SCHEME & SYLLABUS

OF

M.Tech CAID

ELECTRICAL & ELECTRONICS ENGINEERING

2020-21

SRI SIDDHARTHA INSTITUTE OF TECHNOLOGY

(A Constituent College of Sri Siddhartha Academy of Higher Education)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(Accredited by NBA in Tier-1for Six years 2017- 2023)

Master of Technology in Computer Applications in Industrial Drives 2020-21

I Semester

Subject Code	Subject	L – T – P – C	Marks for		
			CIE	SEE	Total
CAI101	Applied Mathematics	4 - 0 - 0 - 4	50	100	150
CAI102	Power Electronics	4 - 0 - 0 - 4	50	100	150
CAI103	Electro Magnetic Compatibility in Power Electronics	4 - 0 - 0 - 4	50	100	150
CAI104	DSP Applications to Drives	4 - 0 - 0 - 4	50	100	150
CAI15X	ELECTIVE-I	4 - 0 - 0 - 4	50	100	150
CAI106	Technical Seminar -I	0 - 0 - 0 - 2	50	--	50
CAIL107	Power Electronics Simulation Laboratory	0 - 0 - 3 - 1	50	--	50
	Total Credits	**20 -0 – 3 - 23**	**350**	**500**	**850**

Elective-I

CAI151 Dynamics of Control Systems
CAI152 Power System Harmonics
CAI153 Embedded Systems

II Semester

Subject Code	Subject	L – T – P – C	Marks for		
			CIE	SEE	Total
CAI201	AC and DC Drives	4 - 0 - 0 - 4	50	100	150
CAI202	Advanced Electrical Drives	4 - 0 - 0 - 4	50	100	150
CAI203	PLC and SCADA	4 - 0 - 0 - 4	50	100	150
CAI204	Hybrid Electric Vehicles	4 - 0 - 0 - 4	50	100	150
CAI25X	Elective-II	4 - 0 - 0 - 4	50	100	150
CAI206	Technical Seminar -II	0 - 0 - 0 - 2	50	--	50
CAIL207	Electrical Drives Laboratory	0 - 0 - 3 - 1	50	--	50
	Total Credits	**20 -0 – 3 - 23**	**350**	**500**	**850**

Elective – II

CAI251 Multilevel Inverters.
CAI252 Fuzzy Logic Control and its Applications
CAI253 Electrical Power Quality

III Semester

Subject Code	Subject	L – T – P – C	Marks for		
			CIE	SEE	Total
CAI301	Internship	0 - 0 - 0 - 10	100	---	100
CAI302	Project Work Phase-I	0 - 0 - 0 - 9	50	--	50
	Total Credits	**0 -0 – 0 - 19**	**150**	**---**	**150**

Note:

- Internship: Report evaluation on Internship (50 Marks) Viva – Voce and Evaluation of Internship (50 Marks)
- Project Work Phase-I: Literature Survey/Visit Industry to finalize the project and presentation of the same (50 Marks)

IV Semester

Subject Code	Subject	L – T – P – C	Marks for		
			CIE	SEE	Total
CAI45X	Elective-III	4 - 0 - 0 - 4	50	100	150
CAI46X	Elective –IV	4 - 0 - 0 - 4	50	100	150
CAI403	Project Work Phase-II	0 - 0 - 0 - 15	100	200	300
	Total Credits	**8 -0 – 0 – 23**	**200**	**400**	**600**

Elective – III

CAI451 Cyber security in the electricity sector
CAI452 FACTS Controllers
CAI453 Artificial neural Network

Elective – IV

CAI461 Special Electrical Machines
CAI462 Intelligent Applications to Electric Drives
CAI463 FPGA and Programmable Logic

Note:

Project Work Phase-II:
Project work Seminar – I: Presentation of the project work carried out for the first six weeks (50 Marks)

1. Project work Seminar – II: Presentation of the project work carried out for the next eight weeks (50 Marks)
2. Project work evaluation taken up at the end of the IV semester.
3. Report Evaluation: Average of the marks evaluated by internal and external examiners (125 Marks)
4. Viva- Voce: Conducted and evaluated jointly by internal and external examiners (75 Marks)

Total Credits (I to IV Semester)	**88**
Total Marks (I to IV Semester)	**2450**

SUBJECT TITLE : APPLIED MATHEMATICS

Subject Code: CAI101	No of Credits : 4:0:0:4 L T P C	No of lecture hours/week : 4
Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52

Course Objectives	To Provide the students with strong foundation advanced mathematics and also its applications toEngineering field.
Course Outcome	1. Understand vector spaces, basis, linear transformations, solving the Linear and non-linear equations bydifferent methods. 2. Use the idea of Eigen values and Eigen vectors for the application of singular value decomposition andalso the formation of Quadratic and cubic spline. 3. Understand the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems. 4. Apply the technique of singular value decomposition for data compression, least square approximationin solving inconsistent linear systems.

Unit No.	SYLLABUS CONTENT	**No. of hours**
1	**Linear Algebra-I** Introduction to vector spaces and sub-spaces, definitions,illustrative examples and simple problems.Linearlyindependent and dependent vectors-definition and problems.Basis vectors, dimension of a vector space. Lineartransformations- definition, properties and problems. Rank-Nullity theorem (without proof). Matrix form of linear transformations-Illustrative examples.	**10**
2	**Linear Algebra-II** **System of Linear Algebraic Equations and Eigen Value Problems:** Iterative Method -Gauss – Seidal method. Eigen value problems- Finding all the Eigen values and Eigen vectors, Gerschgorial circle, Eigen values and Eigen vectors of real symmetric matrices by Jacobi method, Computation of Eigen values and Eigen vectors of real symmetric matrices-Given’s method. QR decomposition, singular value decomposition, least square approximations.	**10**
3	**Numerical Methods:** Solution of algebraic and transcendental equations- Newton-Raphson method for simple roots and multiple roots. Rate of convergence of Newton- Raphson method. System of non-linear equations by Newton- Raphson method. Polynomial equations by Birge – Vieta method and Bairstow method.	**10**
4	**Solution of Simultaneous Linear Algebraic Equations:** Introduction, Engineering Applications, Basic Ill-Conditioned Equations. Graphical Interpretation of the Solution, Solution Using Cramer's Rule, LU Decomposition Method, Jacobi Iteration Method, Relaxation Methods. **Interpolation:** Hermite interpolation, Quadratic and cubic spline interpolations. Numerical solution of differential equations by Numerov method.	**11**
5	**Probability Theory** Review of basic probability theory. Definitions of random variables and probability distributions, probability mass and density functions, expectation, moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Binomial, Poisson, Exponential, Gaussian and Rayleigh distributions	**11**

REFERENCE BOOKS:

1. M K Jain, S R K Iyengar and R K Jain, “ Numerical Methods for Scientific and Engineering Computations”, New Age International , 2004.
2. M K Jain, “ Numerical Solution of Differential Equations”, 2nd Edition, New Age International, 2008.
3. Dr. B S Grewal, “ Higher Engineering Mathematics”, 41st Edition, Khanna Publishers, 2011.
4. Kenneth Hoffman and Ray Kunze, “ Linear Algebra”, 2nd Edition, PHI, 2011.
5. David C.Lay, Steven R. Lay and J.J.McDonald: Linear Algebra and its Applications, 5th Edition, Pearson Education Ltd., 2015.

