R16

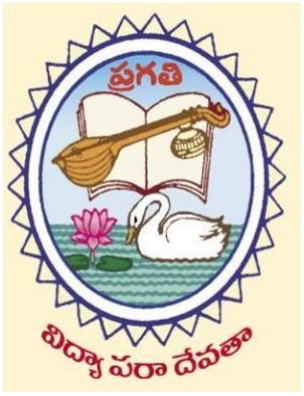
COURSE STRUCTURE AND SYLLABUS

for

M.Tech

POWER ELECTRONICS AND ELECTRIC DRIVES

(*Applicable for batches admitted from 2016-17*)



PRAGATI ENGINEERING COLLEGE

(AUTONOMOUS)

Permanently Affiliated to JNTUK, Kakinada, Accredited by NAAC with –A‖ Grade Recognized by UGC 2(f) and 12(b) under UGC act, 1956
1-378, ADB Road, Surampalem –
533 437 Near Peddapuram, E.G.Dist,
Andhra Pradesh

PRAGATI ENGINEERING COLLEGE : SURAMPALEM
(Autonomous)
ELECTRICAL AND ELECTRONICS ENGINEERING

Vision of the Institute:

To emerge as a Premier Institution for Technical Education in the Country through Academic Excellence and to be recognized as a Center for Excellence in Research & Development, catering to the needs of our Country.

Mission of the Institute:

To realize a strong Institution by consistently maintaining State-of-art-infrastructure and building a cohesive, World Class Team and provide need based Technical Education, Research And Development through enhanced Industry Interaction.

Vision of the Department:

To excel in Engineering Education and Research, inculcating professional and social ethics among the students through academic excellence in the field of Electrical & Electronics Engineering.

Mission of the Department:

M1: To impart quality Technical Education with good infrastructure for students to make them globally competent and technically strong.
M2: To collaborate with industries and academic institutions to enhance creativity and innovation with professional and ethical values.
M3: To motivate faculty and students to do impactful research on societal needs and to build team work among them.

Program Educational Objectives (PEOs):

PEO1: To impart education and train graduate engineers in the field of power Electronics to meet the emerging needs of society
PEO2: To provide knowledge and skill in the development of controls and drives to meet varied applications

Program Outcomes (POs):

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.
PO2: An ability to write and present a substantial technical report/document.
PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

Program Specific Outcomes (PSOs):

PSO1: To involve graduates in research activities leading to innovative solutions in Interfacing of power electronic controllers for any Electrical Applications.

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I Semester

S. No.	Course Category	Course Code	Course Title	L	P	C
1	Professional Core Courses	16051T01	Electrical Machine Modeling & Analysis	4	-	3
2	Professional Core Courses	16051T02	Analysis of Power Electronic Converters	4	-	3
3	Professional Core Courses	16051T03	Electric Drives – I	4	-	3
4	Professional Core Courses	16051T04	Flexible AC Transmission Systems	4	-	3
5	Elective		**Elective I**	4	-	3
6	Elective		**Elective II**	4	-	3
7	Professional Core Courses	16051L01	Systems Simulation Lab	-	4	2
Total Credits				-	-	**20**

II Semester

S. No.	Course Category	Course Code	Course Title	L	P	C
1	Professional Core Courses	16052T05	Switched Mode Power Conversion	4	-	3
2	Professional Core Courses	16052T06	Electric Drives- II	4	-	3
3	Professional Core Courses	16052T07	Digital Controllers	4	-	3
4	Professional Core Courses	16052T08	Custom Power devices	4	-	3
5	Elective		**Elective III**	4	-	3
6	Elective		**Elective IV**	4	-	3
7	Professional Core Courses	16052L02	Power Converters & Drives Lab	-	4	2
Total Credits				-	-	**20**

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III Semester

S. No.	Course Category	Course Code	Course Title	L	P	C
1	Project work, Seminar and Internship	16053S01	Seminar – I	-	-	2
2	Project work, Seminar and Internship	--	Project Work Part– I	-	-	18
Total Credits				-	-	**20**

IV Semester

S. No.	Course Category	Course Code	Course Title	L	P	C
1	Project work, Seminar and Internship	16054S02	Seminar – II	-	-	2
2	Project work, Seminar and Internship	16053P01	Project Work Part– II	-	-	18
Total Credits				-	-	**20**
Total Credits (20+20+20+20)						**80**

Elective I:

1.	16051D01	Modern Control Theory
2.	16051D02	Power Quality
3.	16051D03	Optimization Techniques

Elective II:

1.	16051D04	Energy Auditing, Conservation and Management
2.	16051D05	Artificial Intelligence Techniques
3.	16051D06	HVDC Transmission

Elective III:

1.	16052D07	Renewable Energy Systems
2.	16052D08	Reactive Power Compensation & Management
3.	16052D09	Electrical Distribution Systems

Elective IV:

1.	16052D10	Smart Grid
2.	16052D11	Special Machines
3.	16052D12	Programmable Logic Controllers & Applications

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I Semester

ELECTRICAL MACHINE MODELING AND ANALYSIS

Course Category	Professional core	**Course Code**	**16051T01**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To know the concepts of generalized theory of electrical machines.
2	To represent the DC and AC machines as Basic Two Pole machine.
3	To model the electrical machines with voltage, current, torque and speed equations.
4	To investigate the steady state and transient behaviour of the electrical machines.
5	To understand the dynamic behaviour of the AC machines.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Apply knowledge of behavior of DC motors to model and analyze for different applications.	Applying	K3
CO2	Analyze the characteristics of different types of DC motors to design suitable controllers	Analyzing	K4
CO3	Apply the knowledge of reference frame theory for AC machines to model the induction and Synchronous machines.	Applying	K3
CO4	Evaluate the steady state and transient behavior of induction and synchronous machines to Propose the suitability of drives for different industrial applications	Applying	K3
CO5	Analyze the 2-Phase induction machines using voltage and torque equations to differentiate the behavior and to propose their applications in real world.	Analyzing	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	1	2	3	1
CO2	1	2	3	1
CO3	1	2	3	1
CO4	1	2	3	1
CO5	1	2	3	1

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COURSE CONTENT	
UNIT I	**Basic concepts of Modeling** Basic two-pole machine representation of Commutator machines, representations of 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine voltage, current and torque equations
UNIT II	**DC Machine Modeling** Mathematical model of separately excited D.C motor – Steady state analysis-transient State analysis-sudden application of inertia load-transfer function of separately excited D.C motor- Mathematical model of D.C Series motor, Shunt motor-Linearization techniques for small perturbations
UNIT III	**Reference frame theory& Modeling of single-phase Induction Machines** Linear transformation-Phase transformation - three phase to two phase transformation (abc to αβ0) and two phase to three phase transformation αβ0 to abc - -Power equivalence Mathematical modeling of single phase induction machines.
UNIT IV	**Modeling of three phase Induction Machine** Generalized model in arbitrary reference frame-Electromagnetic torque-Derivation of commonly used Induction machine models- Stator reference frame model-Rotor reference frame model-Synchronously rotating reference frame model-state space model with flux linkages as variables.
UNIT V	**Modeling of Synchronous Machine** Synchronous machine inductances – derivation of voltage equations in the rotor's dq0 reference frame electromagnetic torque-current in terms of flux linkages-three phase synchronous motor. State space models with flux linkages as variables.

TEXT BOOKS	
1.	Electric Motor Drives - Modeling, Analysis& control -R.Krishnan- Pearson Publications- 1st edition -2002
2.	Analysis of Electrical Machinery and Drive systems – P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff – Second Edition-IEEE Press.
3.	amic simulation of Electric machinery using Matlab / Simulink –CheeMunOng- Prentice Hall
REFERENCE BOOKS	
1.	P.S.Bhimbra,'' Generalised theory of Electrical Machines''-Fifth edition, Khanna publishers.
2.	Vedam Subryamanhyam, Thyristor Control of Electric Drives, Tata McGraw Hill
WEB RESOURCES (Suggested)	
1.	.http://www.motor-design.com/cmsAdmin/uploads/induction_motor_modelling.pdf
2.	https://nptel.ac.in/courses/108106023/
3.	http://www.ee.iitm.ac.in/2016/08/ee5201/

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I Semester

ANALYSIS OF POWER ELECTRONIC CONVERTERS

Course Category	Professional core	**Course Code**	**16051T02**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To study the operation of AC voltage controllers.
2	To study the operation of AC-DC voltage converters
3	To study the necessity requirement of power factor correction for converter circuits.
4	To study the operation of inverters with and without PWM controller.
5	To study the operation of different types of multilevel inverters.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Analyze the operation of AC Voltage Controllers.	Analyzing	K4
CO2	Analyze the operation of AC-DC Converters	Analyzing	K4
CO3	Analyze the requirements of power factor correction in converter circuits	Analyzing	K4
CO4	Describe and analyze the operation of 3-phase inverters with and without PWM techniques	Analyzing	K4
CO5	Describe principles of operation and features of multilevel inverters	Understanding	K2

