UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

R23 COURSE STRUCTURE
III B.Tech I Semester

S.No	Course No	Course Name	P.Os	Category	L	T	P	Credits
1		Power Electronics		Professional Core	3	0	0	3
2		Microprocessors and Microcontrollers		Professional Core	3	0	0	3
3		Power Systems-II		Professional Core	3	0	0	3
4		**Professional Elective-I:** 1. Utilization of Electrical Energy 2. Advanced Control Systems 3. Communication Systems		Professional Elective-I	2	0	0	2
5		**Open Elective – I:** 1. Renewable Energy Sources 2. Concepts of Energy Auditing & Management 3. Electrical Wiring Estimation and Costing		Open Elective - I	3	0	0	3
6		Microprocessors and Microcontrollers Lab		Professional Core	0	0	3	1.5
7		Control Systems & Simulation Lab		Professional Core	0	0	3	1.5
8		Soft skills		Skill Enhancement course	0	1	2	2
9		Design Thinking & Ideation		Engineering Science	0	1	2	2
10		Evaluation of Community Service Internship			-	-	-	2
				Total	**13**	**2**	**10**	**23**

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

R23 COURSE STRUCTURE
III B.Tech II Semester

S.No	Course No	Course Name	P.Os	Category	L	T	P	Credits
1		Electrical Measurements and Instrumentation		Professional Core	3	0	0	3
2		Universal Human Values- Understanding Harmony and Ethical Human Conduct		HSMC	2	1	0	3
3		Power System Analysis		Professional Core	3	0	0	3
4		**Professional Elective-II:** 1. Renewable and Distributed Energy Technologies 2. AI Techniques 3. Digital Signal Processing		Professional Elective-II	3	0	0	3
5		**Professional Elective-III:** 1. Electric Drives 2. Switchgear and Protection 3. High Voltage Engineering		Professional Elective-III	3	0	0	3
6		**Open Elective – II:** 1. Fundamentals of Electric Vehicles 2. Basics of Microprocessors and Microcontrollers 3. Digital Electronics		Open Elective - II	3	0	0	3
7		Electrical Measurements and Instrumentation Lab		Professional Core	0	0	3	1.5
8		Power Electronics& Simulation Lab		Professional Core	0	0	3	1.5
9		IoT Applications of Electrical Engineering Lab		Skill Enhancement course	0	1	2	2
10		Research Methodology		Audit Course	2	0	0	-
				Total	**20**	**1**	**08**	**23**

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

R23 COURSE STRUCTURE
IV B.Tech I Semester

S.No	Course No	Course Name	P.Os	Category	L	T	P	Credits
1		Power System Operation and Control		Professional Core	3	0	0	3
2		Energy Management & Auditing		Management Course- II	2	0	0	2
3		**Professional Elective-IV:** 1. HVAC &DC Transmission Systems 2. Battery Management Systems and EV Charging Stations 3. Electrical Distribution Systems		Professional Elective-IV	3	0	0	3
4		**Professional Elective-V:** 1. Electric and Hybrid Electric Vehicles 2. Programmable Logic Controllers 3. VLSI Design		Professional Elective-V	3	0	0	3
5		**Open Elective – III:** 1. Battery Management Systems and Charging Schemes 2. Concepts of Smart Grid Technologies 3. Introduction to Internet of Things		Open Elective - III	3	0	0	3
6		**Open Elective – IV:** 1. Concepts of Power Quality 2. Electrical Energy Utilization 3. Concepts of Control Systems		Open Elective - IV	3	0	0	3
7		Power Systems and Simulation Lab		Skill Enhancement Course	0	0	4	2
8		Constitution of India		Audit Course	2	0	0	-
9		Evaluation of Industry Internship		Internship	-	-	-	2
				Total	**16**	**1**	**02**	**21**

IV B.Tech II Semester

S.No	Course No	Course Name	P.Os	Category	L	T	P	Credits
1		Internship and Project		PR	**-**	**-**	**24**	**12**

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Minor Engineering Courses offered by EEE Department for Other Branches (Except EEE Branch)

S.No.	Course No	Course Name	L	T	P	C
1		Intelligent Control Systems	3	0	0	3
2		Basic Electrical Measurements and Instrumentation	3	0	0	3
3		Concepts of Power System Engineering	3	0	0	3
4		Fundamentals of Power Electronics	3	0	0	3
5		Basic Electric Drives and Applications	3	0	0	3
6		Electrical Safety and Energy Conservation	3	0	0	3
7		Electrical Simulation Lab	0	0	3	1.5
8		Electrical Systems Lab	0	0	3	1.5
Total			**18**	**0**	**0**	**18**

Honors Engineering Courses offered EEE Branch students (Need to Acquire 18 credits)

Power Systems

S.No.	Course No	Course Name	L	T	P	C
1		Electric Power Quality	3	0	0	3
2		Smart Grid Technologies	3	0	0	3
3		Power System Deregulation	3	0	0	3
4		Real Time Control of Power Systems	3	0	0	3
5		Static Relays for Power System Protection	3	0	0	3
6		Flexible AC Transmission Systems	3	0	0	3
7		Power Electronics for Renewable Energy systems	3	0	0	3
8		Electric and Hybrid Electric Vehicles*	3	0	0	3
9		High Voltage Engineering*	3	0	0	3
10		High Voltage Engineering Lab	0	0	3	1.5
11		Renewable Energy & Battery Technologies Laboratory	0	0	3	1.5

*** The Student should not choose these courses if same courses are selected under Professional Elective.**

Power Electronics

S.No.	Course No	Course Name	L	T	P	C
1		Special Electrical Machines	3	0	0	3
2		Machine Modelling and Analysis	3	0	0	3
3		Power Electronic Converters	3	0	0	3
4		Power Quality and Custom Power Devices	3	0	0	3
5		Power Electronics for Renewable Energy systems	3	0	0	3
6		Industrial Applications of Power Electronic Converters	3	0	0	3
7		Advanced Electrical Drives	3	0	0	3
8		FACTS Controllers	3	0	0	3
9		Switched Mode Power Converters	3	0	0	3
10		Electric Drives Laboratory	0	0	3	1.5
11		Renewable Energy & Battery Technologies Laboratory	0	0	3	1.5

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXYY	POWER ELECTRONICS	CATEGORY Professional Core	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Electrical Circuits, Power System-I, Basic concepts of Electronics

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Identify and analyze the static and dynamic characteristics of power semiconductor devices and evaluate their triggering and protection circuits for safe and reliable operation in power electronic circuits.	3
CO2	Analyze and evaluate the performance of controlled rectifiers and **develop** and simulate AC-AC and DC-DC converters including phase controllers, cycloconverters, and choppers under various conduction modes and load conditions.	4
CO3	Design and assess single-phase and three-phase inverter circuits using advanced modulation techniques such as PWM and current source inverters, focusing on voltage regulation, power quality, and harmonic minimization in power electronic systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	1	-	-	-	-	2	3	3	2
CO2	3	3	3	2	3	-	-	-	-	-	2	3	3	3
CO3	3	2	3	2	3	-	-	1	2	2	2	3	-	-

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Power Semi-Conductor Devices** Silicon controlled rectifier (SCR) – Two transistor analogy - Static and Dynamic characteristics – Triggering methods (R, RC and UJT) – Snubber circuit design. Static and Dynamic Characteristics of Power MOSFET and Power IGBT– Gate Driver Circuits for Power MOSFET and IGBT - Numerical problems.	
UNIT - 2	**Single-phase AC-DC Converters** Single-phase half-wave controlled rectifiers - R load and RL load with and without freewheeling diode - Single-phase fully controlled mid-point and bridge converter with R load, RL load and RLE load - Continuous and Discontinuous conduction - Effect of source inductance in Single-phase fully controlled bridge rectifier – Expression for output voltages – Single-phase Semi-Converter with R load-RL load and RLE load – Continuous and Discontinuous conduction - Harmonic Analysis - Single-phase Dual Converters - Numerical Problems.	
UNIT - 3	**Three-phase AC-DC Converters & AC – AC Converters** Three-phase half-wave Rectifier with R and RL load - Three-phase fully controlled rectifier with R and RL load - Three-phase semi converter with R and	

	RL load - Expression for Output Voltage - Harmonic Analysis - Three-phase Dual Converters - Numerical Problems. AC-AC power control by phase control with R and RL loads - Expression for rms output voltage – Single-phase step down and step up bridge Cycloconverter - Numerical Problems.	
UNIT - 4	**DC–DC Converters** Operation of Basic Chopper – Classification - Control Techniques – steady state time domain analysis of Basic Chopper - Analysis of Buck, Boost and Buck-Boost converters in Continuous Conduction Mode (CCM) and Discontinuous Conduction Modes (DCM) - Output voltage equations using volt-sec balance in CCM & DCM – Expressions for output voltage ripple and inductor current ripple- Numerical Problems.	
UNIT - 5	**DC–AC Converters** Introduction - Single-phase half-bridge and full-bridge inverters with R and RL loads – Phase Displacement Control – PWM with bipolar voltage switching, PWM with unipolar voltage switching - Three-phase square wave inverters - 120^0 conduction and 180^0 conduction modes of operation - Sinusoidal Pulse Width Modulation - Current Source Inverter (CSI) - Numerical Problems.	
	Total	

Text Books:

1. Power Electronics: Converters, Applications and Design by Ned Mohan, Tore M Undeland, William P Robbins, John Wiley & Sons.
2. Power Electronics: Circuits, Devices and Applications – by M. H. Rashid, Prentice Hall of India, 2nd edition, 1998
3. Power Electronics: Essentials & Applications by L.Umanand, Wiley, Pvt. Limited, India, 2009.