	SUBJECT TITLE : POWER ELECTRONICS		
	Subject Code: CAI102	**No of Credits: L:T:P:C : 4:0:0:4**	**No of lecture hours/week : 4**
	Exam Duration : 3hours	**Exam Marks : 100**	**Total No of lecture hours: 52**

Course Objectives	1. To understand the operation of power semiconductor switches and rectifiers. 2. To analyze the operation of various types of resonant converters. 3. To apply the concept of PWM techniques for voltage control of converters. 4. To design basic types of DC-DC converter for power supplies and drives applications.
Course Outcome	1. Understand the operation of power semiconductor switches and rectifiers. 2. Analyze the operation of various types of resonant converters. 3. Apply the concept of PWM techniques for voltage control of converters. 4. Design basic types of DC-DC converter for power supplies and drives applications.

Unit No.	**SYLLABUS CONTENT**	**No. of hours**
1	Introduction, classification of power electronic converters and their applications, overview of power Semiconductor switches – Diode, SCR, MOSFET and IGBT, single phase and three phases fully controlled bridge rectifier.	**10**
2	**Buck converter:** continuous and discontinuous conduction modes, current and voltage ripple. **Boost converter:** continuous and discontinuous conduction modes, current and voltage ripple. **Buck-Boost converter:** continuous and discontinuous conduction modes, current and voltage ripple.	**10**
3	**Non-isolated converters:** Cuk and SEPIC converters. **Isolated converters:** Flyback, Forward, Half-Bridge and Full-Bridge converters.	**10**
4	**Resonant converters:** Resonant-switch converter – Zero-current Switching (ZCS) and Zero-voltage Switching (ZVS) converters, Load-resonant converters – series resonant converter, parallel resonant converter and series-parallel resonant converter, Resonant dc link converter.	**10**
5	**Inverters:** Introduction, principle of operation, performance parameters, single phase voltage source inverter, three phase voltage source inverter, voltage control of single phase inverter – sinusoidal pulse width modulation and space vector modulation	**12**

Reference Books:

1. M. H. Rashid, “Power Electronics: Circuits, Devices and Applications”, Third Edition, PHI, 2005.
2. Joseph Vithyathil, “**Power Electronics – Principles and Application**”, MGH.
3. Daniel W. Hart, “Power Electronics”, McGraw Hill, 2011.
4. Ned Mohan, Tore M. Undeland, William P. Robbins, “Power Electronics: Converters, Applications and Design”, John Wiley and Sons, 1989.

	SUBJECT TITLE : ELECTRO MAGNETIC COMPATIBILITY IN POWER ELECTRONICS		
	SubjectCode:CAI103	No of Credits : 4:0:0:4 L T P C	No of lecture hours/week : 4
	Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52
Course Objectives	1. To understand different electromagnetic disturbances and their classification. 2. To analyze suppression of noise in relay systems. 3. To apply the concept of EMI filters for conduction of test as per IEC specifications and reducing internal EMI. **4.** To design and analysis of EMI filters. .		
Course Outcome	1. Understand different electromagnetic disturbances and their classification. 2. Analyze the suppression of noise in relay systems.Analyze the operation of various types of resonant converters. **3.** Apply the concept of EMI filters for conduction of test as per IEC specifications and reducing internal EMI. **4.** Design and analysis of EMI filters		

Unit No.	SYLLABUS CONTENT	**No. of hours**
1	**Introduction**: Designing of electromagnetic compatibility, EMC regulation, typical noise path, and use of network theory, method of noise coupling, miscellaneous noise sources, and method of eliminating interference.	**12**
2	**Cabling**: Capacitive coupling, effect of shield on magnetic coupling, mutual inductance calculations, magnetic coupling between shield and inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, shield transfer impedance, experimental data, example of selective shielding, co-axial cable versus shielded twisted pair braided shields, effect of pig tails, ribbon cable, electrically long cables.	**10**
3	**Grounding**: Safety grounds, signal grounds, single point ground systems, hybrid grounds, multipoint ground systems, functional ground layout, practical low frequency grounding, hardware grounds, single ground reference for a circuit amplifier shields, grounding of cable shields, ground loops, low frequency analysis of common mode choke, high frequency analysis of common mode choke, differential amplifiers, shields grounding at high frequencies, guard shields guarded meters.	**10**
4	**Balancing and Filtering**: Balancing, power supply decoupling, decoupling filters, amplifier decoupling driving capacitive loads, high frequency filtering, system bandwidth, and modulation coding.	**10**
5	**Shielding**: Near field and far fields, characteristic and wave impedance's shielding effectiveness, absorption loss, reflection loss, composite adsorption and reflection loss, summary of shielding equation, shielding with magnetic material, experimental data, apertures, wave guide below cutoff, conductive gaskets, conductive windows, conductive coatings, cavity resonance & brooding of shields. **Electrostatic discharge**: State generation, human body model, static discharge, and ESD protection in equipment design, software and ESD protection & ESD versus EMC.	**10**

Reference Books:

1. "Introduction To Electromagnetic Compatibility (With Cd)", Clayton r. Paul, Wiley India Pvt Ltd.
2. **"**Noise reduction techniques in electronic systems**"**- 2nd edition, Henry W. Ott, John Wiley, 1988

SUBJECT TITLE : DSP APPLICATIONS TO DRIVES

Subject Code: CAI104	No of Credits : 4:0:0:4 L T P C	No of lecture hours/week : 4
Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52

Course Objectives	1. To understand the concept of LTI systems, DFT and its properties. 2. To apply the knowledge of DFT in designing FIR and IIR filters. 3. To analyze the SVPWM technique for AC drives. 4. To demonstrate the concept of DSP controller for DC drives.
Course Outcome	1. Understand the concept of LTI systems, DFT and its properties. 2. Apply the knowledge of DFT in designing FIR and IIR filters. 3. Analyze the SVPWM technique for AC drives. 4. Demonstrate the concept of DSP controller for DC drives.

Unit No.	**SYLLABUS CONTENT**	**No. of hours**
1	**Introduction:** Linear Time-invarient system as frequency selective filter, Properties of discrete fourier transform, Linear filtering methods based on DFT, Implementation of Discrete Time System.	**10**
2	**Design of FIR Filters:** Design of linear phase FIR filters using windows, frequency sampling methods, Design of optimum equi-ripple Linear phase FIR filters, Design of FIR differentiators, Hilbert Transforms, Comparison of FIR filter design methods.	**10**
3	**Design of IIR Filters:** Design of IIR filters by approximation of derivatives, Impulse invariance bilinear transformation, matched Z-transforms, Design of IIR filters by frequency transformations in analog and digital domain.	**10**
4	Introduction to the TMS320LF2407 DSP controller, peripherals, C2xx DSP CPU architecture and instruction set (brief), addressing modes, overview of system configuration registers. **Space Vector Pulse Width Modulation**: Introduction, Principle of Constant V/Hz Control for Induction Motors, Space Vector PWM Technique, DSP Implementation.	**12**
5	**DSP-Based Implementation of DC-DC Buck-Boost Converters:** Introduction, Converter Structure, Continuous Conduction Mode, Discontinuous Conduction Mode, Connecting the DSP to the Buck-Boost Converter, Controlling the Buck-Boost Converter.	**10**

Reference Books:

1. J.G. Proakis and D G Monolikis**"Digital Signal Processing: Principles, algorithms and Applications"**

   Pearson Education, 4th Edition, 2009.
2. M. H. Rashid, "Power Electronics: Circuits, Devices and Applications", Third Edition, PHI, 2005.
3. A V Oppenheim and R W Schafer **" Discrete Time Signal Processing "** Pearson Education, 2002.
4. Hamid A. Toliyat, DSP-Based Electromechanical Motion Control, CRC Press, 2004

	SUBJECT TITLE : DYNAMICS OF CONTROL SYSTEMS		
	SubjectCode:CAI151	No of Credits : 4:0:0:3 L T P C	No of lecture hours/week : 4
	Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52
Course Objectives	1.To understand and solve state space equations for continuous systems. **2.**To apply knowledge of control systems through pole placement for continuous system 3.To analyze steady state equations for discrete system. **4.**To design control systems through pole placement for discrete systems.		
Course Outcome	1. Understand and solve state space equations for continuous systems. **2.** Apply knowledge of control systems through pole placement for continuous system 3. Analyze steady state equations for discrete system. **4.** Design control systems through pole placement for discrete systems.		