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	3	2
CO2	2	2	3	2
CO3	2	2	3	2
CO4	2	2	3	2
CO5	2	2	3	2

COURSE CONTENT	
UNIT I	**AC voltage Controllers:** Single Phase AC Voltage Controllers with RLE loads- ac voltage controller with PWM control –synchronous tap changers Application numerical problems. Three Phase AC Voltage controllers-Analysis of Controllers with star and delta connected resistive–inductive loads-Effects of source and load inductances–Application- numerical problems.
UNIT II	**AC-DC converters:** Single phase fully controlled converters with– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-Power factor improvements-Extinction angle control-symmetrical angle control- PWM control numerical problems. Three Phase ac-dc Converters- fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-three phase dual converters-Power factor improvements-three phase PWM control -twelve pulse converters- numerical problems
UNIT III	**Power Factor Correction Converters:** Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter
UNIT IV	**PWM Inverters:** Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and

	delta modulation – numerical problems. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60^0 PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques-current source inverters-Variable dc link inverter - numerical problems
UNIT V	**Multi-level inverters:** Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying- Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters

TEXT BOOKS	
1.	Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint- 2008
2.	Power Electronics- Ned Mohan, Tore M.Undelan and William P.Robbins –John Wiley& Sons -2nd Edition.
3.	Power Electronics – Lander –Ed.2009
REFERENCE BOOKS	
1.	Modern power Electronics and AC Drives – B.K.Bose
2.	Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee Publishing PvtLtd
WEB RESOURCES (Suggested)	
1.	http://www.edrive.narod.ru/PE.pdf
2.	https://nptel.ac.in/downloads/108105066/
3.	http://www.vssut.ac.in/lecture_notes/lecture1424354515.pdf

PRAGATI ENGINEERING COLLEGE : SURAMPALEM
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ELECTRICAL AND ELECTRONICS ENGINEERING

I Semester

ELECTRIC DRIVES-I

Course Category	Professional core	**Course Code**	**16051T03**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To study the operation of single phase converter fed DC Drives
2	To study the operation of three phase converter fed DC Drives
3	To study modeling concepts of AC – DC converters fed drive components.
4	To study the operation of DC- DC converter fed DC drives.
5	To study the operation of closed loop control based DC-DC converters fed DC drives

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive Level**	
CO1	Analyse single phase converter fed DC drives.	Analyzing	K4
CO2	Analyse three phase converter fed DC drives.	Analyzing	K4
CO3	Analyse the two quadrants and four quadrant controls of DC motor drives	Analyzing	K4
CO4	Develop the mathematical models of DC drive components.	Applying	K3
CO5	Analyse the four quadrant and closed loop control of DC-DC converter fed DC drive	Analyzing	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	3	2
CO2	2	2	3	2
CO3	2	2	3	2
CO4	2	2	3	2
CO5	2	2	3	2

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COURSE CONTENT	
UNIT I	**Introduction on single phase converter fed DC motor drive:** Basic power electronic drive system, components, stability of power electronic drive, single phase full-converter and half-convertor fed dc drives for continuous and discontinuous mode of operation. Four quadrant operation of drive using dual converter.
UNIT II	**Three phase AC-DC converter fed DC motor drive:** Three phase full-converter and half-convertor fed dc drives for continuous and discontinuous mode of operation. Four quadrant operation of drive using three phase dual converter. Pulsating torque
UNIT III	**Modeling of AC-DC convertor fed DC drive components & design of controller:** Transfer function of Dc motor and load, convertor, current and speed controllers, current and speed feedback elements. Design of current controller and speed controller. Closed loop two quadrant DC motor drive, closed loop four quadrant DC motor drive, introduction to simulation of DC motor drive.
UNIT IV	**DC-DC converter fed DC motor drive:** Four quadrant DC-DC convertor fed dc motor drive, steady state analysis of DC-DC converter dc motor drive, pulsating torques.
UNIT V	**Closed loop operation of DC-DC convertor fed dc motor drive:** Design of current controller, design of speed controller, modeling of current and speed controller, introduction to simulation of speed controlled dc motor drive

TEXT BOOKS	
1.	Electrical Motor Drives Modeling, Analysis and Control – R. Krishnan, Prentice Hall India.
2.	Power Semiconductor Controlled Drives – G.K. Dubey.Prentice Hall India.
3.	Power Electronics and Motor control – Shepherd, Hulley, Liang-II Edition, Cambridge University Press
REFERENCE BOOKS	
1.	Power electronic circuits, devices and applications – M.H.Rashid – PHI.
2.	Murphy J. M. D. and Turnbull F. G., "Power Electronics Control of AC Motors", Pregamon Press.1990.
WEB RESOURCES (Suggested)	
1.	www.iare.ac.in/sites/default/files/lecture_notes/sd%20lecture%20notes.pdf
2.	http://shodganga.inflibnet.ac.in
3.	https://www.slideshare.net/psksiva13/63814075-electricaldrivesandcontrollecturenotes

PRAGATI ENGINEERING COLLEGE : SURAMPALEM

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I Semester

ELECTRICAL AND ELECTRONICS ENGINEERING

FLEXIBLE AC TRANSMISSION SYSTEMS

Course Category	Professional core	**Course Code**	**16051T04**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To study the performance improvements of transmission system with FACTS.
2	To study the operation of Voltage source converter
3	. To study the effect of static shunt compensation
4	. To study the effect of SVC and STATCOM
5	To study the effect of static series compensation

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Know the performance improvement of transmission system with FACTS.	Remembering	K1
CO2	Understand the Operation of Voltage Source Convereter	Understanding	K2
CO3	Get the knowledge of effect of static shunt compensation.	Analyzing	K4
CO4	Understand the Effect of SVC and STATCOM	Understanding	K2
CO5	Get the knowledge of effect of static series compensation	Analyzing	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	2	1
CO2	3	2	2	1
CO3	3	2	2	1
CO4	3	2	2	1
CO5	3	2	2	1

COURSE CONTENT

UNIT I	FACTS concepts, Transmission interconnections, power flow in an AC System, loading capability limits, Dynamic controllers, benefits from FACTS controllers. stability considerations, importance of controllable parameters, basic types of FACTS

UNIT II	**Voltage source converters :** Single phase, three phase, full wave bridge converters, transformer connections for 12 pulse, 24 and 48 pulse operation. Three level voltage source converter, pulse width modulation converter, basic concept of current source converters, and comparison of current source converters with voltage source converters.
UNIT III	**Static shunt compensation :** Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, methods of controllable var generation, variable impedance type static var generators, switching converter type var generators, hybrid var generators.
UNIT IV	**SVC and STATCOM :** The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control.
UNIT V	**Static series compensators :** Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC.

TEXT BOOKS	
1.	"Understanding FACTS Devices" N.G.Hingorani and L.Guygi, IEEE Press. Indian Edition is available:--Standard Publications
2.	Sang.Y.HandJohn.A.T, "Flexible AC Transmission systems" IEEE Press (2006).
REFERENCE BOOKS	
1.	K.R Padiyar, Facts Control in Power Transmission and Distribution system, Anshan
2.	HVDC & FACTS Controllers: applications of static converters in power systems- Vijay K.Sood-Springer publishers.
WEB RESOURCES (Suggested)	
1.	http://ethesis.nitrkl.ac.in/2243/1/Project_Thesis_Final.pdf
2.	http://www.site.uottawa.ca/~rhabash/ELG4125FACTS.pdf

PRAGATI ENGINEERING COLLEGE : SURAMPALEM
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ELECTRICAL AND ELECTRONICS ENGINEERING

I Semester

MODERN CONTROL THEORY (Elective-I)

Course Category	Elective – I	**Course Code**	**16051D01**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To facilitate the evolution of state variable approach for the analysis of control systems.
2	To examine the importance of controllability and observability in modern control engineering.
3	To enable students to analyze various types of nonlinearities & construction of trajectories using describing functions.
4	To enable students to analyze various types of nonlinearities & construction of trajectories using phase plane analysis.
5	To study the analysis of stability and instability of continuous time invariant system

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Understanding the state variable approach is suitable for higher order.	Understanding	K2
CO2	To analyze the concepts of controllability and observability.	Analyzing	K4
CO3	To analyze the various non-linearities through describing functions and phase plane analysis.	Analyzing	K4
CO4	To an alyze the various non-linearities through phase plane analysis	Analyzing	K4
CO5	Know the typical issues of stability and instability of continuous time invariant systems	Remembering	K1