Reference Books:

1. Elements of Power Electronics–Philip T.Krein. Oxford University Press; Second edition
2. Power Electronics – by P.S.Bhimbra, Khanna Publishers.
3. Thyristorised Power Controllers – by G. K. Dubey, S. R. Doradla, A. Joshi and R. M. K.Sinha, New Age International (P) Limited Publishers, 1996.
4. Power Electronics: by Daniel W.Hart, Mc Graw Hill.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXYY	MICROPROCESSORS AND MICROCONTROLLERS	CATEGORY Professional Core	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Basics of Processors

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Identify and explain the architecture, memory and register organization of the 8086 microprocessor and its successors (80286, 80386, 80486, Pentium), and differentiate their features and evolution for real-time applications.	3
CO2	Analyze the instruction set, addressing modes, bus operations, and control signal interfacing of the 8086 microprocessor in both minimum and maximum mode configurations using timing diagrams, and design systems for embedded control.	4
CO3	Develop microprocessor and microcontroller-based systems using 8086 with peripherals (8255 PPI, ADC/DAC, stepper motors), and **describe** the architecture and features of microcontrollers like 8051, PIC18, and STM32 for embedded applications.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	-	-	-	-	-	2	3	2	1
CO2	3	3	2	2	2	-	-	1	2	-	2	3	2	2
CO3	3	3	3	3	3	1	-	2	3	2	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Introduction to Microprocessor Architecture** Introduction and evolution of Microprocessors – Architecture of 8086 – Memory Organization of 8086 – Register Organization of 8086– Introduction to 80286- 80386- 80486 and Pentium (brief description about architectural advancements only).	
UNIT - 2	**Minimum and Maximum Mode Operations** Instruction sets of 8086 - Addressing modes – Assembler directives - General bus operation of 8086 – Minimum and Maximum mode operations of 8086 – 8086 Control signal interfacing – Read and write cycle timing diagrams.	
UNIT - 3	**Microprocessors I/O interfacing** 8255 PPI– Architecture of 8255–Modes of operation– Interfacing I/O devices to 8086 using 8255–Interfacing A to D converters– Interfacing D to A converters– Stepper motor interfacing– Types of memories: magnetic memories, semiconductor memories -Static memory interfacing with 8086.	
UNIT - 4	**8051 Microcontroller** Overview of 8051 Microcontroller – Architecture–I/O ports and Interrupts-	

	Register set – Memory Organization - Instruction set– Timers and Counters – Serial Communication. Overview of Atmel ATmega328 microcontroller.	
UNIT - 5	**PIC Architecture:** Block diagram of basic PIC 18 micro controller – registers I/O ports – advantages and applications. Overview of STM32 microcontrollers (ARM Cortex-M): key features- Block diagram - software development tools (cube IDE) – applications.	
	Total	

Text Books:

1. Ray and Burchandi - “Advanced Microprocessors and Interfacing”- Tata McGraw–Hill - 3rd edition - 2006.
2. Kenneth J Ayala - “The 8051 Microcontroller Architecture-Programming and Applications” - Thomson Publishers - 2nd Edition.
3. PIC Microcontroller and Embedded Systems using Assembly and C for PIC 18 - Muhammad Ali Mazidi - RolindD.Mckinay - Danny causey -Pearson Publisher 21st Impression.
4. STM32 Arm Programming for Embedded Systems Using C Language with STM32 Nucleo - Shujen Chen, Muhammad Ali Mazidi, Eshragh Ghaemi · 2018

Reference Books:

1. Microprocessors and Interfacing- Douglas V Hall - Mc–Graw Hill - 2nd Edition.
2. R.S. Kaler- “A Text book of Microprocessors and Micro Controllers” - I.K. International Publishing House Pvt. Ltd.
3. Ajay V. Deshmukh- “Microcontrollers – Theory and Applications” - Tata McGraw–Hill Companies –2005.
4. Ajit Pal- “Microcontrollers – Principles and Applications” - PHI Learning Pvt Ltd - 2011.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXYY	POWER SYSTEMS-II	CATEGORY Professional Core	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Power Systems-I, Electromagnetic Fields.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the fundamental concepts of transmission line parameters, power system transients, voltage control methods, corona effects, and overhead line insulator characteristics.	2
CO2	Calculate transmission line parameters, sag and tension, voltage regulation, and analyze line performance using various mathematical models under different operational conditions.	3
CO3	Analyze transient behaviours, power flow, and insulator string efficiency; evaluate and design optimal voltage control strategies and insulation systems for reliable and efficient transmission line operation.	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	-	-	-	-	2	3	2	1
CO2	3	3	2	2	3	1	-	-	-	-	2	3	3	2
CO3	3	3	3	3	3	2	-	1	2	2	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	Transmission Line Parameters Conductor materials – Types of conductors – Calculation of resistance for solid conductors – Skin and Proximity effects – Calculation of inductance for Single-phase and Three-phase– Single and double circuit lines– Concept of GMR and GMD–Symmetrical and asymmetrical conductor configuration with and without transposition–Bundled conductors – Calculation of capacitance for 2 wire and 3 wire systems – Effect of ground on capacitance – Capacitance calculations for symmetrical and asymmetrical single and Three-phase–Single and double circuit lines without and with Bundled conductors.	
UNIT - 2	Performance Analysis of Transmission Lines Classification of Transmission Lines – Short, medium, long lines and their model representation –Nominal-T, Nominal-Pie and A, B, C, D Constants for symmetrical and Asymmetrical Networks. Rigorous Solution for long line equations – Surge Impedance and Surge Impedance Loading (SIL) of Long Lines – Representation of Long lines – Equivalent T and Equivalent Pie network models - Mathematical Solutions to estimate regulation and efficiency of lines – Interpretation of long line equations	

	– Ferranti effect – Charging Current – Power flow through transmission lines.	
UNIT - 3	Power System Transients Types of System Transients – Propagation of Surges – Attenuation–Distortion–Reflection and Refraction Coefficients. Termination of lines with different types of conditions – Open Circuited Line–Short Circuited Line – T-Junction – Lumped Reactive Junctions.	
UNIT - 4	Voltage Control & Corona Methods of Voltage Control – Sources & Sinks of reactive power – Shunt Capacitors/ Reactors and Series Capacitors – Tap Changing Transformers – Synchronous Phase Modifiers. Corona: Description of the phenomenon – Factors affecting corona – critical voltages and power loss.	
UNIT - 5	Sag and Tension Calculations and Overhead Line Insulators: Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor – Stringing chart and sag template and its applications Types of Insulators – String efficiency and Methods for improvement - Voltage distribution–Calculation of string efficiency – Capacitance grading and Static Shielding.	
	Total	

Text Books:

1. Electrical Power Systems – by C.L.Wadhwa, New Age International (P) Limited, 1998.
2. Power System Engineering by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 3rd Edition.

Reference Books:

1. Power system Analysis–by John J Grainger William D Stevenson, TMC Companies, 4th edition
2. Power System Analysis and Design by B.R.Gupta, Wheeler Publishing.
3. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar A.Chakrabarthy, DhanpatRai Co Pvt. Ltd.2016
4. Electrical Power Systems by P.S.R. Murthy, B.S. Publications, 2017.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXYY	UTILIZATION OF ELECTRICAL ENERGY (Professional Elective – I)	CATEGORY Professional Elective-I	L-T-P 2-0-0	CREDITS 2

Pre-requisite Concepts of Electrical Engineering

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the fundamentals of illumination, selection and characteristics of electric motors, methods of electric heating and welding, principles of electric traction, and types of energy storage systems.	2
CO2	Apply knowledge of illumination techniques, motor selection, heating and welding methods, electric traction calculations, and energy storage principles to practical engineering problems.	3
CO3	Analyze motor performance and traction system efficiency, evaluate lighting designs and energy conservation methods, and assess suitable energy storage technologies for various applications.	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	1	-	-	-	-	-	3	1	-
CO2	3	3	3	2	2	1	-	1	1	1	1	3	3	2
CO3	2	3	2	3	3	2	-	1	1	1	2	2	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Illumination fundamentals** Introduction - terms used in illumination–Laws of illumination–Polar curves–Lux meter–Sources of light. **Various Illumination Methods** Discharge lamps - MV and SV lamps – Comparison between tungsten filament lamps and fluorescent tubes–Basic principles of light control– Types and design of lighting and flood lighting–LED lighting - Energy conservation.	
UNIT - 2	**Selection of Motors** Choice of Motor - Type of Electric Drives - Starting and Running Characteristics – Speed Control–Temperature Rise – Applications of Electric Drives–Types of Industrial Loads–Continuous–Intermittent And Variable Loads–Load Equalization - Introduction To Energy Efficient Motors.	
UNIT - 3	**Electric Heating** Advantages and methods of electric heating–Resistance heating induction heating and dielectric heating. **Electric Welding** Electric welding–Resistance and arc welding–Electric welding equipment–	

	Comparison between AC and DC Welding.	
UNIT - 4	**Electric Traction** System of electric traction and track electrification– Review of existing electric traction systems in India– Special features of traction motor–Mechanics of train movement–Speed–time curves for different services – Trapezoidal and quadrilateral speed time curves. Calculations of tractive effort– power –Specific energy consumption for given run–Effect of varying acceleration and braking retardation–Adhesive weight and braking retardation adhesive weight and coefficient of adhesion-Numerical problems.	
UNIT - 5	**Introduction to Energy Storage Systems** Need For Energy Storage - Types of Energy Storage-Thermal - Electrical - Magnetic And Chemical Storage Systems - Comparison of Energy Storage Technologies-Applications.	
	Total	

Text Books:

1. Utilization of Electric Energy – by E. Openshaw Taylor - Orient Longman.
2. Art & Science of Utilization of electrical Energy – by Partab - Dhanpat Rai& Sons.
3. "Thermal energy storage systems and applications"-by Ibrahim Dincer and Mark A.Rosen. John Wiley and Sons 2002.