Unit No.	SYLLABUS CONTENT	**No. of hours**
1	State variable description of linear systems: State space representation of electrical, mechanical and electromechanical systems. Derivation of transfer function from state model. State transition matrix, computation of state transition matrix by series expansion method, Laplace transform approach and Cayley Hamilton theorem. Solution of linear time invariant and time variant state equations.	**10**
2	Controllability and Observability : State space representation using canonical forms and phase variables. Transformation to phase variable canonical form, similarity transformations. State variable equations of composite systems, effect of pole zero cancellation, subsystems of composite systems and diagonalisation. Controllability and observability.	**10**
3	**Design of control system by state space methods:** Control system design via pole placement techniques, Design of state observer - full order and minimum order observer, effects of addition of the observer on a closed loop system, transfer function of observer based control system.	**10**
4	Linear, discrete, dynamic systems analysis: The z–transform, properties of the z- transform, inverse z-transform, solution of difference equations by z-transform, Impulse sampling and data hold circuits, transfer function of ZOH, transform of functions involving ZOH. Reconstructing original signals from sampled signals. Pulse transfer functions. General procedure for obtaining pulse transfer functions.	**12**
5	State space analysis of discrete time systems : State space representation of discrete –time systems, controllable canonical form, observable canonical form and diagonal form. Solution of discrete time state space equations, pulse transfer function matrix, Discretization of continuous time state space equations. Transformations, design via pole placement, controllability and observability, state observer, design of full state observer.	**10**

Reference Books:

1. Katsuhiko Ogata, '*Modern Control Engineering*', PHI, 4th edition, 2002.
2. I.J.Nagrath, M.Gopal, '*Control System Engineering'*, New Age International Publishers, 3rd Edition, 1999.
3. Katsuhiko Ogata, '*Discrete Time Control Systems'*, Pearson education, 2nd edition, 1995.

	SUBJECT TITLE : POWER SYSTEM HARMONICS		
	SubjectCode:CAI152	No of Credits : 4:0:0:3 L T P C	No of lecture hours/week : 4
	Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52

Course Objectives	1. To understand the effects of harmonics distortion on power system equipment and loads. 2. To apply the methods used to suppress the harmonics in power systems. 3. To analyze harmonic distortion and modeling of power system components for harmonic analysis study. 4. To design transmission lines and cables for harmonic analysis .
Course Outcome	1. Understand the effects of harmonics distortion on power system equipment and loads. 2. Apply the methods used to suppress the harmonics in power systems. 3. Analyze harmonic distortion and modeling of power system components for harmonic analysis study. 4. Design transmission lines and cables for harmonic analysis .

Unit No.	SYLLABUS CONTENT	**No. of hours**
1	**Fundamentals of Harmonics**: Introduction, Examples of harmonic waveforms, characteristics of harmonics in power systems, measurement of harmonic distortion, power in passive elements, calculation of passive elements, resonance, capacitor banks and reactive power supply, capacitor banks and power factor correction, bus voltage rise and resonance, harmonics in transformers. Harmonics in Power system: Introduction, sources of harmonics, transformers, rotating machines, fluorescent lights, static var compensators, cycloconverters. Single phase controlled rectifiers, three phase converters.	**12**
2	**Effects of Harmonic Distortion on Power System**: Introduction, thermal losses in a harmonic environment, harmonic effects on power system equipment, capacitor banks, transformers, rotating machines, protection, communication and electronic equipment. Mitigation of Power system Harmonics: Introduction, harmonic filters, power converters, transformers, rotating machines, capacitor banks, harmonic filter design, active filters.	**10**
3	**Limits of Harmonic Distortion:** Introduction, voltage harmonic distortion limits, current harmonic distortion limits. Harmonic studies – Modelling of System Components: Introduction, impedance in the presence of harmonics, skin effect, modelling of the high voltage grid, generator modelling, modelling of shunt capacitor banks, series capacitor banks, load models, induction motor modelling. **Transformer Modelling:** Introduction, modelling of two winding transformers, phase sequence admittance matrices, transmission of voltage and current across two winding transformers, transmission matrices and phase admittance matrix, modelling of three and four winding transformers.	**10**
4	**Modelling of Transmission lines/Cables:** Introduction, skin effect, modelling of power lines, Line’s series impedance, mutual coupling between conductors, mutually coupled lines, line’s shunt capacitance, surge impedance and velocity of propagation, line’s series impedance and shunt capacitance – single phase equivalents, the transmission (ABCD) matrix, the admittance matrix, conversion between the transmission and admittance matrices, the nominal pi model – single phase equivalent, the equivalent pi model – voltage and current the line, line losses, the equivalent pi model – single phase equivalent, variations in the network’s short circuit capacity, examples – the nominal and equivalent models.	**10**
5	**Power System Harmonic Studies:** Introduction, harmonic analysis using a computer program, harmonic analysis using spread sheet, harmonic distortion limits, harmonic filter rating, and practical considerations. Harmonic study of simple system, 300 -22 kV power system and low voltage system	**10**

Reference Books:

1.George J Wakileh, Power System Harmonics, Springer, Reprint, 2014

2.Jos Arrillaga et al, Power System Harmonic Analysis, Wiley, Reprint, 2014

	SUBJECT TITLE : EMBEDDED SYSTEMS		
	SubjectCode:CAI153	No of Credits : 4:0:0:3 L T P C	No of lecture hours/week : 4
	Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52
Course Objectives	1. To understand the concept of embedded system design, architectures of 6808 and 6811 Embedded Memories and applications of embedded systems. 2. To analyze the concept of Issues in embedded system design, design challenge, design technology. 3. To apply Software aspects of Embedded Systems . 4. To design subsystem interfacing with external systems .		
Course Outcome	1. Understand the concept of embedded system design, architectures of 6808 and 6811 Embedded Memories and applications of embedded systems. 2. Analyze the concept of Issues in embedded system design, design challenge, design technology. 3. Apply Software aspects of Embedded Systems . 4. Design subsystem interfacing with external systems .		

Unit No.	SYLLABUS CONTENT	**No. of hours**
1	**Introduction to Embedded System:** An embedded system, processor, hardware unit, software embedded into a system, Example of an embedded system, OS services, 1/O, N/W, O/S. Real time and embedded OS.	**11**
2	**Processor and Memory Organization:** Structural unit in a processor, processor selection for an embedded systems. Memory devices, memory selection for an embedded system, allocation of memory to program statements and blocks and memory map of a system. Direct memory accesses.	**11**
3	**Micro chip PIC Microcontroller**: Introduction to 16fxx controller, CPU Architecture, Addressing modes, Instruction set, Assembly level programming.	**10**
4	Timers, I/O port expansion, Interrupts, ITC Bus operation, Serial EEPROM, ADC, UART, DAC using PWM	**10**
5	Serial Programming/Parallel slave port, I2C Bus for Peripheral Chip Access	**10**

REFERENCE BOOKS:

1. Rajkamal "Embedded System Architecture- Programming & Design", TMH 2004,
2. J.B.Peatman "Design with PIC Microcontrollers".
3. J.W.Valvano, "Embedded Microcomputer System",
4. Jane W.S. Liu, "Real Time Systems",

