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SEMESTER II

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Course No.	Course Name	L-T-P-Credits
08EE6212	ANALYSIS OF POWER ELECTRONIC CIRCUITS - II	3-0-0-3
Course Objective: <i>To provide a strong foundation to the students on advanced converter techniques and their control in modern Power Electronic Systems.</i>		
Syllabus: <i>PWM strategies for Inverters, Multilevel inverters, Different control Methods, current control , Z-source inverters, PWM Voltage Source Inverters, Matrix converter.</i>		

Expected outcome

The students will be able to analyze and apply advanced converter techniques and their control in modern power electronic systems.

References

1. Fang Lin Luo & Hong Ye, *Power Electronics, Advanced Conversion Technologies*, CRC Press
2. Branko L Dokic & Branko Blanus, *Power Electronics, Converters and Regulators*, Springer
3. Barry Williams, *Principles and Elements of Power Electronics*, University of Strathclyde
4. Muhammad H. Rashid, *Power Electronics Circuits, Design and Applications*, Pearson Education
5. Muhammad H Rashid (Ed), *Power Electronics Handbook*, Academic Press
6. William Shepherd & Li Zhang, *Power Converter Circuits*, Marcel Dekker Inc

Course Plan

<i>Module</i>	<i>Contents</i>	<i>Hours</i>	<i>% marks for semester exam</i>
<i>I</i>	PWM Strategies for Inverters - Review of Sinusoidal PWM – Trapezoidal modulation, staircase modulation, stepped modulation, harmonic injected modulation, delta modulation – Third harmonic PWM - Space Vector Modulation – concept of space vector - space vector switching - over modulation	<i>8</i>	<i>15</i>
<i>II</i>	Power factor improvement of rectifier circuits – Extinction angle control, symmetric angle control, PWM control - 1-phase sinusoidal PWM, 3-phase PWM rectifier -	<i>7</i>	<i>15</i>
FIRST INTERNAL EXAM			
<i>III</i>	1-phase series converters – semi converters & full converters – Twelve-pulse converter Z-source inverter – equivalent circuit & operation – shoot-through zero state – modified carrier based PWM inverter with shoot-through zero state – modulation index and boost factor [1]	<i>8</i>	<i>15</i>

IV	Multilevel inverters – Diode-clamped multilevel inverter – improved diode-clamped inverter - Flying-capacitors multilevel inverter – cascaded multilevel inverter – PWM for multilevel inverters - comparison	7	15
SECOND INTERNAL EXAM			
V	Current Regulated PWM Voltage Source Inverters - Methods of Current Control, hysteresis Control-hysteresis current controller used in specific application- Variable Band Hysteresis Control, Fixed Switching Frequency Current Control Methods	8	20
VI	Matrix converter – principle – matrix converter switches - 3-phase matrix converter – switching control strategy - Venturini control method – principle – switching duty cycles –modulation matrix – realization of input filter - commutation and protection issues in matrix converter	8	20
<p>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.</p> <p>End semester Examination: 60 marks Question pattern Answer any 5 questions by choosing at least one question from each module.</p>			

Course No.	Course Name	L-T-P-Credits
08EE6222	SWITCHED MODE POWER CONVERTERS	3-0-0-3
<p>Course Objective: To acquaint the students with working, analysis and modelling of different types of converters.</p>		
<p>Syllabus: Review of Buck, Boost, Buck-Boost topologies, Flyback converters, Voltage and current mode control of SMPS, Modelling of SMPS, Resonant converters.</p>		