Reference Books:

1. Utilization of Electrical Power including Electric drives and Electric traction – by N.V.Suryanarayana - New Age International (P) Limited - Publishers - 1996.
2. Generation - Distribution and Utilization of electrical Energy – by C.L. Wadhwa - New Age International (P) Limited - Publishers - 1997.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXYY	ADVANCED CONTROL SYSTEMS (Professional Elective – I)	CATEGORY Professional Elective-I	L-T-P 2-0-0	CREDITS 2

Pre-requisite: Concepts of Electrical Engineering

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Illustrate the concepts of state space representation, state transition, controllability, observability, nonlinear system characteristics, Lyapunov stability criteria, and basics of optimal control.	2
CO2	Apply state space methods to analyze and design control systems including canonical forms, pole placement design, phase-plane analysis of nonlinear systems, and use Lyapunov methods for stability assessment.	3
CO3	Analyze the controllability and observability of systems, evaluate system stability using Lyapunov theory, and formulate and solve optimal control problems including tracking and regulator designs under constraints.	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	-	2	3	2	1
CO2	3	3	3	2	3	-	-	1	1	1	2	3	3	2
CO3	2	3	3	3	3	-	-	1	1	1	3	2	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**State Space Analysis** State Space Representation – Canonical forms – Controllable canonical form – Observable canonical form - Jordan Canonical Form - Solution of state equation – State transition matrix.	
UNIT - 2	**Controllability - Observability and Design of Pole Placement** Tests for controllability and observability for continuous time systems – Time varying case – Minimum energy control – Time invariant case – Principle of duality – Controllability and observability form Jordan canonical form and other canonical forms – Effect of state feedback on controllability and observability – Design of state feedback control through pole placement.	
UNIT - 3	**Nonlinear Systems** Introduction to nonlinear systems - Types of nonlinearities. Introduction to phase–plane analysis - Singular points; Describing function - basic concepts - Describing functions of non- linearities.	
UNIT - 4	**Stability analysis by Lyapunov Method** Stability in the sense of Lyapunov – Lyapunov's stability and Lyapunov's instability theorems – Direct method of Lyapunov for the linear and nonlinear	

	continuous time autonomous systems.	
UNIT - 5	**Introduction to optimal control:** Minimization of functional of single function – Constrained minimization – Minimum principle – Control variable inequality constraints – Control and state variable inequality constraints, Quadratic optimal regulator systems-State regulator problems-output regulator problems - tracking problems.	
	Total	

Text Books:

1. Modern Control Engineering – by K. Ogata - Prentice Hall of India - 3rd edition- 1998.
2. Automatic Control Systems by B.C. Kuo - Prentice Hall Publication.

Reference Books:

1. Modern Control System Theory – by M. Gopal - New Age International Publishers - 2nd edition - 1996
2. Control Systems Engineering by I.J. Nagarath and M.Gopal - New Age International (P) Ltd.
3. Digital Control and State Variable Methods – by M. Gopal - Tata Mc Graw–Hill Companies- 1997.
4. Systems and Control by Stainslaw H. Zak - Oxford Press - 2003.
5. Optimal control theory: an Introduction by Donald E.Kirk by Dover publications.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXYY	COMMUNICATION SYSTEMS (Professional Elective – I)	CATEGORY Professional Elective-I	L-T-P 2-0-0	CREDITS 2

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Understand the fundamentals of communication systems, including analog and digital modulation, pulse modulation, and modern communication technologies.	2
CO2	Apply concepts of digital electronics and signal processing to implement error control coding, pulse modulation, and digital modulation schemes for reliable communication.	3
CO3	Analyze and compare various modulation, coding, and PWM techniques, and evaluate their performance in modern communication systems such as microwave, optical, satellite, and mobile networks.	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	1	2	-	-	-	-	-	1	3	2	-
CO2	3	3	2	2	3	-	-	-	1	-	2	3	3	2
CO3	2	3	3	3	3	1	-	-	2	1	3	2	3	3

(Please fill the above with Levels of Correlation, viz., L-1, M-2, H-3)

UNIT	CONTENTS	Contact Hours
Unit – I:	**Basic blocks of Communication System**. Analog Modulation - Principles of Amplitude Modulation, DSBSC, SSB-SC and VSB-SC, AM transmitters and receivers.	12
Unit- II:	**Angle Modulation - Frequency and Phase Modulation**. Transmission Bandwidth of FM signals, Methods of generation and detection, FM Transmitters and Receivers.	12
Unit–III:	**Sampling theorem - Pulse Modulation Techniques -** PAM, PWM and PPM concepts - PCM system – Data transmission using analog carriers (BASK, BFSK, BPSK, QPSK).	12
UNIT -IV:	**Error control coding techniques** – Linear block codes- Encoder and decoder, Cyclic codes – Encoder, Syndrome Calculator, Convolution codes.	12
UNIT -V:	**Modern Communication Systems** – Microwave communication systems - Optical communication system - Satellite communication system - Mobile communication system.	12
	Total	

Text Books:

1. Simon Haykins, ‘Communication Systems’, John Wiley, 3rd Edition, 1995.
2. D.Roddy & J.Coolen, ‘Electronic Communications’, Prentice Hall of India, 4th Edition, 1999.
3. Kennedy G, ‘Electronic Communication System’, McGraw Hill, 1987.

Reference Books:

1. Shulin Daniel, ‘Error Control Coding’, Pearson, 2nd Edition, 2011.
2. B.P. Lathi and Zhi Ding, ‘Modern Digital and Analog Communication Systems’, OUP USA Publications, 4th Edition, 2009.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXYY	RENEWABLE ENERGY SOURCES (Open Elective – I)	CATEGORY Open Elective - I	L-T-P 3-0-0	CREDITS 3

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the principles, components, and applications of solar, wind, biomass, geothermal, ocean, and advanced energy conversion technologies.	2
CO2	Apply knowledge of solar radiation, wind energy conversion, bioenergy, ocean energy systems, fuel cells, and hydrogen technologies to analyze and solve practical renewable energy problems.	3
CO3	Analyze the performance and environmental aspects of various renewable energy systems and evaluate their suitability and integration for sustainable energy solutions.	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	2	-	-	-	-	1	3	1	1
CO2	3	3	3	1	3	2	-	1	1	1	1	3	3	2
CO3	2	3	3	3	3	3	-	1	1	1	2	2	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Solar Energy:** Introduction - Renewable Sources - prospects, Solar radiation at the Earth Surface - Equivalent circuit of a PV- I-V & P-V Characteristics of a PV - Solar Energy Collectors-Flat plate Collectors, concentrating collectors - Solar Energy storage systems – Solar Pond - Applications - Solar water heating - Solar Green house.	
UNIT - 2	**Wind Energy**: Introduction - basic Principles of Wind Energy Conversion, the nature of Wind - the power in the wind - Wind Energy Conversion - Site selection considerations - basic components of a WECS (Wind Energy Conversion Systems) - Classification of WEC Systems - Applications.	
UNIT - 3	**Biomass and Geothermal Energy:** **Biomass:** Introduction - Biomass conversion technologies - Photosynthesis, factors affecting Bio digestion - classification of biogas plants - Types of biogas plants - selection of site for a biogas plant **Geothermal Energy**: Introduction, Geothermal Sources – Applications - operational and Environmental problems.	
UNIT - 4	**Energy From oceans, Waves & Tides:** **Oceans:** Introduction - Ocean Thermal Electric Conversion (OTEC) – methods - prospects of OTEC in India. **Waves:** Introduction - Energy and Power from the waves - Wave Energy conversion devices.	

	Tides: Basic principle of Tide Energy -Components of Tidal Energy.	
UNIT - 5	**Chemical Energy Sources:** **Fuel Cells**: Introduction - Fuel Cell Equivalent Circuit - operation of Fuel cell - types of Fuel Cells - Applications. **Hydrogen Energy:** Introduction - Methods of Hydrogen production - Storage and Applications **Magneto Hydro Dynamic (MHD) Power generation:** Principle of Operation - Types.	
	Total	

Text Books:

1. G.D.Rai, Non-Conventional Energy Sources, Khanna Publications, 2011.
2. John Twidell & Tony Weir, Renewable Energy Sources, Taylor & Francis, 2013.