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	1	2	3	1
CO2	1	2	3	1
CO3	1	2	3	1
CO4	1	2	3	1
CO5	1	2	3	1

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COURSE CONTENT	
UNIT I	**State Variable Analysis** The concept of state – State Equations for Dynamic systems, State diagram - Linear Continuous time model for physical systems – Existence and Uniqueness of Solutions to Continuous, Time State Equations – Solutions – Linear Time Invariant Continuous, Time State Equations, State transition matrix and it's properties
UNIT II	**State Variable Techniques** General concept of Controllability - General concept of Observability Controllability tests for Continuous &Time Invariant systems, Observability tests for Continuous &Time Invariant systems - Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model – State feedback controller design through pole assignment.
UNIT III	**Non Linear Systems – I** Introduction – Non Linear Systems – Types of Nonlinearities – Saturation – Dead Zone – Backlash – Jump Phenomenon etc; - Singular Points – Introduction to Linearization of nonlinear systems, properties of Non Linear Systems – Describing function – describing function analysis of nonlinear systems- Stability analysis of Nonlinear systems through describing functions.
UNIT IV	**Non Linear Systems – II** Introduction to phase plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase plane analysis of nonlinear control systems.
UNIT V	**Stability Analysis** Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

TEXT BOOKS	
1.	Modern Control System Theory by M. Gopal – New Age International – 1984
2.	Modern Control Engineering by Ogata. K – Prentice Hall – 1997
3.	Nonlinear systems, Hassan K. Klalil, Prentice Hall, 1996
REFERENCE BOOKS	
1.	Modern control systems, Richard C. Dorf and Robert H. Bishop, 11th Edition, Pearson Edu, India, 2009
2.	B.N. Sarkar, Advance Control Systems, PHI
WEB RESOURCES (Suggested)	
1.	http://www.ece.rutgers.edu/~gajic/psfiles/chap5.pdf
2.	https://nptel.ac.in/courses/108103007/
3.	https://www.studyindia.com/Pdf_Viewer/web/pdfviewer.aspx?ID=39805&file=3281Brogan_SI9a8.pdf

PRAGATI ENGINEERING COLLEGE : SURAMPALEM
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ELECTRICAL AND ELECTRONICS ENGINEERING

I Semester

POWER QUALITY (Elective-I)

Course Category	Elective-I	**Course Code**	**16051D02**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand significance of power quality and power quality parameters.
2	To know types of transient over voltages and protection of transient voltages.
3	To understand harmonics, their effects, harmonic indices and harmonic minimization techniques.
4	To understand long duration voltage variation and flicker.
5	To know power quality aspects in distributed generation.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Have the knowledge on causes of power quality, power quality parameters.	Understanding	K2
CO2	Understand sources of transient over voltages and providing protection to transient over voltages.	Understanding	K2
CO3	Understand effects of harmonics, sources of harmonics and harmonic minimization.	Analyzing	K4
CO4	Analyze long duration voltage variations and regulation of voltage variations.	Analyzing	K4
CO5	Describe power quality aspects in distributed generation and develop solutions to wiring and grounding problems	Evaluating	K5

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	3	1
CO2	2	3	3	1
CO3	2	3	3	1
CO4	2	3	3	1
CO5	2	3	3	1

COURSE CONTENT	
UNIT I	**Introduction**

	Overview of Power Quality, Concern about the Power Quality, General Classes of Power Quality Problems, Transients, Long-Duration Voltage Variations, Short, Duration Voltage Variations, Voltage Unbalance, Waveform Distortion, Voltage fluctuation, Power Frequency Variations, Power Quality Terms, Voltage Sags and Interruptions - Sources of Sags and Interruptions, Nonlinear loads.
UNIT II	**Transient Over Voltages** Source of Transient Over Voltages - Principles of Over Voltage Protection, Devices for Over Voltage Protection, Utility Capacitor Switching Transients, Utility Lightning Protection, Load Switching Transient Problems, Computer Tools for Transient Analysis
UNIT III	**Harmonic Distortion and solutions** Voltage vs. Current Distortion, Harmonics vs. Transients - Power System Quantities under Non-sinusoidal Conditions, Harmonic Indices, Sources of harmonics, Locating Sources of Harmonics, System Response Characteristics, Effects of Harmonic Distortion, Inter harmonics, Harmonic Solutions Harmonic Distortion Evaluation, Devices for Controlling Harmonic Distortion, Harmonic Filter Design, Standards on Harmonics
UNIT IV	**Long Duration Voltage Variations** Principles of Regulating the Voltage, Device for Voltage Regulation, Utility Voltage Regulator Application, Capacitor for Voltage Regulation, End-user Capacitor Application, Regulating Utility Voltage with Distributed Resources, Flicker
UNIT V	**Distributed Generation and Power Quality** Resurgence of Distributed Generation, DG Technologies, Interface to the Utility System, Power Quality Issues, Operating Conflicts, DG on Low Voltage Distribution Networks, Interconnection standards, Wiring and Grounding, Typical Wiring and Grounding Problems, Solution to Wiring and grounding Problems

TEXT BOOKS	
1.	Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw-Hill, 2002.
2.	Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.
3.	Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000.
REFERENCE BOOKS	
1.	Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.
2.	Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
3	Power Quality c.shankaran, CRC Press, 2001
4	Harmonics and Power Systems –Franciso C.DE LA Rosa-CRC Press (Taylor & Francis)
5	Power Quality in Power systems and Electrical Machines-EwaldF.fuchs, MohammadA.S. Masoum-Elsevier
WEB RESOURCES (Suggested)	
1.	www.tnb.com/eel/docs/furse/bs7671.pdf
2.	http://prof.usb.ve/bueno/Libros/power_quality-0849310407.pdf

PRAGATI ENGINEERING COLLEGE : SURAMPALEM
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ELECTRICAL AND ELECTRONICS ENGINEERING

I Semester

OPTIMIZATION TECHNIQUES (Elective-I)

Course Category	Elective – I	**Course Code**	**16051D03**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To define an objective function and constraint functions in terms of design variables, and then state the optimization problem.
2	To state single variable and multi variable optimization problems, without and with constraints.
3	To explain linear programming technique to an optimization problem, define slack and surplus variables, by using Simplex method.
4	To study and explain nonlinear programming techniques, unconstrained or constrained, and define exterior and interior penalty functions for optimization problems.
5	To introduce evolutionary programming techniques.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	State and formulate the optimization problem and Apply classical optimization techniques to minimize or maximize a multi-variable objective function, without or with constraints, and arrive at an optimal solution.	Applying	K3
CO2	Formulate a mathematical model and apply linear programming technique by using Simplex method. Also extend the concept of dual Simplex method for optimal solutions.	Analyzing	K4
CO3	Apply gradient and non-gradient methods to nonlinear optimization problems and use interior or exterior penalty functions for the constraints to derive the optimal solutions.	Applying	K3
CO4	Able to apply Genetic algorithms for simple electrical problems.	Applying	K3
CO5	Able to solve practical problems using PSO.	Evaluating	K5

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)				
	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	2	1
CO2	2	2	2	1
CO3	2	2	2	1
CO4	2	2	2	1
CO5	2	2	2	1

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I Semester

COURSE CONTENT	
UNIT I	**Introduction and Classical Optimization Techniques:** Statement of an Optimization problem – design vector – design constraints – constraint surface –objective function – objective function surfaces – classification of Optimization problems. Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints. Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.
UNIT II	**Linear Programming** Standard form of a linear programming problem – geometry of linear programming problems –definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm - Duality in Linear Programming – Dual Simplex method.
UNIT III	**Nonlinear Programming:** **Unconstrained cases -** One – dimensional minimization methods: Classification, Fibonacci method and Quadratic interpolation method - Univariate method, Powell's method and steepest descent method. **Constrained cases -** Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods. Introduction to convex Programming Problem.
UNIT IV	**Introduction to Evolutionary Methods:** Evolutionary programming methods - Introduction to Genetic Algorithms (GA)– Control parameters – Number of generation, population size, selection, reproduction, crossover and mutation – Operator selection criteria – Simple mapping of objective function to fitness function– constraints – Genetic algorithm steps – Stopping criteria –Simple examples.
UNIT V	**Introduction to Swarm Intelligence Systems:** Swarm intelligence programming methods - Basic Partial Swarm Optimization – Method –Characteristic features of PSO procedure of the global version – Parameters of PSO (Simple PSO algorithm – Operators selection criteria – Fitness function constraints) – Comparison with other evolutionary techniques – Engineering applications of PSO