<i>Expected outcome</i> The Students will be able to analyse, design and model different types of converters.			
<i>References</i> 1 Ned Mohan, Power Electronics: Converters, Applications And Design , John Wiley & Sons 2 Abraham I Pressman , Switching Power Supply Design , McGraw-Hill Publishing Company 3 R. W. Erickson , Fundamental of Power Electronics , Chapman & Hall Publishers 4 William Shepherd, Li Zhang, Power Converter Circuits, CRC Taylor Francis			
<i>Course Plan</i>			
<i>Module</i>	<i>Contents</i>	<i>Hours</i>	<i>% marks for semester exam</i>
<i>I</i>	Review of Buck, Boost, Buck-Boost topologies - basic operation – Waveforms - modes of operation - voltage mode control principles. Push-pull and Forward converter - basic operation – waveforms - modes of operation – Transformer design - voltage mode control principles.	<i>7</i>	<i>15</i>
<i>II</i>	Half and Full Bridge Converters - basic operation – waveforms - modes of operation -voltage mode control principles. Fly back Converter - basic operation – waveforms - modes of operation - voltage mode control principles.	<i>7</i>	<i>15</i>
FIRST INTERNAL EXAM			
<i>III</i>	Voltage Mode Control of SMPS - Loop gain and Stability Considerations - Shaping the Error Amplifier gain versus frequency characteristics - Error amplifier Transfer function – Transconductance Error amplifiers. Current Mode Control of SMPS – Current Mode Control Advantages - Current Mode versus Voltage Mode Control of SMPS – Current Mode Deficiencies - Slope Compensation.	<i>9</i>	<i>15</i>

IV	Modelling of SMPS - Basic AC modelling Approach – Modelling of non ideal fly back converter -State Space Averaging – basic state space averaged model	7	15
SECOND INTERNAL EXAM			
V	State space averaging of non ideal buckboost converter - Circuit averaging and averaged switch modelling – Modeling of pulse width modulator	7	20
VI	Introduction to Resonant Converters – Classification of Resonant Converters – Basic Resonant circuit concepts – load resonant converters – resonant switch converters – Zero voltage switching, clamped voltage topologies – resonant DC Link inverters with zero voltage switching – High frequency link integral half cycle converter	8	20

Course No.	Course Name	L-T-P-Credits
08EE6232	ADVANCED ELECTRIC DRIVES	3-0-0-3
<i>Course Objective:</i> <i>To provide the students the knowledge of fundamental concepts in modeling and control schemes used in advanced AC drives systems</i>		
<i>Syllabus:</i> Modeling of Induction machines, different control methods of induction motors, Permanent magnet synchronous and brushless DC motor drives.		
<i>Expected outcome</i> The students will be able to analyse, design and model AC drive systems and the various control schemes.		
<i>References</i> <ol style="list-style-type: none"> 1. R Krishnan, Electric Motor Drives, PHI 2. D W Novotny and T A Lipo, Vector Control and Dynamics of AC Drives, Oxford University Press 3. B K Bose, Modern Power Electronics and AC Drives, PHI 4. Leonhard, Control of Electric Drives, Springer 5. Kazmierkowski, Krishnan, Blaabjerg, Control in Power Electronics-Selected Problems, 		