<table>
<tr><td rowspan="3"></td><td colspan="6">SRI SIDDHARTHA INSTITUTE OF TECHNOLOGY TUMKUR-5
DEPARTMENT OF ELECTRICAL AND ELECTRONICS</td></tr>
<tr><td>Subject Code:</td><td>CAIL107</td><td>No of Credits</td><td>0:0: 3: 2
L T P C</td><td>No of hours/week</td><td>3</td></tr>
<tr><td>Exam Duration</td><td>3 hours</td><td>Exam Marks</td><td>50</td><td colspan="2"></td></tr>
<tr><td colspan="7">SUBJECT TITLE: POWER ELECTRONICS SIMULATION LAB</td></tr>
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Course Objectives	**1.** To understand and apply PWM techniques in converters. **2.** To design converters for power supplies **3.** To demonstrate their ability to use software tools to simulate various types of power electronic converters.
Course Outcome	1. Understand and apply PWM techniques in converters. **2.** Design converters for power supplies **3.** Demonstrate their ability to use software tools to simulate various types of power electronic converters.
	SYLLABUS CONTENT
1.	Simulation of single phase inverter using MATLAB/ SIMULINK package. i) Perform FFT analysis to determine THD. ii) Perform FFT analysis to determine THD with SPWM iii) Perform FFT analysis to determine THD with SVPWM
2.	Simulation of three phase Inverter using MATLAB/SIMULINK package. i) Perform FFT analysis to determine THD. ii) Perform FFT analysis to determine THD with SPWM iii) Perform FFT analysis to determine THD with SVPWM
3.	Simulation of BUCK converter using MATLAB/ SIMULINK package.
4.	Simulation of BOOST converter MATLAB/ SIMULINK package.
5.	Simulation of BUCK- BOOST converter MATLAB/ SIMULINK package.
6	Simulation of CUK converter MATLAB/ SIMULINK package.
7	Simulation of single phase rectifier with and without filter.
8	Simulation of Three phase rectifier with and without filter.
9	Conduct a suitable experiment to match grid and generator parameters.
10	Conduct a suitable experiment to achieve power quality by electrical characterization.

<table>
<tr><td rowspan="3"></td><td colspan="3">SUBJECT TITLE : AC & DC DRIVES</td></tr>
<tr><td>Subject Code: CAI201</td><td>No of Credits : 4:0:0:4
L T P C</td><td>No of lecture hours/week : 4</td></tr>
<tr><td>Exam Duration : 3 hours</td><td>Exam Marks : 100</td><td>Total No of lecture hours: 52</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. To understand the basics of an electrical drive system .
2. To apply the concept of PWM converters for AC and C drive systems.
3. To analyze mathematical models of AC and DC drive system .
4. To design and analyze simple drive systems .</td></tr>
<tr><td>Course Outcome</td><td colspan="3">1. Understand the basics of an electrical drive system .
2. Apply the concept of PWM converters for AC and C drive systems.
3. Analyze mathematical models of AC and DC drive system .
4. Design and analyze simple drive systems .</td></tr>
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Unit No.	SYLLABUS CONTENT	**No. of hours**
1	Basic elements of drives, classification of drives, fundamental torque equations, speed torque conventions and multi-quadrant operation, components of load torques, nature and classification of load torques.	10
2	DC motor and their performance, starting, braking, methods of speed control, transfer functions of motors.	10
3	**Rectifier control of DC motors:** Controlled rectifier circuits review, braking operation of rectifier controlled motor, single phase full/half controlled rectifier-fed separately excited motor, pulse width modulated rectifiers, multi-quadrant operation of fully controlled rectifier fed DC motors	10
4	**Chopper Control of DC motors:** Chopper circuits review, control techniques, regenerative braking of DC motors, dynamic braking of DC motors, current control, multi-quadrant control of chopper fed motors.	12
5	**Induction motors:** Speed-torque characteristics, starting, braking, speed control methods Scalar Control, Vector (field oriented) Control. Slip power recovery drives.	10

Reference Books:

1. Gopal. K Dubey, „*Power Semiconductor Controlled Drives'*, Prentice Hall, 1989.
2. Vedam Subrahmanyam, „*Power Electronics: Devices, converters, applications'*, New Age, revised 2nd Edition, 2006.
3. P.C.Sen, „Principles of Electric Machines and Power Electronics', John Wiley & Sons, 2nd Edition, 1996.

SUBJECT TITLE : ADVANCED ELECTRICAL DRIVES

Subject Code: CAI202	No of Credits : 4:0:0:4 L T P C	No of lecture hours/week : 4
Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52

Course Objectives	1. To understand different control & feedback signal estimation techniques for induction motor & synchronous motor drives. 2. To apply control techniques for Special machines. 3. To analyze Synchronous reluctance machine drives. 4. To design and analyze Stepper motors- applications .
Course Outcome	1. Understand different control & feedback signal estimation techniques for induction motor & synchronous motor drives. 2. Apply control techniques for Special machines. 3. Analyze Synchronous reluctance machine drives. 4. Design and analyze Stepper motors- applications

Unit No.	SYLLABUS CONTENT	**No. of hours**
1	Dynamic DQ model, Kron's and Stanley's equations, scalar control of induction motors, v/f control, Energy conservation effect, speed control with slip regulation, torque & flux control, vector control-DC drive analogy, equivalent circuit & phasor diagram.	**10**
2	Principles of vector control, direct vector control, flux vector estimation, indirect vector control, stator flux oriented vector control, direct torque & flux control, control strategy of Direct Torque Control	**10**
3	Equivalent circuit, salient pole m/c characteristics, Park model, control & estimation of synchronous m/c drives – introduction, sinusoidal SPM (surface permanent magnet) machine drives, open loop Volts/Hertz control, self control model, absolute position encoder, vector control, field weakening mode.	**10**
4	PM machines, materials, SPM, IPM, Trapezoidal SM machines, VRM, Synchronous reluctance m/c drives, IPM m/c drives, Synchronous Reluctance Machine drives, Trapezoidal SPM machines drives, Drive operation with inverter,120 degree angle switch-on mode, wound-field synchronous machine drives. Brush and Brushless dc excitation	**12**
5	Stepper motors- applications, variable reluctance stepping motors, PM stepping motors, characteristics, unipolar drive circuit, bipolar drive circuit, brushless DC motors, variable reluctance motors, operating modes, inverter drive circuits for VRM.	**10**

Reference Books:

1. Bimal K. Bose, *Modern Power Electronics and AC Drives*, Pearson Education, 2002
2. Dr. P. S. Bimbhra, "*Generalized theory of Electrical Machines*", Khanna Publishers,

	SUBJECT TITLE **: PLC & SCADA**		
	Subject Code: CAI203	No of Credits : 4:0:0:3 L T P C	No of lecture hours/week : 4
	Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52
Course Objectives	1. To understand architecture and hardware of PLC 2. To apply ladder programming using basic control elements to solve control problems using classical P ID control strategies . 3. To analyze the interface for a variety of input and output devices for PLC and SCADA. 4. To design of automation applications.		
Course Outcome	1. To understand architecture and hardware of PLC 2. To apply ladder programming using basic control elements to solve control problems using classical P ID control strategies . 3. To analyze the interface for a variety of input and output devices for PLC and SCADA. 4. To design of automation applications.		