TEXT BOOKS	
1.	"Engineering optimization: Theory and practice"-by S. S.Rao, New Age International (P) Limited, 3rd edition, 1998.
2.	Soft Computing with Matlab Programming by N.P.Padhy & S.P.Simson, Oxford University Press – 2015
3.	**"**Optimization methods in operations Research and Systems Analysis" by K.V.Mital and C.Mohan, New Age International (P) Limited, Publishers, 3rd edition, 1996.
REFERENCE BOOKS	
1.	Genetic Algorithms in search, optimization, and Machine Learning by David E.Goldberg,ISBN:978-81-7758-829-3, Pearsonby Dorling Kindersley (India) Pvt. Ltd.
2.	"Operations Research: An Introduction" by H.A.Taha, PHI pvt. Ltd., 6th edition.
3.	Linear Programming by G.Hadley.,Narosa Publishers.
WEB RESOURCES (Suggested)	
1.	.slideplayer.com/slide/5028943/
2.	https://nptel.ac.in/downloads/105108127/
3.	https://www.iare.ac.in/sites/default/files/lecture_notes/OT_LECTURE_NOTES_0.pdf

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ELECTRICAL AND ELECTRONICS ENGINEERING

I Semester

ENERGY AUDITING, CONSERVATION AND MANAGEMENT (Elective-II)

Course Category	Elective – II	**Course Code**	**16051D04**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To learn principle of energy.
2	To learn management for industries and utilities for buildings.
3	To study the energy efficient motors and lighting.
4	To learn power factor improvement methods and operation of different energy instruments.
5	To compute depreciation methods of equipment for energy saving.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Perform energy audit in different organizations	Evaluating	K5
CO2	Perform management for industries and utilities for buildings	Evaluating	K5
CO3	Recommend energy efficient motors and design good lighting system.	Evaluating	K5
CO4	Understand advantages to improve the power factor.	Understanding	K2
CO5	Evaluate the depreciation of equipment	Evaluating	K5

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	1	1
CO2	2	3	1	1
CO3	2	3	1	1
CO4	2	3	1	1
CO5	1	3	1	1

COURSE CONTENT

UNIT I	**Basic Principles of Energy Audit** Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams and load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.
UNIT II	**Energy Management** Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manger, qualities and functions, language, Questionnaire – check list for top management
UNIT III	**Energy Efficient Motors and Lighting** Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics – variable speed, variable duty cycle systems, RMS hp- voltage variation-voltage unbalance-over motoring-motor energy audit. Good lighting system design and practice, lighting control, lighting energy audit
UNIT IV	**Power Factor Improvement and energy instruments** Power factor – methods of improvement, location of capacitors, Power factor with non-linear loads, effect of harmonics on p.f. p.f motor controllers – Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's
UNIT V	**Economic Aspects and their computation** Economics Analysis depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method, net present value method- Power factor correction, lighting – Applications of life cycle costing analysis, return on investment.

TEXT BOOKS	
1.	Energy management by W.R.Murphy & G.Mckay Butter worth, Heinemann publications
2.	Energy efficient electric motors by John.C.Andreas, Marcel Dekker Inc Ltd-2nd edition,1995
3.	Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
REFERENCE BOOKS	
1.	Energy management hand book by W.CTurner, John wiley and sons
2.	Energy management and good lighting practice : fuel efficiency- booklet12-EEO
WEB RESOURCES (Suggested)	
1.	://pdhonline.com/courses/e144/e144content.pdf
2.	https://beeindia.gov.in/sites/default/files/1Ch3.pdf
3.	https://www.researchgate.net/publication/309463130_Energy_Audit_Management

I Semester

PRAGATI ENGINEERING COLLEGE : SURAMPALEM
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ELECTRICAL AND ELECTRONICS ENGINEERING

ARTIFICIAL INTELLIGENCE TECHNIQUES (Elective-II)

Course Category	Elective – II	**Course Code**	**16051D05**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To have knowledge on concept of neural network.
2	To know different types of neural networks and training algorithms.
3	To understand the concept of genetic algorithm and its application in optimization.
4	To have the knowledge on fuzzy logic and design of fuzzy logic controllers.
5	To know the applications of AI Techniques in power electronics and DC drives.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Understand neural networks and analyze different types of neural networks.	Understanding	K2
CO2	Design training algorithms for neural networks.	Evaluating	K5
CO3	Develop algorithms using genetic algorithm for optimization.	Applying	K3
CO4	Analyze and design fuzzy logic systems.	Analyzing	K4
CO5	Apply AI Techniques in power electronics and DC drives.	Applying	K3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	2	1
CO2	3	2	2	1
CO3	3	2	2	1
CO4	3	2	2	1
CO5	3	2	2	1

COURSE CONTENT	
UNIT I	**Introduction to Neural Networks** Introduction, Humans and Computers, Biological Neural Networks, Historical development of neural network, Terminology and Topology, Biological and artificial neuron models, Basic learning laws.
UNIT II	**Feed Forward Neural Networks** Introduction, Perceptron models: Discrete, continuous and multi-category, Training algorithms: Discrete and Continuous Perceptron Networks, Perceptron convergence theorem, Limitations and applications of the Perceptron model, Generalized delta learning rule, Feedforward recall and error back propagation training-Radial basis function algorithms-Hope field networks
UNIT III	**Genetic algorithms & Modelling**-introduction-encoding-fitness function-reproduction operators-genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm
UNIT IV	**Classical and Fuzzy Sets** Introduction to classical sets - properties, operations and relations; Fuzzy sets, membership, Uncertainty, operations, properties, fuzzy relations, cardinalities, membership functions. Fuzzy Logic System Components-Fuzzification, Membership value assignment, development of rule base and decision making system, defuzzification to crisp sets, defuzzification methods.
UNIT V	**Application of AI Techniques:** PWM Controllers -Selected harmonic elimination PWM Space vector PWM using neural network. Design of PI controller for speed control of DC motor using fuzzy logic-

TEXT BOOKS	
1.	Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Pai – PHI Publication.
2.	Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.
3.	Modern Power Electronics and AC Drives –B.K.Bose-Pearson Publications
REFERENCE BOOKS	
1.	Genetic Algorithms- David E Goldberg. Pearson publications.
2.	M.C. Trivedi, Artificial Intelligence, Khanna Publishing House, Delhi
WEB RESOURCES (Suggested)	
1.	/www.eolss.net/sample-chapters/c18/e6-43-23-04.pdf
2.	www.vssut.ac.in/lecture_notes/lecture1428643004.pdf
3.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-825-techniques-in-artificial-intelligence-sma-5504-fall-2002/lecture-notes/

I Semester

PRAGATI ENGINEERING COLLEGE : SURAMPALEM
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ELECTRICAL AND ELECTRONICS ENGINEERING
HVDC TRANSMISSION (Elective-II)

Course Category	Elective – II	**Course Code**	**16051D06**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To learn various schemes of HVDC transmission.
2	To learn about the basic HVDC transmission equipment.
3	To learn the control of HVDC systems.
4	To be exposed to the interaction between HVAC and HVDC system.
5	To be exposed to the various protection schemes of HVDC engineering

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Understand the various schemes of HVDC transmission.	Analyzing	K4
CO2	Understand the basic HVDC transmission equipment.	Analyzing	K4
CO3	Understand the control of HVDC systems.	Analyzing	K4
CO4	Understand the interaction between HVAC and HVDC system.	Analyzing	K4
CO5	Understand the various protection schemes of HVDC engineering.	Analyzing	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	2	1
CO2	2	2	2	1
CO3	2	2	2	1
CO4	2	2	2	1
CO5	2	2	2	1

COURSE CONTENT

UNIT I	**Introduction:** Limitation of EHV AC Transmission, Advantages of HVDC Technical economical reliability aspects. HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration. Types of HVDC links Apparatus and its purpose.
UNIT II	**Static power converters:** 6-pulse bridge circuit and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Comparison of the perform of diametrical connection with 6-pulse bridge circuit.
UNIT III	**Control of HVDC converters and systems:** constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control. Factors responsible for generation of Harmonics voltage and current harmonics effect of variation of α and μ. Filters Harmonic elimination.
UNIT IV	**Interaction between HVAC and DC systems:** Voltage interaction, Harmonic instability problems and DC power modulation. Development of DC circuit Breakers, Multiterminal DC links and systems; series, parallel and series parallel systems, their operation and control.
UNIT V	**Transient over voltages in HVDC systems:** Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults **Converter faults and protection in HVDC systems:** Converter faults, over current protection - valve group, and DC line protection, circuit breakers. Over voltage protection of converters, surge arresters.