Academic Press

6. John Chiasson, Modeling and High Performance Control of Electric Machines, Wiley-IEEE Press

7. I Boldea, S A Nasar, Electric Drives, CRC Press

8. K Rajashekara, Sensorless Control of AC motors, IEEE Press

9. I Boldea, S A Nasar, Vector Control of AC Drives, CRC Press

10. J Holtz, Sensorless Control of Induction Motor Drives, Proceedings of the IEEE, August 2002, PP 1359-1394.

Course Plan

<i>Module</i>	<i>Contents</i>	<i>Hours</i>	<i>% marks for semester exam</i>
<i>I</i>	Modeling - Dynamic modeling of induction machines – 3-phase to 2-phase transformation – power equivalence – generalized model in arbitrary reference frame – electromagnetic torque – derivation of stator reference frame model, rotor reference frame model, synchronously rotating reference frame model – equations in flux linkages - dynamic d-q model of synchronous machines.	<i>9</i>	<i>15</i>
<i>II</i>	Vector Control - Vector controlled induction motor drive – Principle of vector or field oriented control– direct rotor flux oriented vector control – estimation of rotor flux and torque– implementation with current source and voltage source inverters - Stator flux oriented vector control - Indirect rotor flux oriented vector control scheme - implementation – tuning - Dynamic simulation -	<i>7</i>	<i>15</i>
FIRST INTERNAL EXAM			
<i>III</i>	Parameter sensitivity and compensation of vector controlled induction motors - Selection of Flux level - Flux weakening operation - Speed controller design – simulation of vector control of induction motor using MATLAB/SIMULINK.	<i>5</i>	<i>15</i>
<i>IV</i>	Doubly-fed machine speed control by rotor rheostat – static kramer drive – phasor diagram, equivalent –speed control – power factor improvement – Static Scherbius drive – Modes of operation –	<i>6</i>	<i>15</i>

SECOND INTERNAL EXAM			
V	Direct torque control of induction motor – principle – control strategy – space vector modulation – reduction of torque and flux ripple – comparison of DTC and FOC – simulation of DTC of induction motor using MATLAB/SIMULINK	8	20
VI	Permanent magnet synchronous and brushless DC motor drives – types of permanent magnet synchronous machines – Vector control of PM synchronous machine – model of PMSM – Vector control – control strategies – constant torque-angle control, unity power factor control, constant mutual flux-linkages control, optimum torque per ampere control, flux weakening operation, direct flux weakening algorithm, speed-controlled PMSM drive sensorless PMSM drive – PM brushless DC motor – modeling – drive scheme – Switched reluctance motor drives.	9	20
<p>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.</p> <p>End semester Examination: 60 marks</p>			

ELECTIVE II

Course No.	Course Name	L-T-P-Credits
08EE6242(A)	FACTS AND CUSTOM POWER DEVICES	3-0-0-3

Course Objective:

To impart knowledge about the operation, control and application of different FACTS devices and custom power devices.

Syllabus:

FACTS concepts and controllers, Static Shunt and Series Compensators, UPFC and IPFC, Power Quality and introduction to custom power devices.

Expected outcome

The students will be able to analyse the operation, control and application of different FACTS devices and custom power devices.

References

1. K. R. Padiyar, FACTS Controllers in Power Transmission and Distribution, New Age International
2. N.G. Hingorani & L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, IEEE Press
3. T.J.E Miller, Reactive Power Control in Electric Systems, John Wiley & Sons.
Ned Mohan et.al, Power Electronics, John Wiley and Sons.
4. Dr Ashok S & K S Suresh Kumar "FACTS Controllers and applications" course book for STTP, 2003.

Course Plan

Module	Contents	Hours	% marks for semester exam
I	FACTS and preliminaries: FACTS concept and general system considerations - power flow in AC system - definitions on FACTS - basic types of FACTS controllers. Converters for Static Compensation - Three phase converters and standard modulation strategies (Programmed Harmonic Elimination and SPWM) - GTO Inverters - Multi-Pulse Converters and Interface Magnetics -	7	15
II	Transformer Connections for 12, 24 and 48 pulse operation - Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM) - Multi-level inverters of Cascade Type and their modulation - Current Control of Inverters.	7	15

FIRST INTERNAL EXAM			
III	Static Shunt and Series Compensators: Static Shunt Compensators - SVC and STATCOM – operation and control of TSC, TCR, STATCOM - Compensator Control - Comparison between SVC and STATCOM - STATCOM for transient and dynamic stability enhancement.	7	15
IV	Static Series Compensation - GCSC, TSSC, TCSC and SSSC - operation and control - external system control for series compensators - SSR and its damping - static voltage and phase angle regulators - TCVR and TCPAR - operation and control.	9	15
SECOND INTERNAL EXAM			
V	UPFC and IPFC: The Unified Power Flow Controller - operation, comparison with other FACTS devices - control of P and Q - dynamic performance - Special Purpose FACTS Controllers – Interline Power Flow Controller - operation and control.	8	20
VI	Power Quality and introduction to custom power devices: Power Quality issues related to distribution systems – custom power devices – Distribution STATCOM – Dynamic Voltage restorer – Unified Power Quality Conditioner – Application of D-STATCOM, DVR and UPQC for improving power quality in distribution 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			