Unit No.	SYLLABUS CONTENT	**No. of hours**
1	**Introduction to PLC**: Programming logic controller hardware and internal architecture, PLC systems Basic configuration and development, desktop and PC configured system, I/O devices, mechanical switches, proximity switches, photoelectric sensors and switches, temperature sensors, position sensors, pressure sensors and smart sensors.	**10**
2	**Output devices**: Relay, directional control valves, control of single and double acting cylinder control, conveyors control, I/O processing-signal conditioning, remote connections,networks, processing inputs, programming features.	**10**
3	**Programming methods:** Ladder programming, ladder diagrams, logic functions, latching multiple outputs, entering programs, function blocks, programming with examples, instruction list(IL), sequential function charts(SFC), structured text example with programs.	**10**
4	**Extended Programming methods:** Ladder program development examples with jump and call subroutines, timers, programming timers, off-delay timers, pulse timers, counters, forms of counter, up and down counting, timer with counters, and programming with examples. **Data handling:** Registers and bits, data movement, moving number to timer, data comparison, sequential switching on arithmetic and BCD, PLC for closed loop control, PID control with PLC, examples with programs, Development of temperature control, valve sequencing.	**12**
5	**SCADA:** Introduction to Supervisory control & data Acquisitions, distributed Control System (DCS): computer networks and communication in DCS. different BUS configurations used for industrial automation – GPIB, HART and OLE protocol, Industrial field bus – FIP (Factory Instrumentation Protocol), PROFIBUS (Process field bus), Bit bus. Interfacing of SCADA with controllers, Basic programming of SCADA, SCADA in PC based Controller.	**10**

Reference Books:

1. W. Bolten, "Programming Logic Controllers", Elsevier Publication, Oxford UK.
2. John W Webb, Ronald Reis, "Programmable logic controllers principle and application", Pearson publication.

<table>
<tr><td rowspan="3"></td><td colspan="4">SUBJECT TITLE : HYBRID ELECTRIC VEHICLES</td></tr>
<tr><td colspan="2">Subject Code: CAI204</td><td>No of Credits : 4:0:0:3
L T P C</td><td>No of lecture hours/week : 4</td></tr>
<tr><td colspan="2">Exam Duration : 3 hours</td><td>Exam Marks : 100</td><td>Total No of lecture hours: 52</td></tr>
<tr><td>Course Objectives</td><td colspan="4">1. To understand plug – in hybrid electric vehicle architecture, design and component sizing.
2. To apply different power electronics devices in hybrid electric vehicles .
3. To analyze electric drive for a specific type of hybrid electric vehicle .
4. To design and analyze different energy storage devices used for hybrid electric vehicles, their technologies and control.</td></tr>
<tr><td>Course Outcome</td><td colspan="4">1. Understand plug – in hybrid electric vehicle architecture, design and component sizing.
2. Apply different power electronics devices in hybrid electric vehicles .
3. Analyze electric drive for a specific type of hybrid electric vehicle .
4. Design and analyze different energy storage devices used for hybrid electric vehicles, their technologies and control.</td></tr>
<tr><td>Unit No.</td><td colspan="3">SYLLABUS CONTENT</td><td>No. of hours</td></tr>
<tr><td>1</td><td colspan="3">Introduction: Sustainable Transportation, A Brief History of HEVs, Why EVs Emerged and Failed, Architectures of HEVs, Interdisciplinary Nature of HEVs, State of the Art of HEVs, Challenges and Key Technology of HEVs.
Hybridization of the Automobile: Vehicle Basics, Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV), Basics of Fuel Cell Vehicles (FCVs).
HEV Fundamentals: Introduction, Vehicle Model, Vehicle Performance, EV Powertrain Component Sizing, Series Hybrid Vehicle, Parallel Hybrid Vehicle, Wheel Slip Dynamics.</td><td>12</td></tr>
<tr><td>2</td><td colspan="3">Plug-in Hybrid Electric Vehicles: Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, PHEV Design and Component Sizing, Component Sizing of EREVs, Component Sizing of Blended PHEVs, HEV to PHEV Conversions, Other Topics on PHEVs, Vehicle-to-Grid Technology.
Power Electronics in HEVs: Introduction, Principle of Power Electronics, Rectifiers Used in HEVs, Buck Converter Used in HEVs, Non-isolated Bidirectional DC–DC Converter, Voltage Source Inverter, Current Source Inverter, Isolated Bidirectional DC–DC Converter, PWM Rectifier in HEVs, EV and PHEV Battery Chargers, Modeling and Simulation of HEV Power Electronics, Emerging Power Electronics Devices, Circuit Packaging, Thermal Management of HEV Power Electronics.</td><td>10</td></tr>
<tr><td>3</td><td colspan="3">Electric Machines and Drives in HEVs: Introduction, Induction Motor Drives, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Thermal Analysis and Modeling of Traction Motors.</td><td>10</td></tr>
<tr><td>4</td><td colspan="3">Batteries, Ultracapacitors, Fuel Cells, and Controls: Introduction, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Modeling Based on Equivalent Electric Circuits, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System.</td><td>10</td></tr>
</table>

5	**Modeling and Simulation of Electric and Hybrid Vehicles:** Introduction, Fundamentals of Vehicle System Modeling, HEV Modeling Using ADVISOR, HEV Modeling Using PSAT, Physics-Based Modeling, Bond Graph and Other Modeling Techniques, Consideration of Numerical Integration Methods. **HEV Component Sizing and Design Optimization:** Introduction, Global Optimization Algorithms for HEV Design, Model-in-the-Loop Design Optimization Process, Parallel HEV Design Optimization Example, Series HEV Design Optimization Example. Vehicular Power Control Strategy and Energy Management: A Generic Framework, Definition, and Needs, Methodology to Implement, Benefits of Energy Management.	**10**

Reference Books:

Chris Mi,M. Abul Masrur,David Wenzhong Gao, Hybrid Electric Vehicles principles and Applications with Practical Perspectives, Newnes, Wiley, 2011

	SUBJECT TITLE : MULTI-LEVEL INVERTERS		
	Subject Code:CAI251	No of Credits : 4:0:0:3 L T P C	No of lecture hours/week : 4
	Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52
Course Objectives	1. To understand the concept of multilevel inverters. 2. To apply PWM techniques for different Multilevel Inverter topologies. 3. To analyze multilevel inverter based drives for induction motors and synchronous motors 4. To design and analyze high power converters		
Course Outcome	1. Understand the concept of multilevel inverters. 2. Apply PWM techniques for different Multilevel Inverter topologies. 3. Analyze multilevel inverter based drives for induction motors and synchronous motors 4. Design and analyze high power converters		

Unit No.	SYLLABUS CONTENT	No. of hours
1	Introduction, Conventional two-level inverters for single and three phase applications. Gate drive circuits for devices. Ratings and device stress. Harmonics.	**10**
2	Concept of multilevel inverters. Its effect on switch stress and harmonics and EMC. Topologies and waveforms. Effect of multilevel inverters on AC motors. SPWM and SVPWM techniques.	**10**
3	Neutral point clamped (NPC) inverters: 3-level, and 5-level, features, advantages and disadvantages. Cascaded H-bridge inverter. Higher levels attained using asymmetrical DC sources, and employing capacitors instead of DC sources. Requirements of number of devices, cost and reliability aspects for different configurations.	**10**
4	Generalized multilevel inverter topology with self voltage balancing. Multilevel inverters with Flying capacitor topology. Cascading two level inverters. Higher level inverter by using an open end induction machine with multilevel inverters on each side.	**12**
5	Issues of capacitor balancing and common mode voltage elimination. 12 and 18 sided Polygonal voltage space vector generation, hybrid inverters and recent trends in multilevel inverters.	**10**

Reference Books:

1. Bin Wu , “*High Power Converters and AC drives*”, IEEE press. John Wiley and Sons, Inc. 2006
2. Keith Corzine, “*Operation and Design of Multilevel Inverters*”, Developed for the office of Naval Research, Dec 2003, Revised June 2005.

