics, Neural Computing Structure and Functioning of Biological Brain & Neuron, Concept of learning/training, biasing effects in ANNS, Artificial Neuron model, Basic Specifications of Brain. Optimization theory of linear and non-linear functions, Gradient methods of optimization.

UNIT:2

Learning Methods and Architectures: Delta-rule for training, LMS Algorithm, Limitations of Perceptron network, Introduction of Hebb's Law and Oja's Rule, Multilayer networks and Training using Back Propagation Algorithm.

UNIT:3

Introduction to Implementation of Neural Networks: Simulation & Hardware applications, Causal Neural Networks, Probabilistic Neural networks and Adaptive Non-linear Networks.

UNIT:4

Hopfield Nets: Architecture, Energy functions, Growth Algorithms, Training Algorithms, Associative Memory and Short Term Memory, Genetic Algorithms.

UNIT:5

Model of an Artificial Neuron: Transfer functions, ADALINES, MADALINES, Taxonomies used in ANNS. Logistic, TAN- Hyperbolic, Sigmoid, Threshold, Ramp, Exponential Functions used in Neural networks.

Text books:

1. Philip D. Wasserman, "Neural computing: Theory and Practice", Van Nostrand Reinhold edition 1989.
2. Clifford Lau, "Neural Networks: Theoretical foundations and Analysis, IEEE Press edition 1987.
3. G. Hadley, "Nonlinear and Dynamic Programming", Addison-Wesley edition 1970.

Reference books:

1. B. Yegnanarayana, “Artificial Neural Networks”, Prentice-Hall of India edition 2009.
2. S. Haykin, “Neural Networks”, Pearson Education edition 1999.
3. Li Ming Fu, “Neural Networks in Computer Intelligence”, Tata McGraw Hill, India edition 2003.

COURSE OUTCOMES:

After completing the course, student will able to:

CO1: Define and illustrate the basic model of neuron, its structure, characteristic and functions.

CO2: Show the skills to develop different algorithms applied in neural computing.

CO3: Demonstrate and analyze rules used in neural computing applications.

CO4: Explain model development of artificial neuron based neural computing.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.

(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALISATION - POWER ELECTRONICS)
SEMESTER-II (ELECTIVE-I)

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE61706	HVDC Engineering	4	-	-	4	-	70	30	-	-	100

PRE- REQUISITE: Basic knowledge of power electronics and power system.

COURSE OBJECTIVES:
Following are the objective of the course:
1. To develop the understanding of basic converter used in HVDC transmission system.
2. To know the effects of harmonics on transmission system.
3. To create an understanding about the AC/DC system power flow methods.
4. To develop the design ability of HVDC system.

COURSE CONTENTS:

UNIT:1
Comparison of AC/DC transmission. Application of DC transmission. Examples of HVDC lines. Analysis of HVDC converter, Pulse No. Six and twelve pulse converter analysis. Relation for current and voltage.

UNIT:2
HVDC system control, Principles of DC link control, converter control characteristics. Firing angle control, System control hierarchy. Harmonics and filters, Generation of harmonics and elimination.

UNIT:3
AC/DC system load flow, system modeling, PU system unified and sequential methods of solution, reactive power requirement at converter bus.

UNIT:4
AC-DC system interactions, voltage interaction, dynamic voltage regulation, voltage instability, dynamic stability and power modulation. Harmonic, instability, torsional interactions with HVDC system.

UNIT:5
Fault modelling and analysis, over current characteristics of DC line, faults, detection of DC line faults, fault characteristics protection of DC line grounding. Main design aspects of HVDC transmission system. General requirements series/parallel arrangements of converters. Converter design. Converter transformer design aspects.

Text Books:

1. J. Arrillaga, “High Voltage Direct Current Transmission”, IET edition 1998.
2. J. Arrillaga and N. R. Watson “Computer Modeling of Electrical Power System” John Wiley edition 2001.

Reference Books:

1. K. R. Padiyar, “HVDC power transmission systems”, New Age International edition 1990.

2. E.W. Kimbark, “Direct Current Transmission”, Wiley Inter science edition 1971.

COURSE OUTCOMES:

After completing the course, student will able to:

CO1: Define and illustrate the role AC-DC and DC-AC converter in HVDC system.

CO2: Show the effects of various control methods and effects of harmonics.

CO3: Analyze the AC-DC system interactions in the context of HVDC system.

CO4: Examine and evaluate the design aspect of HVDC transmission system.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.

(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALISATION - POWER ELECTRONICS)
SEMESTER-II (ELECTIVE-I)

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE61707	Embedded System Programming	4	-	-	4	-	70	30	-	-	100

PRE- REQUISITE: C Programming, Basic Knowledge of Microprocessor and Microcontroller

COURSE OBJECTIVES:
Following are the objective of the course:
1. To explore programming aspects related to the microprocessor.
2. To identify time criticality and time constraints for process control.
3. To enhance knowledge of interfacing protocol and peripheral devices.
4. To explain architecture of real time operating system.