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Course No.	Course Name	L-T-P-Credits	
08EE6242 (B)	POWER QUALITY	3-0-0-3	
Course Objective: To familiarize the students with power quality problems and measurements. To introduce the impact of and on the device and different mitigation techniques.			
Syllabus: Overview of power quality phenomena, IEEE guides, standards and recommended practices., Modeling of networks , Power quality applications, Power quality improvement methods.			
Expected outcome Students will be able to analyse the various power quality issues and mitigation techniques.			
References <div><div>1. Heydt, G.T., Electric Power Quality , Stars in a Circle Publications, Indiana</div><div>2. Ewald F Fuchs, Mohammad A.S., Power Quality in Power Systems and Electrical Machines, Elsevier, Academic Press</div><div>REFERENCES</div><div>3. Bollen, M.H.J., Understanding Power Quality Problems: Voltage sags and interruptions, IEEE Press, New York</div><div>4. Arrillaga, J, Watson, N.R., Chen, S., Power System Quality Assessment, Wiley, New York, 2000.</div></div>			
Course Plan			
Module	Contents	Hours	% marks for semester exam
I	Overview of power quality phenomena-classification of power quality issues-power quality measures and standards-flicker-transient phenomena-Harmonics-sources of harmonics-occurrence of power quality problems-power acceptability curves-IEEE guides, standards and	9	15

	recommended practices.		
II	Modeling of networks and components under non-sinusoidal conditions-transmission and distribution systems-shunt capacitors-transformers-electric machines.	7	15
FIRST INTERNAL EXAM			
III	Ground systems-loads that cause power quality problems-power quality problems created by drives and its impact on drives.	7	15
IV	Power quality application of state estimation-flicker-impulses-high frequency issues-common mode and transverse mode noise-geometric interference-susceptibility of loads-loss of life of power system components	9	15
SECOND INTERNAL EXAM			
V	Power quality improvement: harmonic filters-active filters-phase multiplication-power conditioners-	7	20
VI	Uninterruptible power sources-constant voltage transformers-static compensators and static watt Compensators	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
08EE6242 (C)	DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS	3-0-0-3

Course Objective:

To enable the students model and analyze the power electronics systems with the software tools .

Syllabus:

Modeling of Power Semiconductor Devices, Modeling of Control Circuits for Power Electronic Switches, introduction to Software ORCAD- Pspice, Dynamic modeling and simulation using MATLAB.

Expected outcome

The students will be able to model power electronic systems using different approaches and use software tools for analysis

References

1. V Rajagopalan, Computer Aided Analysis of Power Electronic Systems, Marcel Dekker, Inc.
2. Erickson, Maksimovic, Fundamentals of Power Electronics - 2nd edition, Springer
3. Randall Shaffer, Fundamentals of Power Electronics with MATLAB, Firewall Media, India
4. Mohan, Undeland, Robbins, Power Electronics, 3rd edition, John Wiley
5. Jai P Agrawal, Power Electronic Systems-Theory and Design, Pearson
6. ORCAD PSpice Basics: Circuit Analysis Software, User's Guide, ORCAD

Course Plan

Module	Contents	Hours	% marks for semester exam
I	Principles of Modeling Power Semiconductor Devices - Macro models versus Micro models - Thyristor model - Semiconductor Device modeled as Resistance, Resistance-Inductance and Inductance-Resistance-Capacitance combination - Modeling of Electrical Machines.	9	15
II	Modeling of Control Circuits for Power Electronic Switches. Computer Formulation of Equations for Power Electronic Systems –Review of graph theory as applied to Electric networks- Systematic method of Formulating State Equations - Computer Solution of State Equations - Explicit Integration method -Implicit Integration method.	7	15