	SUBJECT TITLE : FUZZY LOGIC CONTROL AND ITS APPLICATIONS		
	Subject Code:CAI252	No of Credits : 4:0:0:3 L T P C	No of lecture hours/week : 4
	Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52

Course Objectives	1. To understand the basics of Fuzzy rule. 2. To apply the concept of membership functions. 3. To analyze the Fuzzy rule based system. 4. To design and analyze the control system using Fuzzy rule.
Course Outcome	1. Understand the basics of Fuzzy rule. 2. Apply the concept of membership functions. 3. Analyze the Fuzzy rule based system. 4. Design and analyze the control system using Fuzzy rule.

Unit No.	SYLLABUS CONTENT	**No. of hours**
1	**Introduction:** Background, Uncertainty and imprecision, statistics and random processes, Uncertainty in information, Fuzzy sets and membership, chance versus ambiguity. Classical Sets: Operations on classical sets, properties of classical sets, Mapping of classical sets to functions, Fuzzy sets, Fuzzy set operations, Properties of Fuzzy sets, sets as points in Hypercube.	10
2	**Classical relations and fuzzy relations**: Cartesian product, Crisp relations cardinality of crisp relations, operations on crisp relations, properties of crisp relations, compositions, Fuzzy relations-cardinality of fuzzy relations, operations on fuzzy relations, properties of fuzzy relations, Fuzzy Cartesian product and composition, Non interactive fuzzy sets, Tolerance and equivalence relations-crisp equivalence relation, crisp tolerance relation, fuzzy tolerance, value assignments-Cosine amplitude, Max-min Method, other similarity methods.	11
3	**Membership functions:** Features of the membership function, standards forms and boundaries, fuzzification, Membership value assignments-intuition, inference, Rank ordering, Angular fuzzy sets, Genetic algorithms, inductive reasoning. **Fuzzy to crisp conversions:** Lambda-cuts for fuzzy sets, Lambda-cuts for fuzzy relations, Defuzzyfication methods, extension principle-crisp functions, Mapping and relations.	10
4	**Fuzzy rule based system:** Natural language, Linguistic hedges, Rule based systems, canonical rule forms, Decomposition of compound rules, Likelihood and truth qualification, Aggregation of fuzzy rules, Graphical techniques of inference. **Fuzzy Classification:** Classification by equivalence relations-crisp relations, Fuzzy relations, cluster analysis, Cluster validity, C-Means clustering-hard Means (HCM), Classification metric, Hardening the fuzzy C-partition, Similarity relations from clustering.	10
5	**Fuzzy arithmetic:** Functions of fuzzy sets-extension principle, fuzzy transform (Mapping), practical considerations, and fuzzy numbers, interval analysis in arithmetic, Approximate methods of extension-vertex method, DSW algorithm, Restricted DSW algorithm, Comparisions, Fuzzy vectors. **Fuzzy Control Systems:** Review of control systems theory, simple fuzzy logic controllers, general fuzzy logic controllers, special form of fuzzy logic control system models, examples of fuzzy control system design, industrial application of fuzzy logic, control of blood pressure during anesthesia, fuzzy logic application to image processing equipment, image stabilization for camcorders, customer adaptive fuzzy control of home heating system, adaptive fuzzy systems.	11

Reference Books:

1.Timothy J. Ross-"Fuzzy logic with Engineering applications" , McGraw-Hill. 1997.
2.B. Kosko – "Neural networks and fuzzy systems: A dynamical system approach", Pearson Edu. 1991.
3.George J. Klir and Tina A. Folger – "Fuzzy sets Uncertinity and information". Prentice Hall of India, 2003.
4.Kazao Tanaka-an introduction to fuzzy logic for practical applications", Springer-verlag, New York, 1997

	SUBJECT TITLE : ELECTRICAL POWER QUALITY		
	Subject Code:CAI253	No of Credits : 4:0:0:3 L T P C	No of lecture hours/week : 4
	Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52
Course Objectives	1. To understand the passive shunt and series compensation using lossless passive components. 2. To apply the concept of series and shunt compensation to improve power quality. 3. To analyze mitigation of power quality problems due to nonlinear loads . 4. To design series and shunt filters to improve power quality..		
Course Outcome	1. To understand the passive shunt and series compensation using lossless passive components. 2. To apply the concept of series and shunt compensation to improve power quality. 3. To analyze mitigation of power quality problems due to nonlinear loads. 4. To design series and shunt filters to improve power quality.		

Unit No.	SYLLABUS CONTENT	**No. of hours**
1	**Power Quality**: Introduction, State of the Art on Power Quality, Classification of Power Quality, Causes of Power Quality, Effects of Power Quality on Users, Classification of Mitigation Techniques for Power Quality Problems. **Power Quality Standards and Monitoring**: Introduction, State of the Art on Power Quality Standards and Monitoring, Power Quality Terminologies, Power Quality Definitions, Power Quality Standards, Power Quality Monitoring, Numerical Examples. **Passive Shunt and Series Compensation:** Introduction, State of the Art on Passive Shunt and Series Compensators, Classification of Passive Shunt and Series Compensators, Principle of Operation of Passive Shunt and Series Compensators, Analysis and Design of Passive Shunt Compensators, Modeling, Simulation, and Performance of Passive Shunt and Series Compensators, Numerical Examples.	12
2	**Active Shunt Compensation:** Introduction, State of the Art on DSTATCOMs, Classification of DSTATCOMs, Principle of Operation and Control of DSTATCOMs, Analysis and Design of DSTATCOMs, Modeling, Simulation, and Performance of DSTATCOMs, Numerical Examples.	10
3	**Active Series Compensation:** Introduction, State of the Art on Active Series Compensators, Classification of Active Series Compensators, Principle of Operation and Control of Active Series Compensators, Analysis and Design of Active Series Compensators, Modeling, Simulation, and Performance of Active Series Compensators, Numerical Examples.	10
4	**Unified Power Quality Compensators:** Introduction, State of the Art on Unified Power Quality Compensators, Classification of Unified Power Quality Compensators, Principle of Operation and Control of Unified Power Quality Compensators, Analysis and Design of Unified Power Quality Compensators, Modeling, Simulation, and Performance of UPQCs, Numerical Examples	10
5	Unified Power Quality Compensators (continued): Numerical Examples (from 6.11to 20). **Loads That Cause Power Quality Problems:** Introduction, State of the Art on Nonlinear Loads, Classification of Nonlinear Loads, Power Quality Problems Caused by Nonlinear Loads, Analysis of Nonlinear Loads, Modeling, Simulation, and Performance of Nonlinear Loads, Numerical Examples	10

Reference Books:

Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, Power Quality Problems and Mitigation Techniques, Wiley, 2015

	SRI SIDDHARTHA INSTITUTE OF TECHNOLOGY TUMKUR-5 **DEPARTMENT OF ELECTRICAL AND ELECTRONICS**					
	Subject Code	**CAI207**	No of Credits	**0:0: 3: 2** **L T P C**	No of hours/week	**3**
	Exam Duration	**3 hours**	Exam Marks	**50**		

SUBJECT TITLE: ELECTRICAL DRIVES LABORATORY	
Course Objectives	1. To understand basic logic gates using ladder logic. 2. To apply PWM techniques for control of AC and DC motors . 3. To analyze Power, Torque, RPM, Velocity, Efficiency using AC and DC emulator.
Course Outcome	1. To understand basic logic gates using ladder logic. 2. To apply PWM techniques for control of AC and DC motors . 3. To analyze Power, Torque, RPM, Velocity, Efficiency using AC and DC emulator.
	SYLLABUS CONTENT
1.	Construct and develop PLC ladder diagram to control lamp.
2.	Construct and develop PLC ladder diagram to control motor.
3.	Demonstration of water bottle filler using PLC.
4.	Demonstration of elevator using PLC.
5.	Realization of basic logic gates.
6	Simulation of single phase AC voltage controller.
7	Simulation of phase control and on-off control for AC voltage controller.
8	Conduct a suitable experiment to study charging and discharging operation of bidirectional converter.
9	Power, Torque, RPM, Velocity, Efficiency analysis using wind emulator.
10	Power, Torque, RPM, Velocity, Efficiency analysis using DC emulator.