COURSE CONTENTS:

UNIT:1

Embedded System Hardware basics: Inputs (Sensors, A/D converters), Communication (RS232, RS485, USB, CAN, I^2C) Processing Units (MPU, MC, DSP, ARM, FPGA), Memories (RAM, ROM, Flash), Outputs (D/A converters, Display units)

UNIT:2

C programming for embedded systems and Data structures: Array, Link List, Stack, Queue and sorting algorithms (bubble, selection, insertion, merge, quick). Tool-chains for development and testing of software: host, target, linker, locator, loader and debugging.

UNIT:3

Software architecture for implementing various tasks: interrupts, interrupt latency, shared data problem, round robin with and without interrupts, Function Queue scheduling architecture, RTOS architecture

UNIT:4

Real time operating system: semaphores, shared data, operating system services: message queues, mailboxes, pipes, timer function, memory management, ISR in RTOS, scheduling in real time systems.

UNIT:5

Real time databases, access to remote object. Code optimization: code efficiency, code size and memory usage, saving power.

Text BOOKS:

1. David E. Simon, “An Embedded Software Primer”, Addison Wesley 1999.
2. Michael Barr, “Programming Embedded Systems in C and C++”, SPD & O’Reilly 1999.
3. Sundararajan Sriram and Shuvra Bhattacharyya, “Embedded Multiprocessor” Marcel Dekker Inc. New York 2000.

Reference Books:

1. Peter Marwedel, "Embedded System Design", second edition Springer Science & Business Media, 2010.
2. J. G. Ganssle, "The art of Programming Embedded Systems", Academic Press 1992.
3. Dr. Rajkamal, "Embedded Systems Architecture, Programming and Design" second edition Tata McGraw Hill 2008.

COURSE OUTCOMES:

After completing the course, student will able to:

CO1. Design interfacing schemes with peripheral devices

CO2. Evaluate the performance of the system under extreme working condition

CO3. Identify the role of the real time operating system for industrial automation

CO4. Optimize the software system for power, performance and memory size.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.

(b) The end-term theory examination weightage is 70%.

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALIZATION -POWER ELECTRONICS)
SEMESTER -II

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE-61851	LAB -III	-	-	4	-	4	-	-	40	60	100

COURSE OBJECTIVES:

- Exposure to emerging fields of power electronics.
- Understand the basics of conventional and emerging drive technology.
- Design, analyse and monitor performance parameters of various solid state controllers.

LIST OF EXPERIMENTS

1. Open loop and closed loop speed control of DC Shunt Motor with constant torque /variable torque load using Intelligent Power Module of DSPIC30F4011 Trainer Kit.

2. Hands on experience with installation, commissioning and operation on ready to use commercial DC drive (SIMOREG 6RA70 DC MASTER)

3. Hands on experience with installation, commissioning and operation on ready to use commercial 3 phase induction motor drive MICROMASTER 440.

4. Performance analysis of open loop Speed control of Permanent Magnet Brushless DC Motor (PMBLDC) using Intelligent Power Module and DSP TMS320 LF 2407/16 DSP Trainer Kit.

5. Performance analysis of closed loop speed control of Permanent Magnet Brushless DC Motor (PMBLDC) using Intelligent Power Module and DSP TMS320 LF 2407/16 DSP Trainer Kit

6. Performance analysis of Permanent Magnet Synchronous Motor (PMSM) drives using dSPACE1104 and Intelligent Power Module (IPM) and hall-effect position encoder.

7. Performance Analysis of Speed control of four phase Switched Reluctance Motor drive.

8. To study the operation of solar power generation and its uses.

    a. Draw the Voltage-Current (V-I) and Power-Voltage (P-V) characteristics of solar panel.

b. To study the operation of solar panel based battery charger and understand the principle of charge controller.

c. To analyse the performance of Single phase.

9. Minor Project (for the group of two students) based on any one topic

 Develop an algorithm for speed control using V/f control of a 3-phase squirrel cage induction motor. Implement the algorithm on a suitable digital controller platform for its real time implementation. Document the simulation and test results.

 Develop an algorithm for speed control using vector control of a 3-phase squirrel cage induction motor. Implement the algorithm on a suitable digital controller platform for its real time implementation. Document the simulation and test results.

 Develop an algorithm for speed control using vector control of a 3-phase permanent magnet synchronous motor. Implement the algorithm on a suitable digital controller platform for its real time implementation. Document the simulation and test results.

 Develop an algorithm for speed control of a 3-phase permanent magnet brushless DC motor. Implement the algorithm on a suitable digital controller platform for its real time implementation. Prepare document for the simulation and test results.

 Develop an algorithm for maximum power point tracking of solar photovoltaic panel. Implement the algorithm on a suitable digital controller platform for its real time implementation. Document the simulation and test results.

 Any other project based on emerging field of power electronics in consultation with course coordinator.

