==========

SEMESTER 1

Course No.	Course Title	L-T-P-Credits
08EE6211	**APPLIED MATHEMATICS**	**3-0-0- 3**

***Course Objective**:* To enable the students apply calculus and optimization techniques in various electrical engineering problems.

Syllabus: Vector Calculus, Differential equations of higher order and fourier transforms, Complex Analysis- Analytic Functions, Optimization techniques

Expected outcome

Students will be able to apply calculus, higher order differential equations, complex functions and optimization techniques to the design and analysis of power electronic circuits.

References:

1. Advanced Engineering Mathematics " Erwin Kreyszig "Wiley.
2. Vector Calculus by" Thomas "and "Fienney" Addison Wesley.
3. Advanced Engineering Mathematics "Allen Jeffery "Academic Press Inc.
4. Advanced Engineering Mathematics "Dennis .G .Zill , "Warren .S . Right "Jones and Bartlett Publishers, Inc .
5. Operations Research by "Manmohan, P.K Gupta, Kanthi Swaroop" , Sultan Chand and sons Publishers

Course Plan

Module	*Contents*	*Contact Hours*	*% marks for semester exam*
I	**Vector Calculus:**Vector Spaces- Definition and Examples, Subspaces, Bases and Dimensions, Linear Transformations, Quotient Spaces, Direct Sum, The matrix of Linear Transformation, Duality. Canonical Forms: Eigen values and Eigenvectors, The minimal Polynomial, Diagonalisability, Triangular sable Operators, Jordan Forms, The Rational Forms. Vector Differential Calculus: Inner Product Spaces, Orthogonalty, The Adjoint of Linear Transformation, Unitary operators, Self Adjoint and Normal Operators, Polar and Singular Value Decomposition.	***8***	***15***

II	**Differential equations of higher order and fourier transforms :** Bernoulis linear equation, Homogenous equation with constant coefficient, cauchys equation ,Legranges linear equations ,Leibnitz higher order differential equation,	***7***	***15***
FIRST INTERNAL EXAM			
III	Fourier and transforms: Periodic functions, fourier series ,even and odd function, half range expansion, fourier integrals, fourier transforms-cosine and sine transforms.	***7***	***15***
IV	**Complex Analysis- Analytic Functions**: Cauchy-Riemann Equations, analyticity, harmonic functions. Power Series: Sequences, uniform convergence, Maclaurin and Taylor series, operations on power series. Complex Integration and Cauchy's Theorem: Curves, parameterizations ,line integral, Cauchy's Theorem. Applications of Cauchy's Theorem: Cauchy's integral formula, Cauchy's inequality and applications, maximum modulus theorem.	***8***	***15***
SECOND INTERNAL EXAM			
V	Laurent Series and Residue Theorem: Laurent series, classification of singularities, evaluation of real integrals, argument principle. Bilinear Transformations and Mappings: Basic mappings, linear fractional transformations, other mappings .Complex analysis applied to potential theory.	***8***	***20***
VI	**Optimization techniques :** Branch and bound method-Gomory's cutting plane method for integer and mixed integer programming- integer polynomial programming – sequential linear discrete programming and non linear programming-Nonlinear programming –Properties of single and multivariable functions Optimality criteria-Direct search methods-Gradient based methods-Newton's method-conjugate Gradient methods-Quasi-Newton Methods-DFP methods-Broyden-Fletcher-Golfarb-Shanno method	***8***	***20***

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits	
08EE6221	**SYSTEM DYNAMICS**	**3-0-0-3**	

Course Objective:

To enable the students analyze systems using state space model , understand the concept of stability and familiarize the optimal control problems.

Syllabus:

State variable representation continuous and discrete systems, Lyapunov stability analysis, controllers and observers, Optimal and Robust Control systems

Expected outcome

The students will be able to analyse and design the control problems.