TEXT BOOKS	
1.	S Kamakshaih and V Kamaraju:HVDC Transmission- MG hill.
2.	K.R.Padiyar : High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi– 1992.
3.	E.W. Kimbark : Direct current Transmission, Wiley Inter Science – New York.
REFERENCE BOOKS	
1.	J.Arillaga : H.V.D.C. Transmission Peter Peregrinus ltd., London UK 1983
2.	Vijay K Sood :HVDC and FACTS controllers :Applications of static converters in power systems by, Kluwer Academic Press.
WEB RESOURCES (Suggested)	
1.	http://nptel.ac.in/courses/108104013/
2.	https://lecturenotes.in/subject/115/high-voltage-dc-transmission-hvdc
3.	https://drive.google.com/file/d/127RGZtGH3EtxlVaqZjeihj2M_vb7zmPY/view

SYTEMS SIMULATION LAB

Course Category	Lab course	**Course Code**	**16051L01**
Course Type	LAB	**L-T-P-C**	0-0-4-2
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand the characteristics of Thyristor, MOSFET & IGBT by simulation.
2	To understand the operation of power electronics converters by simulation.
3	To understand how to implement PWM techniques in simulation.
4	To understand and analyse the speed control of AC motors in open and closed loop in simulation.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Analyze the characteristics of power semiconductor devices in simulation.	Analyzing	K4
CO2	Analyze the operation of various power electronic converters in simulation.	Analyzing	K4
CO3	Analyze and implementing the speed controlling techniques for AC machines in simulation.	Analyzing	K4
CO4	Analyze and implementing PWM techniques in simulation.	Analyzing	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	3	2
CO2	3	2	3	2
CO3	3	2	3	2
CO4	3	2	3	2

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List of experiments: Any 10 of the following experiments are to be conducted	
S.No	**Name of the Experiment**
1.	Switching characteristics of Thyristor, MOSFET,IGBT using PSPICE Simulation
2.	PSPICE Simulation of Single phase full converter using R-L load, R-L- E load with and without LC Filter.
3.	PSPICE Simulation of Three phase full converter using R-L-E Load.
4.	PSPICE Simulation of single phase AC Voltage controller with PWM control for RL load.
5.	PSPICE Simulation of three phase AC Voltage controller using RL load
6.	PSPICE Simulation of single phase inverter with sinusoidal PWM control for R- load
7.	PSPICE Simulation of Three phase inverter with sinusoidal PWM control for R- load
8.	PSPICE Simulation of dc-dc Boost converter.
9.	Three phase converter fed DC motor using Matlab/Simulink
10.	Development and Simulation of 3-phase PWM Inverter with sinusoidal pulse-width modulation Using Matlab/Simulink
11.	Characteristics of induction machines under balanced and symmetrical conditions for the following using Matlab/Simulink a. dq model in synchronous reference frame b. dq model in stator reference frame c. dq model in rotor reference frame
12.	Volts/Hz closed-loop speed control of an induction motor drive using Matlab/Simulink
13.	Open-loop Volts/Hz control of a synchronous motor drive using Matlab/Simulink.
14	Speed control of a permanent magnet synchronous motor using Matlab/ Simulink
15	Capacitor-start capacitor-run single-phase induction motor using Matlab/Simulink.
16	Single phase IGBT based fully controlled rectifier with PWM control using Matlab-Simpower blockset.
17	Three phase IGBT based ac voltage controller with PWM control using Matlab-Simpower blockset

References – Lab Manuals will be provided

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II Semester

SWITCHED MODE POWER CONVERSION

Course Category	Professional core	**Course Code**	**16052T05**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand the control operation of non-sinusoidal DC-DC converters.
2	To understand the basic operation of resonant converters.
3	To understand the control operation of isolated DC-DC converters.
4	To understand the control schemes of DC-DC converters and designing of magnetic components.
5	To understand the modeling and control design of switch mode conversion based on linearization and how to analyze the switch mode converters using small-signal analysis.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Analyze the control operation of non-isolated switch mode converters.	Analyzing	K4
CO2	Analyze the operation of resonant converters and soft switching.	Analyzing	K4
CO3	Analyze the operation of isolated switch mode converters.	Analyzing	K4
CO4	Analyze the control schemes for resonant converters and design of magnetic components.	Analyzing	K4
CO5	Analyze the design of non-isolated switch mode converters based on linearization.	Analyzing	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	3	2
CO2	3	2	3	2
CO3	3	2	3	2
CO4	3	2	3	2
CO5	3	2	3	2

COURSE CONTENT

UNIT I	**Non-isolated switch mode converters:** Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converter, CUK Converter, Converter realization with non-ideal components.
UNIT II	**Resonant converters:** Basic resonant circuit concepts, series resonant circuits, parallel resonant circuits, zero current switching quasi-resonant buck converter, zero current switching quasi-resonant boost converter, zero voltage switching quasi-resonant buck converter, zero voltage switching quasi-resonant boost converter
UNIT III	**Isolated switched mode converters:** Forwarded converter, flyback converter, push-pull converter, half-bridge converter, full bridge converter
UNIT IV	**Control schemes of switching converters:** Voltage control, Current control, control scheme for resonant converters, proportional integral controller. Magnetic design consideration: Transformers design, dc inductor and capacitor design.
UNIT V	**Modeling and Control design based on linearization:** Formulation of averaged models for buck and boost converters average circuits models, small – signal analysis and linearization. **Control design based on linearization:** Transfer function of converters, control design, large signal issues in voltage-mode and current-mode control.

TEXT BOOKS	
1.	Power Electronics – IssaBatareseh, John Wiley publications,2004
2.	Power switching converters-simonAng, Alejandro olive, CRC Press (Taylor & Francis group).
3.	Elements of Power Electronics – Philip T. Krein, Oxford University press.
REFERENCE BOOKS	
1.	Power Electronics: converters Applications & Design – Mohan, Undeland, Robbins-Wiley publications
2.	Ned Mohan, Power Electronics, John Wiley and Sons.
3.	V.Jagganatham, Power Electronics: Devices and Circuits, PHI.
WEB RESOURCES (Suggested)	
1.	www.peg.ee.iisc.ernet.in/people/faculty/vram/smpc/smpcbook.pdf
2.	http://uni-site.ir/khuelec/wp-content/uploads/Mohan-Power-Electronics.pdf

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ELECTRIC DRIVES -II

Course Category	Professional core	**Course Code**	**16052T06**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To analyze the VSI fed induction motor drive.
2	To Study the vector of Induction Motors
3	To study the performance of different types of BLDC motor drives.
4	To study different traction drives
5	To know the operation and control of switched reluctance motor & stepper motor.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Explain operation of induction motor and analyze speed control of AC drives by VSI fed drives.	Analyzing	K4
CO2	Understand vector control of induction motors.	Analyzing	K4
CO3	Understand operation of traction drives.	Analyzing	K4
CO4	Analyze control schemes to synchronous motor drives.	Analyzing	K4
CO5	Understand the control of switched reluctance motor & stepper motor.	Analyzing	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	3	3	2
CO2	3	3	3	2
CO3	3	3	3	2
CO4	3	3	3	2
CO5	3	3	3	2

COURSE CONTENT	
UNIT I	3-phase induction motor drives–Part 1

	Analysis of IM fed from non-sinusoidal supply, harmonic equivalent circuit, transient analysis –starting and plugging; variable frequency control, torque-slip relation, starting torque and braking torque, closed-loop VSI fed IM drive. Slip-ring IM control, closed-loop speed control with static rotor resistance, closed-loop speed control by using slip power recovery scheme.
UNIT II	3-phase induction motor drives–Part 2 Concept of space vector, vector control of IM: direct or feed-back vector control, flux vector estimation, indirect or feed forward vector control, vector control of line side PWM converter, stator flux oriented vector control, vector control of converter fed inverter drive.
UNIT III	Synchronous motor and BLDC motor drives Variable frequency control of synchronous motor, closed-loop control of inverter fed synchronous motor drive. Permanent magnet synchronous motor drive. BLDC motor drives, VSI fed BLDC motor drives, back emf, phase current and torque waveforms, control of BLDC motors with sensors, sensor-less control of BLDC motors
UNIT IV	Traction drives Motors employed in railway traction and road-vehicles, control of railway traction dc motors using ac-dc converters, control of railway traction ac motors using ac-dc and dc-ac converters, power electronic control circuits of electric vehicles and hybrid electric vehicles
UNIT V	Switched reluctance and stepper motor drives Switched reluctance motor operation and control: modes of operation, converter circuits closed loop speed control. Stepper motor characteristics drive circuits for uni-polar and bipolar stepper motors.