	SUBJECT TITLE : CYBERSECURITY IN THE ELECTRICITY SECTOR		
	SubjectCode:CAI451	No of Credits : 4:0:0:3 L T P C	No of lecture hours/week : 4
	Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52
Course Objectives	1. To understand the current cybersecurity situation in the electricity sector and the relevant standards that can be employed for cybersecurity. 2. To analyze available solutions that support the cost-benefit analyses involved in cybersecurity management and cybersecurity assessment approach. 3. To apply cybersecurity management approach and the methods for the electricity sector. 4. To design cybersecurity controls, for reducing cyber risks.		
Course Outcome	1. Understand the current cybersecurity situation in the electricity sector and the relevant standards that can be employed for cybersecurity. 2. Analyze available solutions that support the cost-benefit analyses involved in cybersecurity management and cybersecurity assessment approach. 3. Apply cybersecurity management approach and the methods for the electricity sector. 4. Design cybersecurity controls, for reducing cyber risks.		

Unit No.	**SYLLABUS CONTENT**	**No. of hours**
1	**Introduction:** Transformation, Dependence on the ICT, 8Cybersecurity, Priority Critical Infrastructure. State of Cybersecurity in the Electricity Sector: Introduction, Vulnerabilities, Threats, Challenges, Initiatives, Future Directions.	**12**
2	**Cybersecurity Standards Applicable to the Electricity Sector:** Introduction, Literature Search, Literature Analysis, Standards' Selection and Evaluation Criteria, Results, Most Relevant Standards, Standards' Limitations, Standards' Implementation and Awareness	**10**
3	**A Systematic Approach to Cybersecurity Management:** Introduction, Cybersecurity Management Approaches in Standards, The Systematic Approach to Cybersecurity Management in the Electricity Sector.	**10**
4	**Cost of Cybersecurity Management:** Introduction, Economic Studies, Organisation Management Studies, CostBenefit Analysis, Cost Calculators, Costing Metrics, CAsPeA. Cybersecurity Assessment: Introduction, Security Assessment Methods for the Electricity Sector, Cybersecurity Test beds for Power Systems, JRC Cybersecurity Assessment Method, Laboratory Infrastructure, MAlSim	**10**
5	**Cybersecurity Controls:** Introduction, Standard Technical Solutions, Information Sharing Platform on Cybersecurity Incidents for the Energy Sector, Situation Awareness Network.	**10**

Reference Books:

1. Cybersecurity in the Electricity Sector, Rafal Leszczyna, Springer, 20192.

SUBJECT TITLE : FACTS CONTROLLERS		
Subject Code: CAI452	No of Credits : 4:0:0:3 L T P C	No of lecture hours/week : 4
Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52

Course Objectives	1. To understand FACTS concept and general system considerations 2. To analyze the static Voltage and Phase Angle Regulations 3. To apply the concept FACTS Controllers for combined compensation 4. To design FACTS Controllers for series and shunt compensation
Course Outcome	1. Understand FACTS concept and general system considerations 2. Analyze the static Voltage and Phase Angle Regulations 3. Apply the concept FACTS Controllers for combined compensation 4. Design FACTS Controllers for series and shunt compensation

Unit No.	**SYLLABUS CONTENT**	**No. of hours**
1	**FACTS concept and general system considerations** Transmission line Interconnections, Flow of power in an AC System, loading limit, Power flow and Dynamic stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Brief Description and Definitions of Basic Types of FACTS controllers.	**12**
2	**Static Voltage and Phase Angle Regulations:** Objective of Voltage and Phase Angle Regulators, Approaches to Thyristor-Controlled Voltage and Phase Angle Regulators (TCVRs and TCPARs), Switching Converter- Based Voltage and Phase Angle Regulators; Hybrid Phase Angle Regulator	**10**
3	**Combined Compensations:** Introduction, Unified Power Flow Controller, Interline Power Flow Controller (IPFC), Generalized and Multifunctional FACTS Controllers	**10**
4	**Special Purpose Facts Controllers:** NGH-SSR Damping Scheme and Thyristor-Controlled Breaking Resistor	**10**
5	Sub synchronous Resource; NGH-SSR Damping Scheme, Thyristor-Controlled Breaking Resistor (TCBR)	**10**

REFERENCE BOOKS:

1. Narain G. Hingorani and Laszlo Gyugyi, *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems*, IEEE Press, Standard Publishers Distributors, Delhi, 1st Edition, 2001,
2. R. Mohan Mathur, *Static Controllers for Electrical Transmission Systems*, IEEE Press and John Wiley & Sons, Inc.
3. R. Mohan Mathur and Rajiv K. Varma, *Thyristor-Based FACTS Controllers for Electrical Transmission Systems*, IEEE Press and John Wiley & Sons, Inc.

<table>
<tr><td rowspan="3"></td><td colspan="3">SUBJECT TITLE : ARTIFICIAL NEURAL NETWORKS</td></tr>
<tr><td>Subject Code: CAI453</td><td>No of Credits : 4:0:0:3
L T P C</td><td>No of lecture hours/week : 4</td></tr>
<tr><td>Exam Duration : 3 hours</td><td>Exam Marks : 100</td><td>Total No of lecture hours: 52</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. To understand basic knowledge of logic gates and circuits using Perceptron, Hebbian algorithm and McCulloch -Pitt's models.
2. To analyze models for classification of patterns, identifications of patterns based on perceptron and Hebbian algorithms.
3. To apply ANN model to solve problems associated with electrical drives.
4. To design ANN model in MATLAB.</td></tr>
<tr><td>Course Outcome</td><td colspan="3">1. Understand basic knowledge of logic gates and circuits using Perceptron, Hebbian algorithm and McCulloch -Pitt's models.
2. Analyze models for classification of patterns, identifications of patterns based on perceptron and Hebbian algorithms.
3. Apply ANN model to solve problems associated with electrical drives.
4. Design ANN model in MATLAB.</td></tr>
</table>

Unit No.	**SYLLABUS CONTENT**	**No. of hours**
1	Introduction, Fundamental concepts and Models of Artificial Neural systems, Biological Neural Networks, Where Are Neural Nets Being Used, How Are Neural Networks Used, Typical Architectures, Setting the Weights, Common Activation Functions, Mc Culloch –Pitts model- AND gate, OR gate, AND-NOT gate, XOR gate. Application of MATLAB in Neural Networks	**12**
2	Simple neural nets for Pattern Classification, Hebb net, examples, Single Layer Perceptron Classifiers, , Single Layer Feedback Networks, examples, Perceptron learning Pattern associations, applications, Training algorithm, Hebb rule &Delta rule, Classification of associative memory. Practical applications of pattern associations in Electrical systems.	**10**
3	Hetero associative neural net architecture, examples, Examples with missing and mistake data, Auto associative net architecture, Examples with missing and mistake data, Storage capacity. Recurrent linear auto associator, Examples	**10**
4	Discrete Hopfield net, Examples with missing and mistake data, Bidirectional associative net, architecture, Examples with missing and mistake data, Hamming distance, Fixed weight competitive nets, Architecture, applications. Constrained optimization examples.	**10**
5	Self-organizing maps, architecture, applications, examples, back propagation neural net, architecture, Application, Example, Applications of neural nets in different fields. Application of neural net in industrial drives. V/f control.	**10**

Reference Books:

1. Laurene Fausett, 'Fundamentals of Neural Networks: Architecture, Algorithms and Applications', Person Education, 2004.