References

1. Thomas Kailath, Linear systems, Prentice Hall Inc
2. K.Ogata, Modern control Engg (Second Edition), Prentice Hall Inc, 1990
3. K.Ogata, Discrete time control systems, P.H.I
4. M.Gopal, Digital Control and State Variable methods, TMH, 1997
5. M.Gopal, Modern Control System Theory
6. P.Kundur, Power System Stability and Control, McGraw-Hill Publishing Company, 1994
6. C.T.Chen, Linear system theory and design, New York,Holt Rinechart and Winston , 1984
7. Richard.C.Dorf and R.T Bishop, Modern Control System, P.H.I

Course Plan

Module	*Contents*	*Contact Hours*	*% marks for semester exam*
I	State variable representation of system - concept of state - Equilibrium points – Stability - Solution of state equation - eigen values - eigen vectors – modes - modal decomposition - eigen value and stability - mode shape – sensitivity - participation factor -	***8***	***15***
II	State space representation of discrete time systems - Discretization of continuous time state equation	***8***	***15***
FIRST INTERNAL EXAM			

III	Lyapunov stability - definition of stability, asymptotic stability and instability - Lyapunov's second method - Lyapunov's stability analysis of LTI continuous time and discrete time systems - stability analysis of non linear system - Krasovski's theorem - variable gradient method	***8***	***15***
IV	Concepts of controllability and observability - controllability and observability tests for continuous time and discrete time systems -controllability and observability studies based on canonical forms of state model -	***7***	***15***
SECOND INTERNAL EXAM			
V	Effect of state feedback on controllability and observability - pole placement by state feedback for continuous and discrete time systems - Design of full order and reduced order observer for continuous time and discrete time systems	8	***20***
VI	Optimal control - formulation of optimal control problem - Minimum time control problem -minimum energy problem - minimum fuel problem - state regulator problem - output regulator problem – tracking problem - choice of performance measure - optimal control based on quadratic performance measure – optimal control system design using second method Lyapunov - solution of reduced Riccatti equation. Robust control systems – introduction - sensitivity analysis of robustness - system with uncertain parameters - design of robust PID controlled systems.	***9***	***20***

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits
08EE6231	**ANALYSIS OF POWER ELECTRONIC CIRCUITS - I**	**4-0-0-4**

Course Objective:

To enable the students analyze the various power electronic circuits .

Syllabus:

Review of Power Devices, Controlled and uncontrolled rectifiers, DC to DC Converters, AC Voltage regulators and Cycloconverters

Expected outcome

The students will be able to design and analyze different power electronic circuits.

References

1. M.H. Rashid, Power Electronics Circuits, Design and Applications, Pearson Education
2. Mohan, Undeland, Robbins, Power Electronics, John Wiley and Sons
3. William Shepherd, Li Zhang, Power Converter Circuits, Marcel Decker
4. Prof. Ramnarayanan, Course Material on Switch Mode Power Conversion, Electrical Department, IISc, Bangalore
5. Philip T Krein, Elements of Power Electronics, Oxford
6. B K Bose, Modern Power Electronics and AC Drives, PHI
7. B W Williams, Principles and Elements of Power Electronics, University of Strathclyde Glasgow
8. Kazmierkowski, Krishnan, Blaabjerg, Control in Power Electronics, Academic Press
9. Issa Batarseh, Power Electronic Circuits, John Wiley
10. Bin WU, High Power Converters and AC drives, John Wiley
11. D Grahame Holmes, Thomas A Lipo, Pulse Width Modulation for Power Converters: Principles and Practice, IEEE Press
12. M H Rashid (Ed), Power Electronics Handbook, Academic Press

Course Plan

Module	*Contents*	*Hours*	*% marks for semester exam*
I	**Review of Power Devices** – characteristics of Ideal and practical switches – Power diodes – reverse recovery characteristics – power diode types – Diodes with RC,RL, LC and RLC loads –power transistors – power MOSFET – IGBT – Thyristor –	***9***	***15***