TEXT BOOKS	
1.	"Electric motor drives, modeling, analysis and control", R. Krishnan, PHI Publisher.
2.	"Control of electric drives", W. Leonhard, Springer Verilog
3.	"Vector control of AC machines", ArindamGhosh, Gerard Ledwich
4.	"Power Electronics: Converters,Application and design" ,Mohan, Undeland and Robbins, Wiley Publications
REFERENCE BOOKS	
1.	"Power control of AC motors", J.M.D. Murphy and F. G. Turnbul
2.	"Power semiconductor drives", G. K. Dubey, Printice Hall International
3.	"Fundamentals of electric drives", G. K. Dubey, Narosa Publishing House
WEB RESOURCES (Suggested)	
1.	http://ethesis.nitrkl.ac.in/5016/1/109EE0039.pdf
2.	http://s1.nonlinear.ir/epublish/book/Permanent_Magnet_Brushless_DC_Motor_Drives_and_Controls_1118188330.pdf
3.	http://kaliasgoldmedal.yolasite.com/resources/SEM/SRM.pdf

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II Semester

DIGITAL CONTROLLERS

Course Category	Professional core	**Course Code**	**16052T07**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand the architecture of PIC micro controller.
2	To understand the architecture of DSP processor and their interface.
3	To understand how to write the program for DSP processor using assembly Programming.
4	To understand the different types of FPGA and configurations.
5	nderstand the basics of programming in Xilinx

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Know the interfacing circuits for input and output to PIC micro controllers.	Understanding	K2
CO2	Know the interfacing circuits for input and output to DSP processors	Understanding	K2
CO3	Know how to write ALP for DSP processors.	Understanding	K2
CO4	Know the operation of ADC in DSP and Event Manager	Understanding	K2
CO5	Design PWM controls for power electronic circuits using FPGA.	Evaluating	K5

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	3	1
CO2	2	2	3	1
CO3	2	2	3	1
CO4	2	2	3	1
CO5	2	2	3	1

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COURSE CONTENT	
UNIT I	**PIC MICROCONTROLLERS** PIC Microcontrollers: Overview and Features, PIC 16C6X/7X, FSR(File Selection Register) [Indirect Data Memory Address Pointer], PIC Reset Actions, PIC Oscillator Connections, PIC Memory Organizations, PIC PIC 16C6X/7X Instructions, Addressing Modes, I/O Ports, Interrupts in PIC 16C61/71, PIC 16C61/71 Timers, PIC 16C71 Analog-to-Digital Converter (ADC)
UNIT II	**INTRODUCTION TO DSP** Introduction to the C2xx DSP core and code generation, The components of the C2xx DSP core, Mapping external devices to the C2xx core , peripherals and Peripheral Interface , System configuration registers , Memory , Types of Physical Memory , memory Addressing Modes , Assembly Programming using C2xx DSP, Instruction Set, Software Tools.
UNIT III	**I/O & CONTROL REGISTERS** Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General Purpose I/O Control Registers .Introduction to Interrupts, Interrupt Hierarchy, Interrupt Control Registers, Initializing and Servicing Interrupts in Software.
UNIT IV	**ADC & EVENT MANAGER** ADC Overview, Operation of the ADC in the DSP , Overview of the Event manager (EV), Event Manager Interrupts , General Purpose (GP) Timers , Compare UNITs, Capture UNITs And Quadrature Enclosed Pulse (QEP) Circuitry , General Event Manager Information
UNIT V	Introduction to Field Programmable Gate Arrays – CPLD Vs FPGA – Types of FPGA , Xilinx XC3000 series , Configurable logic Blocks (CLB), Input/ Output Block (IOB) – Programmable Interconnect Point (PIP) – Xilinx 4000 series – HDL programming – overview of Spartan 3E and Virtex II pro FPGA boards- case study.

TEXT BOOKS	
1.	Microcontrollers-Theory and Applications by Ajay V Deshmukh, McGraw Hills
2.	Microcontrollers by Kennith J ayala, Thomson publishers
3.	oprocessor and Microcontrollers by Prof C.R.Sarma.
REFERENCE BOOKS	
1.	Hamid.A.Toliyat and Steven G.Campbell"DSP Based Electro Mechanical Motion Control " CRC Press New York , 2004.
2.	XC 3000 series datasheets (version 3.1). Xilinx,Inc.,USA, 1998.
3.	Wayne Wolf," FPGA based system design ", Prentice hall, 2004.
WEB RESOURCES (Suggested)	
1.	http://cs.hadassah.ac.il/staff/martin/embedded/slide04-1.pdf
2.	www.nptel.ac.in/courses/108105057/Pdf/Lesson-20.pdf

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II Semester

CUSTOM POWER DEVICES

Course Category	Professional Core	**Course Code**	**16052T08**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand the various power quality issues and their effects on the distribution circuits.
2	To understand principle of working of various custom power devices.
3	To understand the other custom power devices for reactive power and harmonic compensation.
4	To understand the significance of High-Speed Source Transfer Switches, Solid State Limiting, and Breaking Devices:
5	To understand the Application of Custom Power Devices in Power Systems

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Analyze the effect of various power quality issues in distribution system and their mitigation principles.	Analyzing	K4
CO2	Describe the operation of custom power devices for Voltage Sags and Momentary Interruptions	Evaluating	K5
CO3	Describe the operation of custom power devices for reactive power & harmonic compensation.	Evaluating	K5
CO4	Analyse high speed transfer switches.	Analyzing	K4
CO5	Analyse the operation and control of custom power devices in power system applications.	Analyzing	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	3	1
CO2	2	2	3	1
CO3	2	2	3	1
CO4	2	2	3	1
CO5	2	2	3	1

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COURSE CONTENT	
UNIT I	**Introduction** Custom Power and Custom Power Devices, power quality variations in distribution circuits: Voltage Sags, Swells, and Interruptions. System Faults, over voltages and under voltages, Voltage Flicker, Harmonic Distortion, Voltage Notching, Transient Disturbances, Characteristics of Voltage Sags.
UNIT II	**Overview of Custom Power Devices** Reactive Power and Harmonic Compensation Devices, Compensation Devices for Voltage Sags and Momentary Interruptions, Backup Energy Supply Devices, Battery UPS, Super Conducting Magnetic Energy Storage systems, Flywheel – Voltage Source Converter - Multilevel converters
UNIT III	**Reactive Power and Harmonic Compensation Devices** Var control devices - Static Var Compensator, Topologies, Direct Connected Static Var Compensation for Distribution Systems, Static Series Compensator, Static Shunt Compensator (DSTATCOM): Interaction with Distribution Equipment and System, Installation Considerations.
UNIT IV	**High-Speed Source Transfer Switches, Solid State Limiting, and Breaking Devices:** Source Transfer Switch, Static Source Transfer Switch (SSTS),- Hybrid source transfer switch – High-speed mechanical source transfer switch - Solid state current limiter - Solid state breaker .
UNIT V	**Application of Custom Power Devices in Power Systems** P-Q theory – Control of P and Q, Dynamic Voltage Restorer (DVR): Operation and control – Interline Power Flow Controller (IPFC): Operation and control – Unified Power Quality Conditioner (UPQC): Operation and control.

TEXT BOOKS	
1.	Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000
2.	Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, ArindamGhosh, Kluwer Academic Publishers, 2002.
3.	Power Quality, C. Shankaran, CRC Press, 2001
REFERENCE BOOKS	
1.	Instantaneous power theory and application to power conditioning, H. Akagiet.al., IEEE Press, 2007.
2.	Custom Power Devices - An Introduction, Arindam Ghosh and Gerard Ledwich, Springer, 2002
3.	A Review of Compensating Type Custom Power Devices for Power Quality Improvement, Yash Pal et.al., Joint International Conference on Power System Technology and IEEE Power India Conference, 2008. POWERCON 2008.
4.	K.R Padiyar, Facts Control in Power Transmission and Distribution system, Anshan
WEB RESOURCES (Suggested)	
1.	http://www.academia.edu/11090463/
2.	http://uni-site.ir/khuelec/wp-content/uploads/Power-Quality-Enhancement-Using-Custom-Power-Devices-Electrical-Engineering.pdf
3.	https://www.academia.edu/11090463

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II Semester

RENEWABLE ENERGY SYSTEMS (ELECTIVE –III)

Course Category	Elective – III	**Course Code**	**16052D07**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To learn basic principle of solar energy.
2	To adoption of alternative energy sources for power generation and inter connection to grid.
3	To learn about the bio mass energy.
4	To learn alternative energy sources not based on sun. learn the operations of wind and photovoltaic power plants
5	To learn about the geo thermal energy.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Estimate the solar Energy.	Understanding	K2
CO2	Describe the principle operation of induction and synchronous generator and its inter connection to grid.	Analyzing	K4
CO3	Understand the process of power generation through biomass energy.	Understanding	K2
CO4	Understand the principle of operation of alternative energy sources not based on sun.	Analyzing	K4
CO5	Understand the Geo thermal energy.	Understanding	K2