FIRST INTERNAL EXAM			
III	AC equivalent circuit modeling: Basic AC modeling approach-State space averaging-circuit averaging and averaged switch modeling-Modeling the PWM.	8	15
IV	Analysis Using Software Tools Circuit Analysis Software ORCAD- PSpice - Simulation Overview - Creating and Preparing a Circuit for Simulation - Simulating a Circuit with PSpice - Simple Multi-run Analyses - Statistical Analyses - Simulation Examples of Power Electronic systems- Creating Symbols -Creating - Models - Analog Behavioral Modeling - Setting Up and Running analyses – Viewing Results- Examples of Power Electronic Systems.	8	15
SECOND INTERNAL EXAM			
V	Dynamic modeling and simulation of DC-DC converters using MATLAB - Simulation of State Space Models –	8	20
VI	Modeling and simulation of inverters using MATLAB	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			

ELECTIVE III

Course No.	Course Name	L-T-P-Credits
08EE6252 (A)	EMBEDDED CONTROLLERS IN	3-0-0-3

	REAL TIME SYSTEMS			
Course Objective: To introduce the students embedded controllers, its architecture, applications and real time systems.				
Syllabus: Introduction to 8051 and its applications, Real-time Systems, PIC Processors, FPGA devices, DSP architecture and pipelining				
Expected outcome The students will be able to analyse the architecture, applications and real time systems related to embedded controllers.				
References 1. Mazidi & Mazidi, Embedded System Design using 8051 Microcontroller, Pearson 2. Ajay V Deshmukh, Microcontrollers -Theory and Applications, TMH 3. Phillip A Laplante, Real Time Systems Design and Analysis, PHI 4. Daniel W Lewis, Fundamentals of Embedded Software, Pearson 5. Sen M Kuo, Woon Seng Gan, Digital Signal Processors-Architecture, Implementation and Applications, Pearson 6. H A Toliyat, S Campbell, DSP Based Electro Mechanical Motion Control, CRC Press, 7. Avtar Singh, S Srinivasan, Digital Signal Processing, Thomson Brooks 8. Phil Lapsley, Bler, Sholam, E A Lee, DSP Processor Fundamentals, IEEE Press 9. Wayne Wolf, FPGA Based System Design, Pearson 10. Scott Hauck, The Roles of FPGAs in Reprogrammable Systems, Proceedings of the IEEE, Vol. 86, No. 4, pp. 615-639, April, 1998				
Course Plan				
Module	Contents	Hours	% marks for semester exam	
I	8051 Microcontroller - Assembly Language programming and C Programming- Instruction set – Interrupts - Timers – Memory- I/O ports – Serial Communication - Interfacing –Key board, LED display, External memory, ADC, DAC, LCD, RTC – Typical applications- DC motor speed control, speed measurement, Temperature control, Stepper motor control, PID control.	9	15	

II	Real-time Systems - Introduction to real time systems- interrupt driven systems-context switching-scheduling- round robin preemptive-rate monotonic	7	15
FIRST INTERNAL EXAM			
III	Foreground and Background systems-Intertask communication- Buffering data-Mailboxes-Critical regions-Semaphores-Deadlock-Process stack management- Dynamic allocation-Response time calculation-Interrupt latency.	7	15
IV	PIC Processors - RISC concepts - PIC processors- overview-16F877 - Architecture – Elementary Assembly Language Programming- Interrupts – Timers – Memory – I/O ports – SPI – I2C bus - A/D converter - USART- PWM – Interfacing - Introduction to FPGA Devices.	8	15
SECOND INTERNAL EXAM			
V	DSP Architecture - Introduction to DSP architecture- computational building blocks – Address generation unit- Program control and sequencing- Speed issues- Harvard Architecture, Parallelism, Pipelining.	7	20
VI	TMS 320F2407- Architecture- Addressing modes- I/O functionality, Interrupts, ADC, PWM, Event managers- Elementary Assembly Language Programming- Typical applications-buck boost converter, stepper motor control- Software and Hardware Development Tools.	8	20
<p>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.</p> <p>End semester Examination: 60 marks</p>			