	GTO – IGCT – steady state characteristics & switching characteristics – two-transistor model of thyristor - di/dt and dv/dt protection- gate trigger circuits – R, RC & UJT triggering – commutation circuits – natural & forced commutation – class A,B,C,D,E,F commutation - comparison of power devices. **Uncontrolled rectifiers** – single-phase half-wave and full-wave bridge – performance parameters – FF, RF, TUF, DF, HF, input PF - single-phase full-wave bridge with RL load – 3-phase		
II	**Controlled rectifiers** – single-phase half converter and full converters – analysis with R & RL loads – DF, HF, input PF - 3-phase half-wave – full converters & semiconverters – analysis with R & RL loads – continuous conduction & discontinuous conduction – inversion mode - effect of source inductance on 1-phase & 3-phase full converters – overlap angle - single-phase dual converters – circulating & non circulating current operation.	***7***	***15***
FIRST INTERNAL EXAM			
III	**DC-DC converters** – Step-down chopper – step- up chopper - analysis with R & RL load –PWM, frequency modulation control – current limit control – fourier analysis of output voltage - two-quadrant & four-quadrant chopper – voltage commutated chopper – current commutated chopper - switching-mode regulators – buck, boost, buck-boost and cuk regulators – condition for continuous inductor current and capacitor voltage - design of LC filter – comparison of regulators	***7***	***15***
IV	**AC voltage controllers** – ON-OFF control – phase control – 1-phase full wave – analysis with R & RL load – input PF – two stage sequence control with R & RL load – 3-phase full-wave controller with R load – 3-phase bidirectional delta connected controllers	***7***	***15***
SECOND INTERNAL EXAM			
V	**Cycloconverter** – single-phase to single-phase cycloconverter with R & RL load - 3-phase to 1-phase cycloconverter – 3-phase to 3-phase cycloconverter - thyristor-controlled reactor (TCR) -	***7***	***20***

	thyristor-switched capacitor (TSC)		
VI	**Inverters –** 1-phase half bridge and full bridge – HF, THD, DF – 3-phase inverter - 180^o and 120^o conduction – Analysis with R & RL load – PWM techniques – single pulse, multiple pulse & sinusoidal pulse width modulation – modulation index – voltage control of 3-phase inverters – sine PWM – harmonic reduction – bipolar & unipolar modulation – current source inverter – 1-phase & 3-phase – Variable DC link inverter – boost inverter.	***8***	***20***
Internal continuous assessment: 40 marks Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher. **End semester Examination: 60 marks**			

Course No.	**Course Name**	**L-T-P-Credits**
08EE6241	**ELECTRIC DRIVES**	**3-0-0-3**

Course Objective*:*

To provide fundamental concepts about torque speed and stability relation and methods of speed control of different electrical machines

.

Syllabus:

Introduction to electrical drives, DC Drives and its control, Induction motor and synchronous motor drives and their control.

Expected outcome

The students will be able to analyse the torque ,speed and stability relations and speed control of different electric drives

References

1. R. Krishnan, Electical Motor Drives, PHI

2 GK Dubey, Fundamentals of Electrical Drives, Narosa

3. GK Dubey, Power Semi-conductor Controlled Drives, Prentice Hall

4. Bimal K Bose, Modern Power Electronics &AC Drives, PHI

5. S A Nasar, Boldea, Electrical Drives, CRC press
6. M A Elsharkawi, Fundamentals of Electrical Drives, Thomson Learning
7. W Leohnard, Control of Electric Drives, Springer
8. Murphy and Turnbill, Power Electronic Control of AC motors, Pergamon Press
9. Vedam Subarhmanian, Electric Drives, TMH