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	2	1
CO2	2	3	2	1
CO3	2	3	2	1
CO4	2	3	2	1
CO5	2	3	2	1

COURSE CONTENT	
UNIT I	Solar Energy - Availability - Solar radiation data and measurement - Estimation of average solar radiation - Solar water heater types - Heat balance – Flat plate collector efficiency – Efficiency of heat removal - Thermo siphon flow calculation - Forced circulation calculation – Evacuated collectors - Basics of solar concentrators Solar Energy Applications - Solar air heaters – Solar Chimney - Crop driers - Passive solar system - Active solar systems - Water desalination -Output from solar still – Principle of solar ponds.
UNIT II	Wind Energy – Nature of wind – Characteristics – Variation with height and time – Power in wind – Aerodynamics of Wind turbine – Momentum theory – Basics of aerodynamics – Aero foils and their characteristics – HAWT – Blade element theory – Prandtl's lifting line theory (prescribed wake analysis) VAWT aerodynamics – Wind turbine loads – Aerodynamic loads in steady operation–Yawed operation and tower shadow. Wind Energy Conversion System – Sitting – Rotor selection –Annual energy output – Horizontal axis wind turbine (HAWT) – Vertical axis wind turbine (VAWT) – Rotor design considerations – Number of blades – Solidity - Blade profile –Upwind/Downwind – Yaw system – Tower – Braking system - Synchronous and asynchronous generators and loads – Integration of wind energy converters to electrical networks–Inverters–Control system – Requirement and strategies – Noise Applications of wind energy
UNIT III	Biomass energy - Bio fuel classification – Examples of thermo chemical, Pyrolysis, biochemical and agrochemical systems – Energy farming – Direct combustion for heat – Process heat and electricity– Ethanol production and use – Anaerobic digestion for biogas – Different digesters Digester sizing – Applications of Biogas - Operation with I.C. Engine
UNIT IV	Ocean Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle -heat exchanger calculations – Major problems and operational experience. Tidal Power - Principles of power generation - components of power plant – Single and two basin systems – Turbines for tidal power - Estimation of energy – Maximum and minimum power ranges - tidal powerhouse. Wave Energy – Concept of energy and power from waves – Wave characteristics–period and wave velocities - Different wave energy conservation devices (Saltor duck, oscillating water column and dolphin types) – operational experience.
UNIT V	Geothermal Energy - Classification- Fundamentals of geophysics - Dry rock and hot aquifier energy analysis - Estimation of thermal power - Extraction techniques - Prime movers.

TEXT BOOKS	
1.	**Renewable Energy Resources / John Twidell and Tony Weir / E &F.N.Spon**
2.	Renewable Energy Resources Basic Principles and Applications / G.N.Tiwari and M.K.Ghosal / Narosa
3.	Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme / TMH
REFERENCE BOOKS	
1.	Solar Energy Thermal Processes,/Duffie& Beckman
2.	Solar Heating and Cooling / Kreith&Kreider, CRC press.
3.	Wind Energy Handbook / Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / WileyWind Electrical Systems / S.N.Bhadra, D.Kastha and S.Banerjee / Oxford
4.	Biogas Technology - A Practical Hand Book / K.Khendelwal& S.S. Mahdi / McGrawHill.
WEB RESOURCES (Suggested)	
1.	http://www.cs.kumamoto-u.ac.jp/epslab/APSF/sub5.html
2.	https://nptel.ac.in/courses/117108141/

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ELECTRICAL AND ELECTRONICS ENGINEERING

II Semester

ELECTRICAL DISTRIBUTION SYSTEMS (Elective-III)

Course Category	Elective – III	**Course Code**	**16052D08**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To learn the importance of economic distribution of electrical energy
2	To analyze the distribution networks for V-drops, P_{Loss} calculations and reactive power.
3	To understand the co-ordination of protection devices.
4	To impart knowledge of capacitive compensation/voltage control.
5	To understand the principles of voltage control.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Analyze a distribution system.	Analyzing	K4
CO2	Design equipment for compensation of losses in the distribution system.	Evaluating	K5
CO3	Design protective systems and co-ordinate the devices.	Evaluating	K5
CO4	Understand of capacitive compensation.	Analyzing	K4
CO5	Understand the principles of voltage control.	Analyzing	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	2	1
CO2	2	3	2	1
CO3	2	3	2	1
CO4	2	3	2	1
CO5	2	3	2	1

COURSE CONTENT

UNIT I	**General :** Introduction to Distribution systems, an overview of the role of computers in distribution system planning-Load modeling and characteristics: definition of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor – Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics.
UNIT II	**Distribution Feeders and Substations**: Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, feeder-loading. Design practice of the secondary distribution system. Location of Substations: Rating of a Distribution Substation, service area with 'n' primary feeders. Benefits derived through optimal location of substations.
UNIT III	**System analysis:** Voltage drop and power loss calculations: Derivation for volt-drop and power loss in lines, manual methods of solution for radial networks, three-phase balanced primary lines, non-three-phase primary lines.
UNIT IV	**Protective devices and coordination:** Objectives of distribution system protection, types of common faults and procedure for fault calculation. Protective Devices: Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers. Coordination of protective devices : General coordination procedure..
UNIT V	**Capacitive compensation for power factor control:** Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched) power factor correction, capacitor location. Economic justification. Procedure to determine the best capacitor location. Voltage control: Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation

TEXT BOOKS	
1.	"Electric Power Distribution System Engineering " byTuranGonen, Mc.Graw-Hill Book Company,1986.
2.	Electric Power Distribution-by A.S.Pabla, Tata McGraw-Hill Publishing Company, 4th edition, 1997.
REFERENCE BOOKS	
1.	Electrical Distribution V.Kamaraju-McGraw Hill
2.	Handbook of Electrical Power Distribution – Gorti Ramamurthy-Universities press
WEB RESOURCES (Suggested)	
1.	http://www.tech.mtu.edu/~avsergue/EET3390/Lectures/CHAPTER6.pdf
2.	http://textofvideo.nptel.ac.in/108107112/lec1.pdf

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II Semester

REACTIVE POWER COMPENSATION AND MANAGEMENT (Elective-III)

Course Category	Elective – III	**Course Code**	**16052D09**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To know the basic objectives of reactive power compensation.
2	To know the types of compensation and their behaviour.
3	To know the mathematical modeling of reactive power compensating devices.
4	To know the reactive power compensation has to be done at distribution side
5	To know the role of reactive power compensation at electric traction systems and Arc furnaces

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Learn various load compensations.	Understanding	K2
CO2	Obtain the mathematical model of reactive power compensating devices.	Applying	K3
CO3	Get application of reactive power compensation in electrical traction & arc furnaces	Applying	K3
CO4	Understand the distribution and user side reactive power management technique	Analyzing	K4
CO5	Understand the reactive power management in electric traction systems	Analyzing	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	2	1
CO2	2	3	2	1
CO3	2	3	2	1
CO4	2	3	2	1
CO5	2	3	2	1

COURSE CONTENT	
UNIT I	**Load Compensation** Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.
UNIT II	**Reactive power compensation in transmission system:** Steady state -Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples Transient state - Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers –examples
UNIT III	**Reactive power coordination:** Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences
UNIT IV	**Distribution side Reactive power Management:** System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks **User side reactive power management:** KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations
UNIT V	**Reactive power management in electric traction systems and are furnaces:** Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements– remedial measures –power factor of an arc furnace

TEXT BOOKS	
1.	Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982
2.	Reactive power Management by D.M.Tagare,Tata McGraw Hill,2004
REFERENCE BOOKS	
1.	Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just “Reactive Power Compensation: A Practical Guide, April, 2012, Wiely publication.
WEB RESOURCES (Suggested)	
1.	http://ethesis.nitrkl.ac.in/2243/1/Project_Thesis_Final.pdf
2.	https://shodhganga.inflibnet.ac.in/bitstream/10603/62667/10/10_chapter_03.pdf

PRAGATI ENGINEERING COLLEGE : SURAMPALEM
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SMART GRID (Elective-IV)

II Semester

Course Category	Elective – IV	**Course Code**	**16052D10**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand concept of smart grid and developments on smart grid.
2	To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
3	To have knowledge on smart substations, feeder automation and application for monitoring and protection.
4	To have knowledge on micro grids and distributed energy systems.
5	To know power quality aspects in smart grid