Reference Books:

1. S.P.Sukhatme & J.K.Nayak, Solar Energy-Principles of Thermal Collection and Storage, TMH, 2011.
2. John Andrews & Nick Jelly, Energy Science- principles, Technologies and Impacts, Oxford, 2nd edition, 2013.
3. Shoba Nath Singh, Non- Conventional Energy Resources, Pearson Publications, 2015.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXYY	CONCEPTS OF ENERGY AUDITING & MANAGEMENT (Open Elective – I)	CATEGORY Open Elective - I	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Basics of Conservation of Electrical Energy

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the fundamental concepts of energy audit types, energy management principles, energy-efficient motors and lighting, power factor improvement methods, and economic analysis techniques in energy conservation.	2
CO2	Apply energy audit tools and techniques, manage energy conservation programs, perform energy audits for motors and lighting systems, and implement power factor correction measures using various instruments.	4
CO3	Analyze energy consumption patterns using Sankey diagrams and load profiles, evaluate energy-saving potentials in industries and buildings, and conduct economic feasibility studies incorporating lifecycle costing and payback methods for energy-efficient investments.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	2	-	-	-	-	2	3	1	1
CO2	3	3	3	2	3	2	-	1	1	1	1	3	3	2
CO3	2	3	3	3	2	3	-	1	1	2	2	2	2	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Basic Principles of Energy Audit** Energy audit- definitions - concept - types of **Energy** 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 - Conservation of Energy Building Codes (ECBC-2017)	
UNIT - 2	**Energy Management** Principles of energy management - organizing energy management program - initiating - planning - controlling - promoting - monitoring - reporting. Energy manager - qualities and functions - language - Questionnaire – check list for top management.	
UNIT - 3	**Energy Efficient Motors and Lighting** Energy efficient motors - factors affecting efficiency - loss distribution - constructional details - characteristics – variable speed - RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. lighting system design and practice - lighting control - lighting energy audit.	

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

UNIT - 4	**Power Factor Improvement and Energy Instruments** Power factor – methods of improvement - location of capacitors - Power factor with non-linear loads - effect of harmonics on power factor - power factor motor controllers – Energy Instruments- watt meter - data loggers - thermocouples - pyrometers - lux meters - tongue testers.	
UNIT - 5	**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.	
	Total	

Text Books:

1. Energy management by W.R.Murphy &G.Mckay Butter worth - Heinemann publications - 1982.
2. Energy management hand book by W.C Turner - John wiley and sons - 1982.

Reference Books:

1. Energy efficient electric motors by John.C.Andreas - Marcel Dekker Inc Ltd-2nd edition - 1995
2. Energy management by Paul o' Callaghan - Mc-graw Hill Book company-1st edition - 1998
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXYY	ELECTRICAL WIRING ESTIMATION AND COSTING (Open Elective -I)	CATEGORY Open Elective -I	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Basics of Power Systems

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Identify electrical symbols, wiring methods, and basic electrical circuits used in residential, commercial, and industrial installations, including substations and motor control components.	2
CO2	Apply principles of electrical installation design, protection, earthing, and cost estimation to plan and implement electrical systems for different types of buildings and small industries.	3
CO3	Analyze motor starting and control circuits, evaluate protection schemes for electrical installations, and assess substations' design and installation for efficient power distribution.	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	2	-	-	-	-	2	3	1	-
CO2	3	3	3	2	3	2	-	1	1	2	1	3	3	2
CO3	2	3	3	3	3	3	-	1	1	2	1	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Electrical Symbols and Simple Electrical Circuits** Identification of electrical symbols - Electrical Diagrams - Methods of representation of wiring diagrams - introduction to simple light and fan circuits - system of connection of appliances and accessories.	
UNIT - 2	**Design Considerations of Electrical Installations** Electric supply system - Three-phase four wire distribution system - protection of electric installation against overload - short circuit and earth fault - earthing - neutral and earth wire - types of loads - systems of wiring - permissible of voltage drops and sizes of wires - estimating and costing of electrical installations.	
UNIT - 3	**Electrical Installation for Different Types of Buildings and Small Industries** Electrical installations for electrical buildings - estimating and costing of material - simple examples on electrical installation for residential buildings -	

	electrical installations for commercial buildings - electrical installation for small industries-case study.	
UNIT - 4	**Substations** Introduction - types of substations- outdoor substations-pole mounted type - indoor substations-floor mounted type - simple examples on quantity estimation-case study.	
UNIT - 5	**Motor control circuits** Introduction to AC motors - starting of three phase squirrel cage induction motors - starting of wound rotor motors - starting of synchronous motors - contractor control circuit components - basic control circuits - motor protection	
	Total	

Text Books:

1. Electrical Design and Estimation Costing - K. B. Raina and S.K.Bhattacharya – New Age International Publishers- 2007.

References Books:

1. Electrical wiring estimating and costing – S.L.Uppal and G.C.Garg – Khannapublishers - 6th edition- 1987.
2. A course in electrical installation estimating and costing – J.B.Gupta –Kataria SK & Sons - 2013.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXYY	MICROPROCESSORS AND MICROCONTROLLERS LAB	CATEGORY Professional Core	L-T-P 0-0-3	CREDITS 1.5

Pre-requisite: Concepts of Microprocessors and Microcontrollers

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Summarize the architecture, instruction sets, and basic programming concepts of 8086 and 8051 microprocessors and microcontrollers.	2
CO2	Develop and execute assembly language programs for arithmetic and logic operations, string manipulation, sorting algorithms, and interfacing with peripheral devices like 8255 PPI, stepper motors, and serial communication modules.	3
CO3	Analyze program logic and memory usage for performance optimization, evaluate interfacing techniques, and troubleshoot microprocessor and microcontroller-based control and communication applications for efficient embedded system design.	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	-	-	-	-	-	2	3	1	-
CO2	3	3	3	2	3	-	-	1	1	1	1	3	3	2
CO3	2	3	3	3	3	-	-	1	1	1	2	2	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

S.No	CONTENTS Any 10 of the following experiments are to be conducted:	Contact Hours
	8086 Microprocessor Programs:	
1.	Arithmetic operations – Two 16-bit numbers and multibyte addition-subtraction - multiplication and division – Signed and unsigned arithmetic operations - ASCII – Arithmetic operations.	
2.	Logic operations – Shift and rotate – Converting packed BCD to unpacked BCD- BCD to ASCII conversion.	
3.	Arrange the given array in ascending and descending order	
4.	Determine the factorial of a given number	
5.	By using string operation and Instruction prefix**:** Move block - Reverse string Sorting- Inserting - Deleting - Length of the string - String comparison.	
6.	Find the first and n^{th} number of ‘n’ natural numbers of a Fibonacci series.	
7.	Find the number and sum of even and odd numbers of a given array	
8.	Find the sum of ‘n’ natural numbers and squares of ‘n’ natural numbers	
9.	Arithmetic operations on 8051	
10.	Conversion of decimal number to hexa equivalent and hexa equivalent to decimal number	
11.	Find the Sum of elements in an array and also identify the largest & smallest number of a given array using 8051	

Programs on Interfacing:		
12.	Interfacing 8255–PPI with 8086.	
13.	Stepper motor control using 8255 and 8086.	
14.	Traffic Light Controller using 8051.	
15.	PIC microcontroller	
16.	STM32 microcontroller	

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXYY	CONTROL SYSTEMS& SIMULATION LABORATORY	CATEGORY Professional Core	L-T-P 0-0-3	CREDITS 1.5

Pre-requisite: Basics of Control Systems Theory.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Perform experiments to observe and verify control system behaviours, controllers, compensators, and motor transfer functions including PLC logic operations.	2,3
CO2	Perform experiments to analyze stability and performance of control systems using time and frequency domain methods, assess controllability and observability, and evaluate servo motor and temperature controller characteristics.	4,5
CO3	Integrate theoretical knowledge with practical skills to design, implement, and troubleshoot control systems and automation using simulation tools and PLCs for real-world engineering applications.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	3	3	-	-	2	-	-	1	3	3	1
CO2	3	3	2	3	3	-	-	2	-	-	1	3	3	2
CO3	2	3	3	3	3	1	-	2	1	1	3	2	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

Exp. No.	CONTENTS (Any 10 of the following experiments are to be conducted)	Contact Hours
1	Analysis of second order system in time domain.	
2	Determination of performance characteristics of Synchro pair as error detector.	
3	Determination of performance of second order systems with P - PD - PI - PID Controllers.	
4	Design of Lag and lead compensating network using frequency domain technique.	
5	Transfer function of DC motor	
6	Determination of stability of the transfer functions using Bode Plot - Root locus - Nyquist Plots by simulation tools.	
7	Kalman’s test of Controllability and Observability.	
8	Temperature controller using PID	
9	Performance analysis of magnetic amplifiers	
10	Performance analysis of AC servo motor	
11	Performance analysis of DC servo motor	
12	To study and verify the truth table of logic gates and simple Boolean expressions using PLC	

III B.Tech I Semester

COURSE CODE – R2311XXYY	SOFT SKILLS (Skill Enhancement course)	CATEGORY Skill Enhancement course	L-T-P 0-1-2	CREDITS 2

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXXYY	DESIGN THINKING & IDEATION (Engineering Science)	CATEGORY Engineering Science	L-T-P 0-1-2	CREDITS 2

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Summarize the fundamental elements and principles of design, the history and process of design thinking, and the role of innovation and creativity in product and business design.	2
CO2	Apply the design thinking process—including empathy, analysis, ideation, prototyping, and testing—to develop and present innovative solutions, products, and business models addressing real-world and social challenges.	3
CO3	Analyze innovation strategies and design thinking tools within business and social contexts; evaluate product design decisions, prototype effectiveness, and the impact of design thinking on startups and corporate innovation.	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	2	-	1	2	1	1	-	1	2
CO2	2	3	3	1	3	3	-	3	3	2	1	-	2	3
CO3	1	3	3	3	2	3	-	2	2	3	3	-	2	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	Introduction to Design Thinking Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to Design Thinking, history of Design Thinking, New materials in Industry.	
UNIT - 2	Design Thinking Process Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social Innovations. Tools of design thinking – person, costumer, journey map, brainstorming, product development Activity: Every student presents their idea in three minutes, Every student can present designprocess in the form of flow diagram or flow chart etc. Every student should explain about product development.	
UNIT - 3	Innovation Art of innovation, Difference between innovation and creativity, role of creativity andinnovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity. Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.	