Course Plan

Module	***Contents***	***Hours***	***% marks for semester exam***
I	Components of electrical Drives – electric machines, power converter, controllers - dynamics of electric drive - torque equation - equivalent values of drive parameters- components of load torques types of load - four quadrant operation of a motor — steady state stability - load equalization – classes of motor duty- determination of motor rating	***8***	***15***
II	DC motor drives – dc motors &their performance (shunt, series, compound, permanent magnet motor, universal motor, dc servomotor) – braking – regenerative, dynamic braking, plugging – Transient analysis of separately excited motor – converter control of dc motors – analysis of separately excited &series motor with 1-phase and 3-phase converters – dual converter.	***7***	***15***
FIRST INTERNAL EXAM			
III	Analysis of chopper controlled dc drives – converter ratings and closed loop control - transfer function of self, separately excited DC motors – linear transfer function model of power converters – sensing and feeds back elements – current and speed loops, P, PI and PID controllers – response comparison – simulation of converter and chopper fed DC drive.	***8***	***15***
IV	Induction motor drives – stator voltage control of induction motor – torque-slip characteristics –operation with different types of loads – operation with unbalanced source voltages and single phasing –analysis of induction	***8***	***15***

	motor fed from non-sinusoidal voltage supply – stator frequency control – variable frequency operation – V/F control, controlled current and controlled slip operation.		
SECOND INTERNAL EXAM			
IV	Effect of harmonics and control of harmonics – PWM inverter drives – multi-quadrant drives – rotor resistance control – slip torque characteristic – torque equations, constant torque operation – slip power recovery scheme – torque equation – torque slip characteristics – power factor – methods of improving power factor –limited sub synchronous speed operation – super synchronous speed operation	***8***	***20***
V	Synchronous motor drives – speed control of synchronous motors – adjustable frequency operation of synchronous motors – principles of synchronous motor control – voltage source inverter drive with open loop control – self controlled synchronous motor with electronic commutation – self controlled synchronous motor drive using load commutated thyristor inverter.	***9***	***20***

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits
08GN6001	**RESEARCH METHODOLOGY**	**0-2-0-2**

Course Objectives

The main objective of the course is to provide a familiarization with research methodology and to induct the student into the overall research process and methodologies. This course addresses:

The scientific research process and the various steps involved formulation of research problem and research design, design of experiments,
thesis preparation and presentation,

research proposals, publications and ethics;
Important research methods in engineering

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role.

Syllabus:

Overview of research methodology - research process - scientific methods - research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences

Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modelling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis

Course Outcome

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

- Discuss research methodology concepts, research problems, research designs, thesis preparations, publications and research methods.
- Analyze and evaluate research works and to formulate a research problem to pursue research
- Prepare a thesis or a technical paper, and present or publish them
- Apply the various research methods followed in engineering research for formulation and design of own research problems and to utilize them in their research project.

References

1. C. R. Kothari, (2004) "*Research Methodology, Methods and Techniques"*, New Age International Publishers
2. R. Panneerselvam,(2014) *"Research Methodology"*, PHI Learning
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, M. Mathirajan, (2006)) "*Management Research Methodology, Integration of principles", Methods and Techniques*, Pearson Education
4. Deepak Chawla, Meena Sondhi,(2011) "*Research Methodology – concepts & cases"*, Vikas Publishing House
5. J.W Bames, *"Statistical Analysis for Engineers and Scientists"*, McGraw Hill, New York
6. Schank Fr.,(2008) "*Theories of Engineering Experiments"*, Tata Mc Graw Hill Publication.
7. John W Best, James V Kahan, (2010) "*Research in Education"*, PHI Learning
8. Sinha, S.C. and Dhiman, A.K. (2002), "*Research Methodology"*, ESS Publications. (2 volumes)