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Understand smart grids and analyze the smart grid policies and developments in smart grids.	Analyzing	K4
CO2	Develop concepts of smart grid technologies in hybrid electrical vehicles etc.	Evaluating	K5
CO3	Understand smart substations, feeder automation, GIS etc.	Understanding	K2
CO4	Analyze micro grids and distributed generation systems.	Analyzing	K4
CO5	Analyze the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.	Analyzing	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	2	1
CO2	3	2	2	1
CO3	3	2	2	1
CO4	3	2	2	1
CO5	3	2	2	1

COURSE CONTENT

UNIT I	**Introduction to Smart Grid:** Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.
UNIT II	**Smart Grid Technologies: Part 1:** Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation and Phase Shifting Transformers.
UNIT III	**Smart Grid Technologies: Part 2:** Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) and their application for monitoring & protection, Smart storage like battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).
UNIT IV	**Microgrids and Distributed Energy Resources:** Concept of micro grid, need and applications of microgrid, formation of microgrid, Issues of interconnection, protection and control of microgrid. Variable speed wind generators, fuel cells, microturbines, Captive power plants, Integration of renewable energy sources.
UNIT V	**Power Quality Management in Smart Grid:** Power Quality and EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit. **Information and Communication Technology for Smart Grid:** Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

TEXT BOOKS	
1.	Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2.	Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press
3.	JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", Wiley
4.	Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
REFERENCE BOOKS	
1.	Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
2.	S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
3.	Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press
4.	Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
WEB RESOURCES (Suggested)	
1.	https://www.engineering.unsw.edu.au/electrical.../sites/.../GSOE9141_S12015.pdf
2.	http://ctijabalpur.com/Download/Study-Material/Smart%20Grid%20Notes.pdf

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II Semester

SPECIAL MACHINES (Elective-IV)

Course Category	Elective – IV	**Course Code**	**16052D11**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To know the concepts of special types of electrical machines.
2	To understand the different control schemes for PMSM.
3	To learn about the different sensor used in brushless DC motors.
4	To draw the characteristics of servo motors, tacho meters and SRM
5	To understand the concepts of linear induction motor.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Analyze the characteristics of different types of PM type brushless DC motors and design suitable controllers.	Analyzing	K4
CO2	Apply the knowledge of sensors used in PMSM which can be used for controllers and synchronous machines.	Applying	K3
CO3	Analyze the different controllers used in electrical machines to propose the suitability of drives for different industrial applications.	Analyzing	K4
CO4	Classify the types of DC linear motors and apply the knowledge of controllers to propose their application in real world.	Applying	K3
CO5	Evaluate the steady state and transient behavior linear induction motors.	Evaluating	K5

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	1	2	2	1
CO2	1	2	2	1
CO3	1	2	2	1
CO4	1	2	2	1
CO5	1	2	2	1

COURSE CONTENT	
UNIT I	**Stepper Motors** Constructional features, Principle of operation, Modes of excitation torque production in Variable Reluctance (VR) stepping motor, Dynamic characteristics, Drive systems and circuit foropen loop control, closed loop control of stepping motor
UNIT II	**Permanent Magnet Synchronous Motors (PMSM) and Switched Reluctance Motors(SRM)** PMSM: Power electronic controllers, Torque speed characteristics, Self control, Vector control, Current control SRM: Constructional features, Principle of operation. Torque equation, Characteristics, Control Techniques, Drive concept
UNIT III	**Permanent Magnet Brushless DC Motors** Concept of electronic commutation, Hall sensors, Optical sensors, back emf detection, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque andemf equation, Torque-speed characteristics, Speed control by microcontroller.
UNIT IV	Servomotors and AC Tachometers Servomotor – Types – Constructional features – Principle of Operation – Characteristics Control – Microprocessor based applications. AC Tachometers: Permanent magnet ac tachometer, AC induction tachometer, Schematic diagrams, Operating principle.
UNIT V	**Linear Motors** Linear Motors: Linear Induction Motor (LIM) Classification – Construction – Principle of operation – Concept of Current sheet –Goodness factor – DC Linear Motor (DCLM) types – Circuit equation – DCLM control-applications.

TEXT BOOKS	
1.	Miller, T.J.E. "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.
2.	Kenjo, T, "Stepping Motors and their Microprocessor control", Clarendon Press, Oxford,1989.
3.	Naser A and Boldea I, "Linear Electric Motors: Theory, Design and Practical Application", Prentice Hall Inc., New Jersey,1987
REFERENCE BOOKS	
1.	Special Electrical Machines-K.Venkataratnam- University press
2.	Floyd E Saner,"Servo Motor Applications", Pittman USA, 1993.
3.	Kenjo, T and Naganori, S "Permanent Magnet and brushless DC motors", Clarendon Press, Oxford, 1989.
4.	Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th edition- 1995
WEB RESOURCES (Suggested)	
1.	www.nct-tech.edu.lk/Download/Technology%20Zone/Stepping%20Motors.pdf
2.	https://nptel.ac.in/syllabus/108104011/

PRAGATI ENGINEERING COLLEGE : SURAMPALEM
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ELECTRICAL AND ELECTRONICS ENGINEERING

II Semester

PROGRAMMABLE LOGIC CONTROLLERS AND APPLICATIONS (Elective-IV)

Course Category	Elective – IV	**Course Code**	**16052D12**
Course Type	Theory	**L-T-P-C**	4-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To have knowledge on PLC.
2	To acquire the knowledge on programming of PLC.
3	To understand different PLC registers and their description.
4	To have knowledge on data handling functions of PLC.
5	To know how to handle analog signal and converting of A/D in PLC.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	Understand the PLCs and their I/O modules.	Understanding	K2
CO2	Develop control algorithms to PLC using ladder logic etc.	Evaluating	K5
CO3	Manage PLC registers for effective utilization in different applications.	Applying	K3
CO4	Handle data functions and control of two axis and their axis robots with PLC.	Analyzing	K4
CO5	Design PID controller with PLC.	Evaluating	K5

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	1	2	2	1
CO2	1	2	2	1
CO3	1	2	2	1
CO4	1	2	2	1
CO5	1	2	2	1

PRAGATI ENGINEERING COLLEGE : SURAMPALEM
(Autonomous)
ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CONTENT	
UNIT I	**PLC Basics:** PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.
UNIT II	**PLC Programming**: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.
UNIT III	**PLC Registers:** Characteristics of Registers, module addressing, holding registers, input registers, output registers. PLC Functions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.
UNIT IV	**Data Handling functions:** SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis Robots with PLC, Matrix functions.
UNIT V	**Analog PLC operation:** Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

TEXT BOOKS	
1.	Programmable Logic Controllers – Principle and Applications by John W. Webb andRonald A. Reiss, Fifth Edition, PHI
2.	Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.
REFERENCE BOOKS	
1.	Introduction to Programmable Logic Controllers- Gary Dunning-Cengage Learning.
2.	Programmable Logic Controllers –W.Bolton-Elsevier publisher.
WEB RESOURCES (Suggested)	
1.	https://nptel.ac.in/courses/112102011/11
2.	https://nptel.ac.in/courses/112103174/pdf/mod3.pdf

II Semester

PRAGATI ENGINEERING COLLEGE : SURAMPALEM
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ELECTRICAL AND ELECTRONICS ENGINEERING

POWER CONVERTERS AND DRIVES LAB

Course Category	Lab course	**Course Code**	**16052L02**
Course Type	Laboratory	**L-T-P-C**	0-0-4-2
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To verify the operation of various converters and also their usage in the motor speed control application.

COURSE OUTCOMES			
Upon successful completion of the course, the student will be able to:		**Cognitive level**	
CO1	To analyze the working of phase-controlled converters, AC voltage controllers, DC-DC converters, and PWM inverters and analyze the speed control operation of power converter fed motors.	Analyzing	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)				
	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	1	2	2

List of experiments: Any 10 of the following experiments are to be conducted	
S.No	**Name of the Experiment**
1	Operation of 3- phase Full-Converter on R & R-L loads...
2	Performance & speed control of D.C. drive using 3-phase full Converter.
3	Performance & Operation of a four quadrant Chopper on D.C. Drive
4	Performance & Operation of a 3-phase A.C. Voltage controller on motor load.
5	Single Phase IGBT based PWM Inverter on R & R-L load
6	Operation of 3-phase IGBT based PWM Inverter on R & R-L load.
7	Performance & speed control of 3 phase slip ring Induction motor by Static Rotor Resistance controller.
8	Three phase PWM Pulse generation using PIC Micro controlle
9	PIC Microcontroller based speed control of three phase Induction Motor.
10	DSP based V/F Control of 3 phase Induction motor.

References – Lab Manuals will be provided