UNIT - 4	Product Design Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications. Innovation towards product design Case studies. Activity: Importance of modelling, how to set specifications, Explaining their own product design	
UNIT - 5	Design Thinking in Business Processes Design Thinking applied in Business & Strategic Innovation, Design Thinking principles thatredefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs. Design thinking for Startups. Defining and testing Business Models and Business Cases. Developing & testing prototypes. Activity: How to market our own product, about maintenance, Reliability and plan for startup.	
	Total	

Textbooks:

1. Tim Brown, Change by design, 1/e, Harper Bollins, 2009.
2. Idris Mootee, Design Thinking for Strategic Innovation, 1/e, Adams Media, 2014.

Reference Books:

1. David Lee, Design Thinking in the Classroom, Ulysses press, 2018.
2. Shrrutin N Shetty, Design the Future, 1/e, Norton P
3. William lidwell, Kritinaholden, &Jill butter, Universal principles of design, 2/e, Rockport Publishers, 2010.
4. Chesbrough.H, The era of open innovation, 2003.

Online Learning Resources:

- https://nptel.ac.in/courses/110/106/110106124/
- https://nptel.ac.in/courses/109/104/109104109/
- https://swayam.gov.in/nd1_noc19_mg60/preview
- https://onlinecourses.nptel.ac.in/noc22_de16/preview

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech I Semester

COURSE CODE – R2311XXYY	EVALUATION OF COMMUNITY SERVICE INTENSHIP	CATEGORY	L-T-P 0-0-0	CREDITS 2

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXYY	ELECTRICAL MEASUREMENTS AND INSTRUMENTATION	CATEGORY Professional Core	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts of Electrical Engineering.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the principles, construction, and operation of analog and digital electrical measuring instruments.	2
CO2	Apply various measurement methods and use transducers to accurately measure electrical parameters such as resistance, capacitance, inductance, power, and frequency.	3
CO3	Analyze instrument errors and performance, evaluate measurement results from advanced instruments, and interpret data for precise electrical parameter assessment.	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	1	-	-	-	-	1	3	1	-
CO2	3	3	2	3	3	2	-	1	-	1	1	3	3	2
CO3	2	3	2	3	3	2	-	1	-	1	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Analog Ammeter and Voltmeters** Classification – deflecting - control and damping torques - – PMMC - moving iron type and electrostatic instruments - Construction - Torque equation - Range extension - Errors and compensations - advantages and disadvantages. Instrument transformers: Current Transformer and Potential Transformer- construction- theory - errors-Numerical Problems.	
UNIT - 2	**Analog Wattmeter and Power Factor Meters** Electrodynamometer type wattmeter (LPF and UPF) - Power factor meters: Dynamometer and M.I type (Single phase and Three phase) - Construction- theory - torque equation - advantages and disadvantages. Potentiometers: Introduction to DC and AC Potentiometers –Construction- working – Applications-Numerical Problems.	
UNIT - 3	**Measurements of Electrical parameters** **DC Bridges:** Method of measuring low - medium and high resistance - sensitivity of Wheat stone's bridge - Kelvin's double bridge for measuring low resistance - Loss of charge method for measurement of high resistance - Megger – measurement of earth resistance - Numerical Problems. **AC Bridges:** Measurement of inductance and quality factor - - Maxwell's bridge- Hay's bridge - - Anderson's bridge. Measurement of capacitance and loss angle - Desauty's bridge- Schering Bridge - Wien's bridge - Wagner's earthing device - Numerical Problems.	

UNIT - 4	**Transducers** Definition - Classification - Resistive - Inductive and Capacitive Transducer - LVDT - Strain Gauge - Thermistors - Thermocouples - Piezo electric and Photo Diode Transducers - Hall effect sensors- Numerical Problems.	
UNIT - 5	**Digital meters** Digital Voltmeters – Successive approximation DVM - Ramp type DVM and Integrating type DVM – Digital frequency meter - Digital multimeter- Digital tachometer - Digital Energy Meter - Q meter - Power Analyzer. CRO- measurement of phase difference & Frequency using lissajious patterns - Numerical Problems.	
	Total	

Text Books:

1. Electrical Measurements and measuring Instruments by E.W. Golding and F.C.Widdis - 5th Edition - Wheeler Publishing.
2. Modern Electronic Instrumentation and Measurement Techniques by A.D. Helfrick and W.D. Cooper - PHI - 5th Edition - 2002.
3. Electronic Instrumentation by H.S. Kalsi - McGraw Hill - 4th Edition - 2019.

Reference Books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney Dhanpat Rai & Co.Publications- 19th revised edition - 2011.
2. Electrical and Electronic Measurements and instrumentation by R.K.Rajput- S.Chand - 3rd edition.
3. Electrical Measurements by Buckingham and Price- Prentice – Hall
4. Electrical Measurements by Forest K. Harris. John Wiley and Sons
5. Electrical Measurements: Fundamentals- Concepts - Applications by Reissland - M.U - New Age International (P) Limited- Publishers.
6. Electrical and Electronic Measurements by G.K.Banerjee- PHI Learning Private Ltd - New Delhi–2012.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXYY	UNIVERSAL HUMAN VALUES - UNDERSTANDING HARMONY AND ETHICAL HUMAN CONDUCT	CATEGORY HSMC	L-T-P 2-1-0	CREDITS 3

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXYY	POWER SYSTEM ANALYSIS	CATEGORY Professional Core	L-T-P 3-0-0	CREDITS 3

Pre-requisite:

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain power system modeling concepts including graph theory, per unit representation, and formation of Ybus and Zbus matrices along with single-line and impedance diagrams.	3
CO2	Apply power flow study methods such as Gauss-Seidel, Newton-Raphson, and decoupled approaches; perform symmetrical and unsymmetrical fault analyses using symmetrical components and sequence networks.	4
CO3	Analyze power system stability using swing equation and equal area criterion, evaluate transient and steady-state stability factors, and assess fault calculations and system performance improvement methods.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	2	-	-	-	-	-	1	3	2	-
CO2	3	3	2	3	3	2	-	-	-	1	1	3	3	2
CO3	2	3	3	3	3	2	-	-	-	1	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Circuit Topology & Per Unit Representation** Graph theory definition – Formation of element node incidence and bus incidence matrices – Primitive network representation – Formation of Y_{bus} matrix by singular transformation and direct inspection methods– Per Unit Quantities– Single line diagram – Impedance diagram of a power system.	
UNIT - 2	**Power Flow Studies** Necessity of power flow studies – Derivation of static power flow equations – Power flow solution using Gauss-Seidel Method – Newton Raphson Method (Rectangular and polar coordinates form) – Decoupled and Fast Decoupled methods – Algorithmic approach – Numerical Problems on 3–bus system only.	
UNIT - 3	**Z-Bus Algorithm & Symmetrical Fault Analysis** Formation of Z_{bus}**:** Algorithm for the Modification of Z_{bus} Matrix (without mutual impedance). **Symmetrical Fault Analysis:** Reactance's of Synchronous Machine – Three Phase Short Circuit Currents - Short circuit MVA calculations for Power Systems.	
UNIT - 4	**Symmetrical Components** Definition of symmetrical components – symmetrical components of unbalanced three phase systems – Power in symmetrical components – Sequence	

	impedances: Synchronous generator – Transmission line and transformers – Sequence networks. **Unsymmetrical Fault analysis** Various types of faults: LG– LL– LLG and LLL on unloaded alternator.	
UNIT - 5	**Power System Stability Analysis** Elementary concepts of Steady state – Dynamic and Transient Stabilities – Swing equation – Steady state stability – Equal area criterion of stability – Applications of Equal area criterion – Factors affecting transient stability – Methods to improve steady state and transient stability.	
	Total	

Text Books:

1.Power System Analysis by Grainger and Stevenson- Tata McGraw Hill.2003
2. Modern Power system Analysis – by I.J.Nagrath & D .P.Kothari: Tata McGraw–Hill Publishing Company- 3rd edition - 2007.