Course Plan			
Module	***Contents***	***Hours***	***% marks for semester exam***
I	**Overview of Research Methodology** Research concepts – meaning – objectives – motivation -types of research –research process – criteria for good research – problems encountered by Indian researchers - scientific method - research design process – decisional	***5***	***15***
II	**Research Problem and Design** Formulation of research task – literature review – methods – primary and secondary sources – web as a source – browsing tools -formulation of research problems – exploration - hypothesis generation – problem solving approaches- introduction to TRIZ (TIPS) experimental research – principles - Laboratory experiment - experimental designs - ex post facto research - qualitative research.	***5***	***15***
FIRST INTERNAL EXAM			
III	**Thesis writing, reporting and presentation** Interpretation and report writing– techniques of interpretation – precautions in interpretation – significance of report writing – principles of thesis writing- format of reporting - different steps in report writing – layout and mechanics of research report - references – tables – figures – conclusions - oral presentation – preparation - making presentation – use of visual aids - effective communication - preparation for and presentation in seminars and conferences	***4***	***15***
IV	**Research proposals, publications, ethics and IPR** Research proposals - development and evaluation – research paper writing – layout of a research paper - journals in engineering – considerations in publishing – scientometry -impact factor- other indexing like h-index citations - open access publication - ethical issues - plagiarism – software for plagiarism checking- intellectual property right- patenting case studies .	***5***	***15***

SECOND INTERNAL EXAM			
V	**Research methods – Modelling and Simulation** Modelling and Simulation – concepts of modelling – mathematical modelling - composite modelling – modelling with – ordinary differential equations – partial differential equations – graphs-heuristics and heuristic optimization - simulation modeling.	***5***	***20***
VI	**Research Methods – Measurement, sampling and Data acquisition** Measurement design – errors -validity and reliability in measurement - scaling and scale construction - sample design - sample size determination - sampling errors - data collection procedures - sources of data - data collection methods - data preparation and data analysis	***4***	***20***
Internal continuous assessment: 40 marks Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher. **End semester Examination: 60 marks**			

EPE10 105: ELECTIVE

Course No.	Course Name	L-T-P-Credits
08EE6251 (A)	**POWER SEMICONDUCTOR DEVICES & MODELING**	**3-0-0-3**

Course Objective:
The purpose is to make students cognizant of the intricacies of common power semiconductor devices in their devices in their device physics and operation.

Syllabus:
Power switching devices, Current Controlled Devices, Voltage Controlled Devices, Firing and Protection Circuits, Thermal Protection

Expected outcome
The students will be able to analyse the device physics and operation of various power semiconductor devices and also the new developments in this area.

References

1.MohanUndeland,Robins,'Power Electronics-concepts,applications and design',John Wiley and sons
2.M D Singh,K K Khanchandani,'Power Electronics,Tata McGraw Hill
3.B W Williams ,'Principles and elements of Power Electronics',University of Strathclyde'Glasgow
4.Kassakian JG etal.,'Principles of Power Electronics',Addison Wesley

Course Plan

Module	***Contents***	***Hours***	***% marks for semester exam***
I	Power switching devices overview- Relevance of switches and high frequency in converters-symbols-attributes and application requirements of power switches Power handling capability- SOA- Strategy of device selection-On state and switching losses – EMI due to switching- Conduction in semiconductors- drift-diffusion-Energy gap in semiconductors – Significance and application of static and dynamic characteristics-Failure of signal diode for high power applications	***7***	***15***
II	Significance of n- layer in a diode – Power diode-Construction- Static and dynamic characteristics Current controlled devices- BJTs- Construction- device physics- Static and dynamic characteristics- Vcbo and Vceo – Negative temperature coefficient and secondary breakdown – Power darlington – Increase of β – Construction	***8***	***15***
FIRST INTERNAL EXAM			
III	SCR- Construction and device physics – 2 transistor analogy- gate and switching characteristics Converter grade and inverter grade – series and parallel operation- Comparison of BJT and thyristor- Steady state and dynamic models of BJT and thyristor	***7***	***15***
IV	Voltage controlled devices- power MOSFETs and IGBTs-Principle of voltage controlled devices-construction-types-device physics-static and switching characteristics-steady state and dynamic models of MOSFETs and IGBTs	***8***	***15***