Course No.	Course Name	L-T-P-Credits	
08EE6252 (B)	DSP AND ITS APPLICATIONS	3-0-0-3	
Course Objective: To enable the students design and analyze various digital systems ,the architecture and applications of digital signal processors			
Syllabus: Review of FFT, Fast FFT and FIT FFT Transforms, IIR filters and design ,Digital signal processors and architecture, its applications.			
Expected outcome The students will be able to do analysis of digital systems and design of digital filters.			
References 1. Oppenheim A. V. & Schafer R. W., Discrete- time Signal Processing, Pearson Education 2. Proakis J. G. & Manolakis D. G., Digital Signal Processing, Principles, algorithms & applications, Pearson Education. 3. Li Tan, Digital Signal Processors- Architectures, Implementations and applications, Academic Press (Elsevier) 4. Sen M. Kuo & Woon-Seng S. Gan, Digital Signal Processors- Architectures, Implementations and Applications, Pearson Education. 5. A. V. Oppenheim & R. W. Schafer, Digital Signal Processing, Prentice- Hall of India 6. Sanjit K. Mitra, Digital Signal Processing- A computer based approach, Tata Mc Graw Hill 7. Emmanuel C. Ifeachor, Barrie W. Jervis, Digital Signal Processing- A practical approach, Pearson education. 8. Ludeman, Fundamentals of Digital Signal Processing, Wiley India Pvt. Ltd.			
Course Plan			
Module	Contents	Hours	% marks for semester exam
I	Review of signals and systems – Review of discrete-time Fourier transform (DTFT) – Discrete Fourier Transform – properties – inverse DFT – relationship between DFT and Z-transform – circular convolution – linear convolution using DFT – overlap add/save method – Fast Fourier Transform (FFT) - Decimation-in-time (DIT) & Decimation-	8	15

	in-Frequency (DIF) FFT algorithms.		
II	Realization of IIR filters – direct form I & II – cascade – parallel – lattice-ladder – state space realizations – type I & II – realization of FIR filters – direct form – cascade – linear phase realizations – lattice – conversion from lattice to direct form	8	15
FIRST INTERNAL EXAM			
III	Digital filter design – analog to digital transformation –backward-difference technique – impulse invariant – bilinear transformation – design of IIR filter from analog filter – Butterworth & Chebyshev filter – FIR filter design – Fourier series method – design using windows – Rectangular, Bartlett, Hanning, Hamming, Blackman, Kaiser windows - comparison of FIR & IIR filters.	7	15
IV	Multirate digital signal processing – sampling rate conversion – decimation, interpolation – sampling rate alternation or conversion – filter design and implementation for sampling rate alternation – direct form FIR digital filter structure, polyphase filter structure, time-varying digital filter structure – sampling rate conversion by an arbitrary factor .Finite word length effects – fixed point and floating point formats – quantization errors – limit cycle oscillations	7	15
SECOND INTERNAL EXAM			
V	Digital signal processors – selection of digital signal processors – Von Neumann & Harvard architecture – Multiply Accumulate Unit (MAC) - architecture of DSP processor - fixed point & floating point (block diagram approach) - applications of digital signal processors	7	20
VI	Applications of DSP – speech processing – speech analysis, synthesis and compression – radar signal processing – image processing – image formation, recording, compression, restoration, enhancement – echo cancellation .Execution of simple programs using digital signal processor – solution of specific	8	20

	problems in digital signal processing using MATLAB programs		
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	
08EE6252 (C)	DIGITAL CONTROL SYSTEMS	3-0-0-3	
Course Objective: To familiarize the students digital controllers ,its analysis and design concepts.			
Syllabus: Introduction to digital systems, pulse transfer functions ,Stability analysis, design of digital controllers, state space analysis			
Expected outcome The students will be able to design and analyze digital control systems			
References <div><div>1. K. Ogata, Discrete- time control systems, PHI</div><div>2. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill</div><div>3. B. C. Kuo, Digital Control Systems, Prentice Hall</div><div>4. Charles L. Philip and Troy Nagle, Digital control Systems, Prentice Hall</div></div>			
Course Plan			
Module	Contents	Hours	% marks for semester exam