Reference Books:

1. Power System Analysis – by A.R.Bergen- Prentice Hall - 2nd edition - 2009.
2. Power System Analysis by HadiSaadat – Tata McGraw–Hill 3rd edition- 2010.
3. Power System Analysis by B.R.Gupta- A H Wheeler Publishing Company Limited - 1998.
4. Power System Analysis and Design by J.Duncan Glover- M.S.Sarma - T.J.Overbye – Cengage Learning publications- 5th edition - 2011.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXXYY	RENEWABLE AND DISTRIBUTED ENERGY TECHNOLOGIES (Professional Elective – II)	CATEGORY Professional Elective – II	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts of Electrical Machines - Power Electronics

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the principles, components, and operation of wind, solar, hydel, and other renewable energy systems along with their advantages and site considerations.	2
CO2	Apply energy estimation, power optimization, and control techniques to design and operate wind turbines, PV systems, hydel plants, and hybrid renewable energy setups.	3
CO3	Analyze integration challenges and evaluate energy storage and control strategies to design optimized grid-connected and standalone hybrid renewable energy systems.	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	2	-	-	-	-	1	3	1	1
CO2	3	3	3	2	3	2	-	1	1	1	1	3	3	2
CO3	2	3	3	3	3	2	-	1	1	1	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	Brief idea on renewable and distributed sources - their usefulness and advantages; Wind Energy Systems: Estimates of wind energy potential - wind maps - Instrumentation for wind velocity measurements - Aerodynamic and mechanical aspects of wind machine design - Conversion to electrical energy - Aspects of location of wind farms.	
UNIT - 2	Wind speed and energy - Speed and power relations - Power extraction from wind - Tip speed ratio (TSR) - Functional structure of wind energy conversion systems - Pitch and speed control - Power-speed-TSR characteristics - Fixed speed and variable speed wind turbine control - Power optimization - Electrical generators - Self-Excited and Doubly-Fed Induction Generators operation and control.	
UNIT - 3	Solar PV Systems: Present and new technological developments in photovoltaic - estimation of solar irradiance - components of solar energy systems - solar-thermal system applications to power generation - heating - Types of PV systems - Modelling of PV cell - current-voltage and power-voltage characteristics - Effects of temperature - Solar array simulator - Sun tracking - Peak power operations - PV system - MPPT techniques - Effects	

	of partial shading on the characteristic curves and associated MPPT techniques - Solar park design outline.	
UNIT - 4	Hydel Power: Water power estimates - use of hydrographs - hydraulic turbine - characteristics and part load performance - design of wheels - draft tubes and penstocks - plant layouts; Brief idea of other sources viz. - tidal - geothermal - gas-based - etc.	
UNIT - 5	Requirements of hybrid/combined use of different renewable and distributed sources - Need of energy storage; Control of frequency and voltage of distributed generation in Stand-alone and Grid-connected mode - use of energy storage and power electronics interfaces for the connection to grid and loads - Design and optimization of size of renewable sources and storages.	
	Total	

Text Books & Reference Books:

1. Math J. Bollen - Fainan Hassan ‘Integration of Distributed Generation in the Power System’ - IEEE Press - 2011.
2. Loi Lei Lai and Tze Fun Chan ‘Distributed Generation: Induction and Permanent Magnet Generators’ - Wiley-IEEE Press - 2007.
3. Studies’ Craig Anderson and Rudolf I. Howard ‘Wind and Hydropower Integration: Concepts - Considerations and Case - Nova Publisher - 2012.
4. Amanda E. Niemi and Cory M. Fincher ‘Hydropower from Small and Low-Head Hydro Technologies’ - Nova Publisher - 2011.
5. D. Yogi Goswami - Frank Kreith and Jan F. Kreider ‘Principles of Solar Engineering’ - Taylor & Francis 2000.
6. G. N. Tiwari ‘Solar Energy Technology’ - Nova Science Publishers - 2005.
7. Math J. Bollen - Fainan Hassan ‘Integration of Distributed Generation in the Power System’ - IEEE Press - 2011.
8. S. Heier and R. Waddington ‘Grid Intergration of Wind Energy Conversion Systems’ – Wiley - 2006.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXXYY	AI TECHNIQUES (Professional Elective –II)	CATEGORY Professional Elective – II	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts of Linear and Boolean Algebra - Optimization Techniques.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the fundamentals of artificial neural networks, including neuron models, architectures, learning strategies, and fuzzy set theory.	2
CO2	Apply neural network training algorithms and fuzzy logic methods to develop models for classification, pattern recognition, and control applications.	3
CO3	Analyze neural network architectures and fuzzy logic systems, evaluate their performance, and implement them for real-world applications like load forecasting and speed control	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	2	-	-	-	-	-	1	3	1	1
CO2	3	3	3	2	3	2	-	1	1	1	1	3	3	2
CO3	2	3	3	3	3	2	-	1	1	1	2	2	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Introduction** Artificial Neural Networks (ANN) – Humans and computers – Biological neural networks – ANN Terminology – Models of Artificial neuron – activation functions – typical architectures – biases and thresholds – learning strategy(supervised - unsupervised and reinforced) – Neural networks learning rules. Single layer feed forward neural networks: concept of pattern and its types - perceptron training and classification using Discrete and Continuous perceptron algorithms– linear separability- XOR function.	
UNIT - 2	**Multi-layer feed forward networks** Generalized delta rule– Back Propagation algorithm– Radial Basis Function (RBF) network - Kohonen's self-organizing feature maps (KSOFM) - Learning Vector Quantization (LVQ) – Bidirectional Associative Memory (BAM) – Hopfield Neural Network.	
UNIT - 3	**Classical Sets and Fuzzy Sets** Introduction to classical sets- properties - Operations and relations - Fuzzy sets - Operations - Properties - Fuzzy relations - Cardinalities - Membership functions.	
UNIT - 4	**Fuzzy Logic Modules** Fuzzification - Membership value assignment - development of rule base and decision making system - Defuzzification to crisp sets - Defuzzification methods.	

UNIT - 5	**Applications** **Neural network applications:** Load flow studies - load forecasting - reactive power control. **Fuzzy logic applications:** Economic load dispatch - speed control of DC motors - single area and two area load frequency control.	
	Total	

Text Books:

1. Introduction to Artificial Neural Systems - Jacek M. Zuarda - Jaico Publishing House - 1997.
2. Neural Networks - Fuzzy logic - Genetic algorithms: synthesis and applications by RajasekharanandPai – PHI Publication.

Reference Books:

1. Artificial Neural Network – B.Yegnanarayana - PHI - 2012.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – Mc Graw Hill Inc - 1997.
3. Introduction to Neural Networks using MATLAB 6.0 – S N Sivanandam - SSumathi - S N Deepa TMGH
4. Introduction to Fuzzy Logic using MATLAB – S N Sivanandam - SSumathi - S N Deepa Springer - 2007.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXYY	DIGITAL SIGNAL PROCESSING (Professional Elective –II)	CATEGORY Professional Elective – II	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Mathematics and concepts of filters.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain the fundamental concepts of discrete-time signals and systems, including stability, invertibility, and system responses; analyze difference equations using Z-transforms, and describe frequency domain representations using Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) algorithms.	2
CO2	Apply the design methodologies for digital filters by implementing IIR filters based on Butterworth and Chebyshev approximations and FIR filters using window and frequency sampling techniques, analyze and compare various filter structures for practical implementations	3,4
CO3	Analyze multirate digital signal processing techniques including decimation, interpolation, and sampling rate conversion; evaluate the performance and effectiveness of digital filter banks and FFT algorithms in real-world signal processing applications	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	-	1	3	2	-
CO2	3	3	3	2	3	2	-	1	1	1	1	3	3	2
CO3	2	3	3	3	3	2	-	1	1	1	2	2	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	**Introduction** Introduction to Digital Signal Processing: Discrete time signals & sequences - Classification of Discrete time systems - stability of LTI systems- Invertability - Response of LTI systems to arbitrary inputs. Solution of Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems. Review of Z-transforms - solution of difference equations using Z-transforms - System function.	
UNIT - 2	**Discrete Fourier Transforms and FFT Algorithms** Discrete Fourier Series representation of periodic sequences -Properties of Discrete Fourier Series - Discrete Fourier transforms: Properties of DFT - linear filtering methods based on DFT - Fast Fourier transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms- Inverse FFT.	
UNIT – 3	**Design and Realizations of IIR Digital Filters** Analog filter approximations – Butter worth and Chebyshev - Design of IIR Digital filters from analog filters - Design Examples. Analog and Digital	

	frequency transformations. Basic structures of IIR systems – Direct-Form Structures - Transposed Structures - Cascade-Form Structures - Parallel-Form Structures Lattice and Lattice-Ladder Structures.	
UNIT –4	**Design and Realizations of FIR Digital Filters** Characteristics of FIR Filters with Linear Phase - Frequency Response of Linear Phase FIR Filters - Design of FIR Digital Filters using Window Techniques and Frequency Sampling technique - Comparison of IIR & FIR filters. Basic structures of FIR systems – Direct-Form Structure - Cascade-Form Structures Linear Phase Realizations - Lattice structures.	
UNIT – 5	**Multirate Digital Signal Processing** Introduction-Decimation –Interpolation-SamplingRate Conversion by a Rational Factor-Implementation of sampling rate converters-Applications of Multirate Signal Processing-Digital Filter Banks.	
	Total	

Text Books:

1. Digital Signal Processing- Principles - Algorithms - and Applications: John G. Proakis - Dimitris G.Manolakis - 4th Edition - Pearson Education / PHI - 2007.
2. Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer- PHI.
3. Digital Signal Processing: A Computer based approach. Sanjit K Mitra- 4th Edition - TMH - 2014.