	Basics of GTO,MCT,FCT,RCT and IGCT		
SECOND INTERNAL EXAM			
V	Firing and protection circuits-necessity of isolation-pulse transformers-optocoupler-gate drive circuit: SCR,MOSFET,IGBT and base driving for power BJT-over voltage ,overcurrent and gate protection-design of snubbers and magnetic circuits.	***8***	***20***
VI	Thermal protection-Heat transfer-conduction-convection-radiation-liquid cooling-vapour phase cooling-guidance for heat sink selection-thermal resistance and impedance-electrical analogy of thermal components-Heat sink types and design-mounting types	***8***	***20***
Internal continuous assessment: 40 marks Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher. **End semester Examination: 60 marks**			

Course No.	**Course Name**	**L-T-P-Credits**
08EE6251(B)	**DYNAMICS OF ELECTRICAL MACHINES**	**3-0-0-3**

Course Objective

To make the students aware of the generalized modeling and analysis of different electrical machines used for industrial drive applications..

Syllabus:

Introduction to the analysis of electrical machines .Modelling of DC , induction and synchronous machines

Expected outcome

The students will be able to model and analyze different electrical machines used for industrial drive applications.

References

1. PS. Bhimbra, Generalized Theory of Electrical Machines, Khanna Publishers
2. Krauss, Wasyncsuk and Sudholf, Analysis of Electrical Machines and Drive Systems, John Wiley
3. A E Fitzgerald, Kingsley, Umans, Electric Machinery, McGraw Hill
4. Adkins and Harey, General Theory of AC Machines
5. Bimal K Bose, Modern Power Electronics &AC Drives, Pearson Education

Course Plan

Module	*Contents*	*Hours*	*% marks for semester exam*
I	Introduction – Unified approach to the analysis of electrical machine – basic two-pole machine – Kron's primitive machine – voltage, power and torque equation – linear transformation from 3-phase to 2-phase - transformation from rotating axes to stationary axes – power invariance –.	***9***	***15***
II	Park's transformation for 3-phase synchronous and induction machines. DC machines – application of generalized theory to separately excited, shunt, series and compound machines	***7***	***15***
FIRST INTERNAL EXAM			
III	Sudden short circuit of separately excited generator - separately excited dc motor - steady state and transient analysis – transfer functions of separately excited dc generator &motor..	***8***	***15***
IV	Polyphase synchronous machines – generalized machine equations – steady state analysis of salient pole and non salient pole machines – phasor diagrams – power angle characteristics – reactive power – short circuit ratio transient analysis – sudden 3-phase short circuit at generator terminals – reactance – time constants – transient power angle characteristics.	***8***	***15***
SECOND INTERNAL EXAM			

V	Induction machines – 3-phase induction machine-generalized model – voltage equation – steady state analysis – equivalent circuit – torque-slip characteristics – effect of voltage and frequency variations – electric transients in induction machines	***8***	***20***
VI	speed control of induction motor – introduction to vector control – applications in speed control of induction machine – single phase induction motor – generalized model – voltage and torque equations – steady state analysis.	***8***	***20***

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits
08EE6251(C)	**OPTIMIZATION TECHNIQUES**	**3-0-0-3**

Course Objective:

To enable the students apply different optimization techniques to both linear and non-linear systems.

Syllabus:

Linear programming, Unconstrained dimensional optimization techniques, Constrained optimization techniques & dynamic programming, Recent developments in optimization techniques

Expected outcome

The students will be able to apply different optimization techniques to both linear and non linear systems.