2. Simon Hayking, 'Neural Networks: A Comprehensive Foundation',2nd Ed., PHI.

3. S.N Sivanandam, S Sumathi, S.N Deepa ' Introduction to Neural Net using Matlab 6.0' , TMH, 2008.

	SUBJECT TITLE : SPECIAL ELECTRICAL MACHINES		
	SubjectCode:CAI461	No of Credits : 4:0:0:3 L T P C	No of lecture hours/week : 4
	Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52

Course Objectives	1. To understand the types of Stepper Motor, construction and operation of BLDC motor 2. To analyze design aspect of switched Reluctance Motor. 3. To apply the properties of Permanent magnetic materials. 4. To design drive and power circuit for special machines.
Course Outcome	1. Understand the types of Stepper Motor, construction and operation of BLDC motor 2. Analyze design aspect of switched Reluctance Motor. 3. Apply the properties of Permanent magnetic materials. 4. Design drive and power circuit for special machines.

Unit No.	**SYLLABUS CONTENT**	**No. of hours**
1	**Stepper Motor:** Introduction, types, hybrid stepper motor; construction, principle of operation, two phases energized at a time, conditions for operation, different configurations, VR stepper motor; single stack and multi stack, drive systems and circuit for open loop and closed loop control of stepping motor, dynamic characteristics, single phase stepper motor, expression of voltage, current and torque for stepper motor and criteria for synchronization.	**12**
2	**Switched Reluctance Motor:** Constructional features, principle of operation, Design aspects and profile of the SRM, torque equation, power converters and rotor sensing mechanism, expression of torque and torque – speed characteristics.	**10**
3	**Permanent Magnet Materials:** Permanent magnetic materials, properties, minor hysteresis loop and recoil line, equivalent circuit, stator frames with permanent magnets.	**10**
4	**Brushless DC Motors:** Construction, operation, sensing and switching logic scheme, drive and power circuit, theoretical analysis and performance prediction, transient analysis.	**10**
5	**Linear Induction Motor:** Construction and principle of operation, calculation of the force on rotor.	**10**

Reference Books:

1. K Venkataratham, “Special Electrical Machines”, University Press (India), 2009.

2. T J E Miller, “Brushless Permanent Magnet and Reluctance Motor Drives”, Clerendon Press, Oxford, 1989.

	SUBJECT TITLE : INTELLIGENT APPLICATIONS IN ELECTRIC DRIVES		
	Subject Code: CAI462	No of Credits : 4:0:0:3 L T P C	No of lecture hours/week : 4
	Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52
Course Objectives	1. To understand the basics of physical structure and sparsity. 2. To analyze the Expert systems. 3. To apply basics AI applications to Power Systems. 4. To design the structure of Electrical Systems using Artificial Intelligence.		
Course Outcome	1. Understand the basics of physical structure and sparsity. 2. Analyze the Expert systems. 3. Apply basics AI applications to Power Systems. 4. Design the structure of Electrical Systems using Artificial Intelligence.		

Unit No.	**SYLLABUS CONTENT**	**No. of hours**
1	**Sparsity oriented Programming**: Introduction, physical structure and sparsity, pivoting, conservation of sparsity by optimal ordering of buses, schemes for ordering, UD table storage scheme.	**10**
2	**Artificial Intelligence:** Introduction**,** definitions, history and evolution, essential abilities of intelligence, AI applications; Problem solving: problem characteristics, problem search strategies, forward and backward reasoning, AND-OR graphs, game trees, search methods- informed and uninformed search, breadth first search and depth first search methods.	**12**
3	**Knowledge representation**: logical formalisms, propositional and predicate logic, syntax and semantics, wffs, clause form expressions, resolution- use of RRTs for proofs and answers, examples from electric power systems. Non-monotonic logic-TMS, modal, temporal and fuzzy logic.	**10**
4	**Structured representation** of knowledge: ISA/ISPART trees, semantic nets, frames and scripts, examples from electric systems.	**10**
5	**Expert systems:** Basic components, forward and backward chaining, ES features, ES development, ES categories, ES tools and examples from electric drive systems. AI languages: LisP and ProLog - Introduction, sample segments, LisP primitives, list manipulation functions, function predicates, variables, iteration and recursion, property lists, sample programs for examples from electric power systems.	**10**

REFERENCE BOOKS:

1. D.W.Patterson, ``Introduction to Artificial Intelligence and Expert Systems", Prentice-Hall of India, 1992.
2. J.Vlach and Singhal, ``Computer Methods for Circuit Analysis and Design", CBS Publishers, 1986.
3. Rich, Elaine, Kevin Knight, ``Artificial Intelligence", Tata McGraw-Hill, 1991.
4. Charniak E. and Mcdermott D., ``Introduction to AI", Addison-Wesley, 1985.
5. Nils J.Nilson, ``Problem Solving Methods in AI", McGraw-Hill, 1971.
6. Nils J.Nilson, ``Principles of AI", Berlin Springer-Verlag, 1980.

	SUBJECT TITLE : FPGA AND PROGRAMMABLE LOGIC		
	Subject Code: CAI463	No of Credits : 4:0:0:3 L T P C	No of lecture hours/week : 4
	Exam Duration : 3 hours	Exam Marks : 100	Total No of lecture hours: 52
Course Objectives	1. To understand basics of FPGA. 2. To analyze FPGA by using VHDL hardware description language for electronic application 3. To apply concept of reverse engineering of a product by using alternative FPGA solutions. 4. To design state machines using HDL and come up with an integrated chip (IC) solution in the form of a FPGA to be used in the area of drives		
Course Outcome	1. Understand basics of FPGA. 2. Analyze FPGA by using VHDL hardware description language for electronic application 3. Apply concept of reverse engineering of a product by using alternative FPGA solutions. 4. Design state machines using HDL and come up with an integrated chip (IC) solution in the form of a FPGA to be used in the area of drives		

Unit No.	**SYLLABUS CONTENT**	**No. of hours**
1	Recapitulation of combinational logic circuits. Timing hazards in combinational circuits. Introduction to the history and development of programmable logic. Birth of hardware description languages. Types of programmable logic devices, simple PLDs and CPLDs.	**12**
2	Architecture of FPGA - generic features. Definition and construction of FPGA. Architecting an FPGA. Performance, density and capacity of an FPGA. Programmability issues. A study of the XC4000 configurable logic block. Introduction to major FPGA families, Xilinx, Altera and Cypress.	**10**
3	Programming of FPGAs. Introduction to VHDL hardware description language. Programming elements, constructs and syntax. Entities and architecture, Creating combinational and synchronous logic. Details of function and procedures. Topics on identifiers, data objects, data types and attributes. Synthesis and fitting of designs.	**10**
4	Simulation and verification of the programs. Considerations of area, speed and device resource utilization in FPGA technology. Creating test benches. Systematic study of implementing state machines using VHDL. Unit	**10**
5	FPGA versus CPLD and case studies. Pipe lining and resource sharing concepts. Applications of FPGA in electric drives and communication devices. Future advances in FPGA technology	**10**

Text Books:

1. Kevin Skahill, “VHDL for Programmable logic”. Pearson Education, 2004

2. John F. Wakerly, ‘Digital Design, Principles and Practices’, Pearson Prentice Hall.