Reference Books:

1. Digital Signal Processing: Andreas Antoniou - TATA McGraw Hill - 2006
2. Digital Signal Processing: MH Hayes- Schaum's Outlines - TATA Mc-Graw Hill - 2007.
3. DSP Primer - C. Britton Rorabaugh- Tata McGraw Hill - 2005.
4. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling- Sandra L. Harris - Thomson- 2007.
5. Digital Signal Processing – Alan V. Oppenheim- Ronald W. Schafer - PHI Ed. - 2006.
6. Digital Signal Processing – K Raja Rajeswari- 1st edition - I.K. International Publishing - House - 2014.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXYY	ELECTRIC DRIVES (Professional Elective – III)	CATEGORY Professional Elective – III	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Pre-requisite: Electrical Circuit Analysis, Power electronics, Electrical Machines and Control Systems.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Understand various converter control schemes for driving & braking of the motors and select suitable scheme for the given applications.	2
CO2	Compare and analyse the merits of different drive topologies and develop better control schemes for AC and DC drives.	4
CO3	Evaluate the performance of various AC and DC drives in different modes with open and closed loop control.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	1	-	1	-	-	-	1	2	2	2	-
CO2	3	2	2	3	3	1	-	-	-	1	1	3	3	2
CO3	3	3	3	3	3	1	-	-	-	1	1	3	3	2

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Fundamentals of Electric Drives** Electric drive and its components– Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods**:** Dynamic – Plugging – Regenerative methods.	
UNIT - 2	**Controlled Converter Fed DC Motor Drives** 3-phase half and fully-controlled converter fed separately and self-excited DC motor drive – Output voltage and current waveforms – Speed-torque expressions – Speed-torque characteristics – Dual converter fed DC motor drives -Numerical problems.	
UNIT - 3	**DC–DC Converters Fed DC Motor Drives** Single quadrant – Two quadrant and four quadrant DC-DC converter fed separately excited and self-excited DC motors – Continuous current operation - Output voltage and current waveforms – Speed–torque expressions and characteristics – Closed loop operation (qualitative treatment only).	
UNIT - 4	**Stator and Rotor side control of 3-phase Induction motor Drive** Stator voltage control using 3-phase AC voltage regulators – Waveforms – Speed torque characteristics– Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter – Closed loop V/f control of	

	induction motor drives (qualitative treatment only). Static rotor resistance control – Slip power recovery schemes – Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics.	
UNIT - 5	**Control of Synchronous Motor Drives** Separate control of synchronous motor – self-control of synchronous motor employing load commutated thyristor inverter - closed loop control of synchronous motor drive (qualitative treatment only)– PMSM (Basic operation only).	
	Total	

Text Books:

1. Fundamentals of Electric Drives – by G K Dubey - Narosa Publications - 2nd edition – 2002.
2. Power Semiconductor Drives - by S.B.Dewan - G.R.Slemon - A.Straughen - Wiley India - 1984.

Reference Books:

1. Electric Motors and Drives Fundamentals - Types and Apllications - by Austin Hughes and Bill Drury - Newnes.4th edition - 2013.
2. Thyristor Control of Electric drives – Vedam Subramanyam Tata McGraw Hill Publications - 1987.
3. Power Electronic Circuits - Devices and applications by M.H.Rashid - PHI - 3rd edition - 2009.
4. Power Electronics handbook by Muhammad H.Rashid - Elsevier - 2nd edition - 2010.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXYY	SWITCHGEAR AND PROTECTION (Professional Elective – III)	CATEGORY Professional Elective – III	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts of Power systems

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain the operating principles and applications of circuit breakers, protection relays, and grounding techniques used in power systems.	2
CO2	Apply appropriate protection schemes for generators, transformers, feeders, and bus bars by selecting suitable relays and circuit breakers, and analyze protection system responses under various fault conditions.	3,4
CO3	Evaluate the effectiveness of different overvoltage protection methods and grounding practices, and synthesize comprehensive protection strategies to optimize reliability and safety in modern electrical power systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	2	-	-	-	-	1	3	2	1
CO2	3	3	3	3	3	2	-	-	-	1	1	3	3	2
CO3	2	3	3	3	3	3	-	-	-	1	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Circuit Breakers** Application oriented evolution of Switchgear - Miniature Circuit Breaker(MCB)– Elementary principles of arc interruption– Restriking Voltage and Recovery voltages– Restriking phenomenon - RRRV– Average and Max. RRRV– Current chopping and Resistance switching– Concept of oil circuit breakers– Description and operation of Air Blast– Vacuum and SF6 circuit breakers– CB ratings and specifications– Concept of Auto reclosing.	
UNIT - 2	**Electromagnetic Protection** Relay connection – Balanced beam type attracted armature relay - induction disc and induction cup relays–Torque equation - Relays classification–Instantaneous– DMT and IDMT types– Applications of relays**:** Over current and under voltage relays– Directional relays– Differential relays and percentage differential relays– Universal torque equation– Distance relays**:** Impedance– Reactance– Mho and offset mho relays– Characteristics of distance relays and comparison.	
UNIT - 3	**Generator Protection** Protection of generators against stator faults– Rotor faults and abnormal conditions– restricted earth fault and inter turn fault protection– Numerical examples. **Transformer Protection**	

	Percentage differential protection– Design of CT's ratio– Buchholz relay protection.	
UNIT - 4	**Feeder and Bus bar Protection &Static Relays:** Over current Protection schemes – PSM - TMS– Numerical examples – Carrier current and three zone distance relay using impedance relays. Protection of bus bars by using Differential protection. Static relays**:** Introduction – Classification of Static Relays – Basic Components of Static Relays.	
UNIT - 5	**Protection against over voltage and grounding** Generation of over voltages in power systems– Protection against lightning over voltages– Valve type and zinc oxide lighting arresters. Grounded and ungrounded neutral systems – Effects of ungrounded neutral on system performance – Methods of neutral grounding**:** Solid–resistance–Reactance–Arcing grounds and grounding Practices.	
	Total	

Text Books:

1. Power System Protection and Switchgear by Badri Ram and D.N Viswakarma - Tata McGraw Hill Publications - 2nd edition - 2011.
2. Power system protection- Static Relays with microprocessor applications by T.S.Madhava Rao - Tata McGraw Hill - 2nd edition.

Reference Books:

1. Fundamentals of Power System Protection by Paithankar and S.R.Bhide. - PHI - 2003.
2. Art & Science of Protective Relaying – by C R Mason - Wiley Eastern Ltd.
3. Protection and SwitchGear by BhaveshBhalja - R.P. Maheshwari - Nilesh G.Chothani - Oxford University Press - 2013.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXXYY	HIGH VOLTAGE ENGINEERING (Professional Elective – III)	CATEGORY Professional Elective – III	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts on Electric Supply Systems

		Knowledge Level (K)#
CO1	Explain the mechanisms of electrical breakdown in gaseous, liquid, and solid insulating materials, and discuss how different properties and applications of insulating media influence high voltage engineering.	2
CO2	Apply circuit principles to design and analyze high-voltage generation and measurement systems—including DC, AC, and impulse voltages and currents—by selecting appropriate configurations for laboratory and industrial scenarios.	3,4
CO3	Evaluate and synthesize optimal methods for generating, controlling, and accurately measuring high-voltage and high-current waveforms, justifying choices based on safety, reliability, and application requirements in advanced electrical insulation and testing systems.	5

Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	1	2	2	-	-	-	-	1	3	2	1
CO2	3	3	3	3	3	2	-	-	-	-	1	3	3	2
CO3	2	3	3	3	3	3	-	-	-	-	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Break down phenomenon in Gaseous:** Insulating Materials: Types - applications and properties. Gases as insulating media – Collision process – Ionization process – Townsend's criteria of breakdown in gases and its limitations – Streamers Theory of break down – Paschen's law- Paschens curve.	
UNIT - 2	**Break down phenomenon in Liquids:** Liquid as Insulator – Pure and commercial liquids – Breakdown in pure and commercial liquids. **Break down phenomenon in Solids:** Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown – Breakdown of composite solid dielectrics.	
UNIT - 3	**Generation of High DC voltages:** Voltage Doubler Circuit - Voltage Multiplier Circuit – Vande- Graaff Generator. **Generation of High AC voltages**: Cascaded Transformers – Resonant Transformers –Tesla Coil	
UNIT - 4	**Generation of Impulse voltages:** Specifications of impulse wave – Analysis of RLC circuit only- Marx Circuit.	

	Generation of Impulse currents: Definitions – Circuits for producing Impulse current waves – Wave shape control - Tripping and control of impulse generators.	
UNIT - 5	**Measurement of High DC & AC Voltages:** Resistance potential divider - Generating Voltmeter - Capacitor Voltage Transformer (CVT) - Electrostatic Voltmeters – Sphere Gaps. **Measurement of Impulse Voltages & Currents:** Potential dividers with CRO - Hall Generator - Rogowski Coils.	
	Total	

Text Books:

1. High Voltage Engineering: Fundamentals by E.Kuffel - W.S.Zaengl - J.Kuffel by Elsevier - 2nd Edition.
2. High Voltage Engineering and Technology by Ryan - IET Publishers - 2nd edition.