References

1. Rao S.S, Optimisation:Theory and Application, Wiley Eastern Press
2. Pierre, D.A., Optimisation, Theory with Applications, John Wiley & Sons
3. Fox, R.L., Optimisation method for Engineering Design, Addition Wesley

4. Hadely,G., Linear Programming, Addition Wesley
5. Bazaara & Shetty, 'Non-linear Programming'
6. D.E. Goldberg, Genetic Algorithm in Search, Optimization, and Machine Learning, Addison-Wesly, 1989.
7. Marco Dorigo, Vittorio Miniezza and Alberto Colorni, "Ant System:Optimization by a colony of Cooperation Agent", IEEE transaction on system man and Cybernetics-Part B:cybernetics, Volume 26, No 1, pp. 29-41,1996.
8. Shi, Y. Eberhart, R.C., "A Modified Particle Swarm Optimizer", Proceedings of the IEEE International conference on Evolutionary Computation, Anchorage, AK, pp. 69-73, May 1998
9. Recent literature should also be referred

Course Plan

Module	*Contents*	*Hours*	*% marks for semester exam*
I	**Linear programming:** Statement and classification of optimization problems overview of optimization techniques standard form of linear programming problems-Definitions and theorems-Simplex method-Revised simplex method-Duality and Dual simplex method-Sensitivity analysis.	***8***	***15***
II	**Unconstrained dimensional optimization techniques**: Necessary and sufficient conditions-search methods(unrestricted Fibonacci and golden)-Interpolation methods(Quadratic, Cubic and direct root method).	***7***	***15***
	FIRST INTERNAL EXAM		
III	**Direct search methods**-Random search-pattern search and Rosen Brock's hill climbing method-**Descent methods**-Steepest descent, conjugate gradient, Quasi Newton and DFE method.	***7***	***15***
IV	**Constrained optimization techniques & dynamic programming:** Necessary and sufficient conditions-Equality and inequality constraints-Kuhn-Tacker conditions-Gradient projection method-cutting plane method-	***7***	***15***
	SECOND INTERNAL EXAM		
V	Penalty function method(Interior and exterior).Principle of optimality-recurrence relation-Computation procedure-continuous dynamic programming.	***7***	***20***

VI	**Recent developments in optimization techniques:** Rosenbrocks Rotating Coordinate Method-Tabu search-Simulated Annealing-Genetic Algorithm-Particle Swarm Optimization –Ant colony Optimization-Bees Algorithm.	*8*	*20*

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits
08EE6251 (D)	**HIGH VOLTAGE DC AND AC TRANSMISSION**	**3-0-0-3**

Course Objective:

To give the students an in depth knowledge of the configuration and working of HVDC & AC systems .

Syllabus:

General Aspects, Converter circuits and analysis, Bridge converters-Analysis, Control, Protection and Harmonics Filters, Lightning, Travelling waves and switching Transients, Protective device in HVAC transmission, Interaction between AC & dc System

Expected outcome

The students will be able to analyse the configuration and working of HVDC and AC systems

References

1. Kimbark,E.W., Direct current transmission-Vol.1, Wiley Interscience, New York, 1971
2. Arrilaga,J., High Voltage Direct current transmission, Peter Pereginver Ltd., London,UK.
3. Allen Greenwood, Electrical Transients in power system, Wiley Interscience
4. Diesendorf,W., Overvoltage on High voltage system, Rensselaer Book store ,Troy, New York,1971
5. Klaus Ragallea, Surges and high voltage networks, Plenum Press
6. Padiyar,K.R., HVDC Transmission system, Wiley Eastern Limited, NewDelhi
7. R.D.Begamudre, High Voltage Engineering, New Age International Publishers