Note:
The project work comprises following activities

- literature survey
- Schematic diagram of the work
- Simulation model of the project
- Simulation result analysis and discussion
- Detailed design of the each component used in project including specifications of passive elements, semiconductor switches, heat sink design
- Prototype
- Experimental results and analysis
- Seminar
- Report writing

COURSE OUTCOMES:

Student will be able to

1. Experiments with and apply control to Electrical drives using various converter topologies and digital controllers.

2. Demonstrate, identify and list the operating parameters and the process of installation, commissioning and operation of ready to use commercial drives technology.
3. Apply professional quality textual and graphical presentations of laboratory data and computational results, incorporating accepted data analysis and synthesis methods, mathematical software, and word-processing tools.
4. Team-based laboratory activities for designing power electronics based solution for real life applications to demonstrate the creativity, ability to interact effectively on a social and interpersonal level, divide up and share task responsibilities to complete assignments.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through lab report assessments (10%), mid semester and end semester internal submissions (10%). It includes class attendance (5%) as well as report questions based on lab experiments (5%). The minor project will be submitted at the end of semester and its outcome will be assessed by an internal examiner (10%). Total (40% marks)

(b) The end-term practical examination. (The student is asked to perform the given laboratory task based on experimentation done during the semester. The student is allowed to perform experiment and take observation and justify the obtained results. The exam will be conducted by external and internal examiners. Total (60% marks)

M.E. FIRST YEAR ELECTRICAL ENGINEERING
(SPECIALIZATION -POWER ELECTRONICS)
SEMESTER -II

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE-61852	LAB -IV	-	-	4	-	4	-	-	40	60	100

COURSE OBJECTIVES:

1. Learn to verify the analytical designs of power electronic circuits through simulation.
2. Evolve from analytical designs to hardware designs through development of lab prototypes.
3. Get acquainted with basics of magnetics, PCB design and control circuitry design.

LIST OF EXPERIMENTS

1. Review of basic power electronic concepts through design and simulation of buck, boost and buck-boost converter.

2. Confirmation of analytical design of Cuk & Forward converter through simulation.

3. Understanding the concept of controller design through simulation of DC-DC buck converter in closed loop.

4. Controller design to deal with right half zero using buck-boost DC-DC converter.

5. Design of L-C parameters for ZCS switched DC-DC buck converter and verification of the design through simulation.

6. Design and simulation of two-stage power supply using AC-DC and DC-DC stages.

7. Generation of PWM waveforms for MOSFETS/IGBTs using IC SG3524.

8. Generation of PWM waveforms for MOSFETS/IGBTs using microcontroller 8015.

9. Design and testing of single winding inductor for power supply application.

10. Minor Project (for the group of two students)

MINOR PROJECT TOPICS

- Design and development of Fly-back converter for power supply applications.
- Design and development of Z-source DC-DC converter.
- Design and development of single phase H-bridge PWM inverter.
- Design and development of controlled rectifier for DC motor speed control.
- Any other project based on emerging field of power electronics in consultation with course coordinator.

Note:

The project work comprises following activities

- literature survey
- Schematic diagram of the work
- Simulation model of the project
- Simulation result analysis and discussion
- Detailed design of the each component used in project including specifications of passive elements, semiconductor switches, heat sink design
- Prototype
- Experimental results and analysis
- Seminar
- Report writing

COURSE OUTCOMES:

By the end of the course student will be able to,

CO1: Design the basic power electronic converter circuits theoretically and analyse the performance of the theoretical design through simulations.

CO2: Design controllers theoretically for closed loop systems and verify the performance specifications of the controllers through simulations.

CO3: Identify the design issues of the individual converter topologies and accordingly select applicable power electronics devices, identify and select control platform and perform magnetics design aiding to the development of the lab-prototype.

CO4: Discriminate between analytical and practical designs and construct lab-prototypes for basic power electronic converters while learning to deal with heating and protection issues.

COURSE ASSESSMENT:

Students will be assessed on

(a) Continuous evaluation through lab report assessments (10%), mid semester and end semester internal submissions (10%). It includes class attendance (5%) as well as report questions based on lab experiments (5%). The minor project will be submitted at the end of semester and its outcome will be assessed by an internal examiner (10%). Total (40% marks)

(b) The end-term practical examination. (The student is asked to perform the given laboratory task based on experimentation done during the semester. The student is allowed to perform experiment and take observation and justify the obtained results. The exam will be conducted by external and internal examiners. Total (60% marks)

M.E. FIRST YEAR ELECTRICAL ENGINEERING

(SPECIALIZATION - POWER ELECTRONICS)

SEMESTER-II

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
EE61881	Seminar	-	-	-	2	-	-	-	100	-	100

COURSE OUTCOMES:

CO1: Develop adequate technical presentation and documentation capabilities

CO2: Effectively lead a team while creating a collaborative and learning environment for other group members

CO3: Present their design and analytical capabilities through the use of real life/ industry oriented problems

CO4: Demonstrate their expertise and research orientation in solving practical problems.

CRITERIA & RUBRICS:

Maximum Marks: 100 Marks Passing Marks: 40 Marks

Student will be judged using following criteria and rubrics:

1. Technical Content – 30 Marks (CO1, CO2, CO3, CO4)
2. Presentation Capabilities – 20 Marks (CO1, CO2, CO3, CO4)
3. Knowledge – 20 Marks (CO1, CO2, CO3, CO4)
4. Documentation – 20 (CO1, CO2, CO3, CO4)
5. Confidence – 10 (CO1, CO2, CO3, CO4)