I	Introduction to discrete time control system-Block diagram of a digital control system-Typical examples-Sampling process- Data reconstruction and hold circuits-Zero and first order hold-Review of z- transforms and inverse z- transforms- solution of difference equations- pulse transfer function- pulse transfer function with dead time- system time response- Realization of pulse transfer functions (Digital Controllers)- Direct Programming- Standard Programming- Series programming- parallel programming- ladder programming.	9	15
II	Review of stability analysis in z- plane- Jury's stability test and extension of Routh's stability criterion to discrete systems- Transient and Steady state response analysis- transient response specifications- steady state error analysis.	7	15
FIRST INTERNAL EXAM			
III	Construction of root loci- effect of sampling period on transient response specifications- frequency response specifications- Nyquist stability criterion in the z- plane-Digital Controllers- PI, PD & PID Controllers- Lag, lead, and lag-lead compensators- Design of lag compensator and lead compensator based on root locus and Bode plot approaches	7	15
IV	State Space analysis of digital control systems- state space representation of discrete time systems- Transfer function from state model- Diagonal/ Jordan Canonical forms from transfer function-	7	10
SECOND INTERNAL EXAM			
V	Solution of linear time invariant discrete time state equations- discretization of continuous time space equation- representing state models in CCF, OCF, DCF/ JCF using transformation matrix	7	15
VI	Concept of controllability and observability for a linear time invariant discrete time control system- condition for controllability and observability-	8	15

	state feedback- condition for arbitrary pole placement- design via pole placement- state observers- design of full order state observer.		
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
08EE6262 (P)	MINI PROJECT	0-0-4-2
Course Objective: <ul style="list-style-type: none"> To estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model of a power electronic system. For enabling the students to gain experience in organisation and implementation of a mini project and thus acquire the necessary confidence to carry out hardware implementation of main project.. 		
Expected outcome Students will be able to design and develop a working model of the given power electronic circuit and gain experience in developing the hardware models for the main project.		
This is a hardware based mini project and each student is expected to develop a power electronic based system with practical applications .Student has to design, fabricate, test and assemble a power electronics based system in an enclosure with appropriate terminals and control mounted on an enclosure. This should be a working model. The basic concepts of product design may be taken into consideration while designing the project.		
Internal continuous assessment: 100 marks		
Course No.	Course Name	L-T-P-Credits

08EE6272 (P)	ADVANCED POWER ELECTRONICS LAB	0-0-2-2
Course Objective: <i>To provide practical knowledge through hardware implementation & simulation of power electronic circuits</i>		
Expected outcome The students will be able to design, simulate and implement different power electronic circuits.		
LIST OF EXPERIMENTS <ol style="list-style-type: none"> 1. Simulation of Closed loop control of converter fed DC motor drives 2. Simulation of Closed loop control of chopper fed DC motor drives 3. Simulation of sine PWM & space vector PWM 4. Simulation of 3-phase induction motor drive using V/f control 5. Simulation of Brushless DC Motor drive 6. Simulation of Multilevel Inverters 7. MOSFET/ IGBT/Transistor based DC Choppers (Buck , Boost & Cuk) 8. Half bridge square wave inverter 9. Single-phase Sine triangle PWM inverter 10. Microcontroller based control of dc-dc converter 11. Closed loop control of Brushless DC motors 12. Closed loop control of Switched reluctance motors. 13. Closed loop control of permanent magnet synchronous motors. <p>(At least 10 experiments in the list are to be conducted in the laboratory. Additional experiments and simulation assignments can also be given by the department)</p> <p>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.</p> <p>Internal continuous assessment: 100 marks</p> <ol style="list-style-type: none"> a. Regularity – 30% b. Record – 20% c. Test and Viva – 50% 		