Course Plan

Module	*Contents*	*Hours*	*% marks for semester exam*
I	**General Aspects, Converter circuits and analysis**: HVDC links - comparison –Economic, Technical	*8*	*15*

	performance – Reliability – Limitations - Properties of thyristor converter circuits- assumptions-Choice of best circuit for HVDC converters-Transformer connections - Analysis with gate control but no overlap less than 60 degrees- operation of inverters		
II	**Bridge converters-Analysis, Control, Protection and Harmonics Filters:** Converter Inverter circuits for HVDC Transmission-basic means of control –Power reversal-desired features of control – actual control characteristics. Converter disturbance –bypass action in bridges- commutation failure-basics of protection-	***8***	***15***
FIRST INTERNAL EXAM			
III	DC Reactors-Voltage and current oscillations-Circuit breakers - Over voltage protection-Characteristics and uncharacteristic harmonics-troubles due to harmonics-harmonic filters-Converter charts of direct current and voltage- active and reactive power.	***7***	***15***
IV	**Lightning, Travelling waves and switching Transients**: Mathematical model to represent lightning-Travelling wave in transmission lines-Circuits with distributed constants- Wave equations- Reflection and Refraction of travelling waves-Travelling waves at different line terminations-effect of short length of cables- Shape and attenuation and distortion of travelling waves-	***8***	***15***
SECOND INTERNAL EXAM			
V	Selection of typical wave to represent over voltages-Switching transients- the circuit closing transient-the recovery transient initiated by the removal of the short circuit – Double frequency transients- Abnormal switching transients- Current suppression- capacitance switching- Arcing ground-Transformer inrush current – Ferro resonance- neutral connections- Transients in switching a three phase reactor –Three phase capacitor	***8***	***20***
VI	**Protective device in HVAC transmission, Interaction between AC & dc System**: Basic ideas about protection – surge diverters- surge absorbers- ground fault neutralizers- Protection of lines and stations by shielding- Ground wires – counter poises-Driven rods-Modern lightning arrestors- Insulation co ordination-Protection of alternators- Industrial drive system. Interaction between AC & DC systems- Voltage interaction-Harmonic instabilities- Smoothing Reactors – Overhead lines – Cable Transmission-Earth Electrodes-Design of back to back thyristor convertor	***9***	***20***

	system.		

Course No.	Course Name	L-T-P-Credits
08EE6271	**SEMINAR**	**0-0-2-2**

Course Objective:

To assess the debating capability of the student to present a technical topic. Also to impart training to a student to face audience and present his ideas and thus creating in him self esteem and courage that are essential for an engineer.

Expected outcome

The students will develop an ability to give oral presentation related to a technical topic and also to write technical documents**.**

Individual students are required to choose a topic of their interest from power electronics and drive related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in power electronics) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Internal continuous assessment: 100 marks

Course No.	Course Name	L-T-P-Credits
08EE6281 (P)	**POWER ELECTRONICS LABORATORY**	**0-0-2-2**

Course Objective:

To provide practical knowledge through hardware implementation & simulation of power electronic circuits

Expected outcome

The students will be able to design, simulate and implement different power electronic circuits.

LIST OF EXPERIMENTS

A) HARDWARE

1. Single Phase Semi-converter with R-L load for continuous & discontinuous conduction modes
2. Single Phase Full-converter with R-L load for continuous & discontinuous conduction modes
3. Controlled and Uncontrolled rectifier with different types of filters - continuous & discontinuous modes of operation
4. Transformer and Inductor design
5. Transfer function of armature controlled DC Motor
6. Single Phase AC Voltage Controller
7. Digital firing circuit
8. Three Phase Full-converter with R-L-E load
9. Current & voltage commutated thyristorized chopper
10. Study of harmonic pollution by power electronics loads using power quality analyser

B) SIMULATION

1. 3-phase full converter and semi-converter with R, RL and RLE loads
2. 3-phase ac voltage controller
3. Closed loop control of DC-DC converter
4. 3-phase sine PWM inverter
5. Measurement of THD of current & voltage waveforms of controlled & uncontrolled 3-phase rectifiers.

Out of the above, a minimum of SIX hardware experiments and FOUR simulation experiments are to be conducted. Simulation can be done using any of the software packages like MATLAB/SIMULINK, PSPICE, PSCAD etc.

Internal continuous assessment: 100 marks

a. Regularity – 30%

b. Record – 20%

c. Test and Viva – 50%