Reference Books:

1. High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications - 3rd Edition.
2. High Voltage Engineering by C.L.Wadhwa - New Age Internationals (P) Limited - 1997.
3. High Voltage Insulation Engineering by RavindraArora - Wolfgang Mosch - New Age International (P) Limited - 1995.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXYY	FUNDAMENTALS OF ELECTRIC VEHICLES (Open Elective – II)	CATEGORY Open Elective -II	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Basics of Machines and Electronics.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain the fundamentals, evolution, and advantages of electric and hybrid vehicles, along with their key components and energy storage systems.	2
CO2	Analyze and select appropriate power converters, electric motors, and energy sources for different electric vehicle architectures to meet specific performance and application requirements.	3,4
CO3	Evaluate various electric and hybrid vehicle technologies and synthesize effective system configurations for enhanced efficiency, sustainability, and practical implementation in modern transportation systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	2	-	-	-	-	1	3	2	1
CO2	3	3	3	2	3	2	-	-	-	-	1	3	3	2
CO3	2	3	3	3	3	3	-	-	-	-	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Introduction** Fundamentals of vehicles - Components of conventional vehicles- drawbacks of conventional vehicles – Need for electric vehicles - History of Electric Vehicles – Types of Electric Vehicles – Advantages and applications of Electric Vehicles.	
UNIT - 2	**Components of Electric Vehicles** Main components of Electric Vehicles – Power Converters - Controller and Electric Traction Motor – Rectifiers used in EVs – Bidirectional DC–DC Converters – Voltage Source Inverters – PWM inverters used in EVs.	
UNIT - 3	**Hybrid Electric Vehicles** Evolution of Hybrid Electric Vehicles – Advantages and Applications of Hybrid Electric Vehicles – Architecture of HEVs - Series and Parallel HEVs – Complex HEVs – Range extended HEVs – Examples- Merits and Demerits.	
UNIT - 4	**Motors for Electric Vehicles** Characteristics of traction drive - requirements of electric machines for EVs – Different motors suitable for Electric and Hybrid Vehicles – Induction Motors – Synchronous Motors – Permanent Magnetic Synchronous Motors – Brushless DC Motors – Switched Reluctance Motors (Construction details and	

	working only)	
UNIT - 5	**Energy Sources for Electric Vehicles** Batteries - Types of Batteries – Lithium-ion - Nickel-metal hydride - Lead-acid – Comparison of Batteries - Battery Management System – Ultra capacitors – Flywheels – Fuel Cell – it's working.	
	Total	

Text Books

1. Iqbal Hussein- Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2021.
2. Denton- Tom. Electric and hybrid vehicles. Routledge- 2020.

Reference Books:

1. Kumar- L. Ashok - and S. Albert Alexander. Power Converters for Electric Vehicles. CRC Press- 2020.
2. Chau- Kwok Tong. Electric vehicle machines and drives: design- analysis and application. John Wiley & Sons- 2015.
3. Berg- Helena. Batteries for electric vehicles: materials and electrochemistry. Cambridge university press- 2015.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXYY	BASICS OF MICROPROCESSORS AND MICROCONTROLLERS (Open Elective – II)	CATEGORY Open Elective -II	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Basics of Processors

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the evolution, architecture, and memory organization of microprocessors and microcontrollers, including key features of 8086 and 8051 families.	2
CO2	Analyze and apply instruction sets, addressing modes, and interfacing techniques to connect peripherals and memory devices with 8086 and 8051 for given application requirements.	3,4
CO3	Evaluate and synthesize suitable microprocessor and microcontroller system configurations and interfacing solutions for advanced automation and embedded system applications.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	-	-	-	-	-	1	3	2	-
CO2	3	3	3	2	3	-	-	-	-	-	1	3	3	2
CO3	2	3	3	3	3	2	-	-	-	-	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Introduction to Microprocessor Architecture** Introduction and evolution of Microprocessors – Architecture of 8086 – Memory Organization of 8086 – Register Organization of 8086– Introduction to 80286 - 80386- 80486 and Pentium (brief description about architectural advancements only).	
UNIT - 2	**Minimum and Maximum Mode Operations** Instruction sets of 8086 - Addressing modes – Assembler directives - General bus operation of 8086 – Minimum and Maximum mode operations of 8086 – 8086 Control signal interfacing – Read and write cycle timing diagrams.	
UNIT - 3	**Microprocessors I/O Interfacing** 8255 PPI– Architecture of 8255–Modes of operation – Interfacing I/O devices to 8086 using 8255 – Interfacing A to D converters – Interfacing D to A converters – Stepper motor interfacing– Static memory interfacing with 8086.	
UNIT - 4	**8051 Microcontroller** Overview of 8051 Microcontroller – Architecture – Memory Organization – Register set.	
UNIT - 5	**8051 Interfacing and Applications** Instruction set – I/O ports and Interrupts – Timers and Counters – Serial Communication – Interfacing of peripherals – Applications of microcontrollers.	
	Total	

Text Books:

1. Ray and Burchandi - "Advanced Microprocessors and Interfacing" - Tata McGraw–Hill - 3rd edition - 2006.
2. Kenneth J Ayala - "The 8051 Microcontroller Architecture - Programming and Applications" - Thomson Publishers - 2nd Edition.
3. PIC Microcontroller and Embedded Systems using Assembly and C for PIC 18 - - Muhammad Ali Mazidi - RolindD.Mckinay - Danny causey -Pearson Publisher 21st Impression.

Reference Books:

1. Microprocessors and Interfacing - Douglas V Hall - Mc–Graw Hill - 2nd Edition.
2. R.S. Kaler - "A Text book of Microprocessors and Micro Controllers" - I.K. International Publishing House Pvt. Ltd.
3. Ajay V. Deshmukh - "Microcontrollers – Theory and Applications" - Tata McGraw–Hill Companies –2005.
4. Ajit Pal - "Microcontrollers – Principles and Applications" - PHI Learning Pvt Ltd - 2011.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXYY	DIGITAL ELCTRONICS (Open Elective – II)	CATEGORY Open Elective -II	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Knowledge of electronic components and semiconductor devices, number systems, binary arithmetic, Boolean or switching algebra and logic gates.

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

		Knowledge Level (K)#
CO1	Explain different number systems, digital codes, and theorems of Boolean algebra, and describe basic and universal logic gates along with error detection and correction methods.	2
CO2	Design, minimize, and implement combinational and sequential logic circuits—such as adders, encoders, multiplexers, flip-flops, counters, and registers—using Boolean theorems, K-maps, and hardware building blocks.	3,4
CO3	Evaluate and synthesize advanced digital system designs by developing optimized circuit configurations using programmable logic devices, state machines, and modern minimization techniques for reliable real-world applications.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	1	-	-	-	-	-	1	3	2	-
CO2	3	3	3	2	3	-	-	-	-	-	-	3	3	2
CO3	2	3	3	3	3	2	-	-	-	-	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Review Of Number Systems & Codes** Representation of numbers of different radix, conversation from one radix to another radix, r-1's compliments and r's compliments of signed members.Gray code ,4 bit codes; BCD, Excess-3, 2421, 84-2-1 code etc., Error detection & correction codes: parity checking, even parity, odd parity, Hamming code. **Boolean theorems and logic operations** Boolean theorems, principle of complementation & duality, De-morgan theorems. Logic operations ; Basic logic operations -NOT, OR, AND, Universal Logic operations, EX-OR, EX-NOR operations. Standard SOP and POS Forms, NAND-NAND and NOR-NOR realizations.	
UNIT - 2	**Minimization Techniques** Minimization and realization of switching functions using Boolean theorems, K-Map (up to 6 variables) and tabular method. **Combinational Logic Circuits Design** Design of Half adder, full adder, half subtractor, full subtractor, applications of full adders; 4-bit adder-subtractor circuit, BCD adder circuit, Excess 3 adder circuit and carry look-a-head adder circuit	

UNIT - 3	**Combinational Logic Circuits Design Using MSI &LSI** Design of encoder ,decoder, multiplexer and demultiplexers, Implementation of higher order circuits using lower order circuits . Realization of Boolean functions using decoders and multiplexers. Design of Priority encoder, 4-bit digital comparator and seven segment decoder. **Introduction of PLD's** PLDs: PROM, PAL, PLA -Basics structures, realization of Boolean functions.	
UNIT - 4	**Sequential Circuits -I** Classification of sequential circuits (synchronous and asynchronous) , operation of NAND & NOR Latches and flip-flops; truth tables and excitation tables of RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals. Conversion from one flip-flop to another flip-flop. Design of ripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bi-directional shift register, universal shift register.	
UNIT - 5	**Sequential Circuits - II** Finite state machine; state diagrams, state tables, reduction of state tables. Analysis of clocked sequential circuits Mealy to Moore conversion and vice-versa. Realization of sequence generator and sequence detector circuits.	
	Total	

Text Books:

1. Switching and finite automata theory Zvi.KOHAVI 3RD EDITION
2. Fundamentals of Logic Design by Charles H. Roth Jr, Jaico Publishers
3. Digital Design by Mano PHI.

Reference Books:

1. Switching Theory and Logic Design by A. Anand Kumar
2. Switching Theory and Logic Design by Hill and Peterson Mc-Graw Hill TMH edition

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXXYY	ELECTRICAL MEASUREMENTS AND INSTRUMENTATION LABORATORY	CATEGORY Professional Core	L-T-P 0-0-3	CREDITS 1.5

Pre-requisite: Concepts of Electrical Instruments and its Measurements.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain the principles and working of various electrical measuring instruments, bridges, and transducers used for resistance, capacitance, inductance, power, and strain measurements.	2
CO2	Perform calibration and measurement procedures using dynamometer wattmeters, energy meters, potentiometers, and bridge circuits to accurately determine electrical parameters.	3
CO3	Analyze measurement data from methods such as phantom loading, null deflection, and bridge methods to compute errors, tolerances, and characteristics of transformers, thermocouples, and transducers.	4
CO4	Evaluate accuracy and performance of instrument transformers (CTs, PTs), energy meters, and power measurement setups and synthesize improved calibration techniques ensuring reliable and precise measurements.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	1	-	-	-	-	1	3	2	-
CO2	3	3	-	3	3	2	-	-	-	-	-	3	3	-
CO3	2	3	-	3	3	-	-	-	-	-	-	3	3	2
CO4	2	3	3	3	3	2	-	-	-	-	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

S.No	CONTENTS	Contact Hours
1.	Calibration of dynamometer wattmeter using phantom loading	
2.	Measurement of resistance using Kelvin's double Bridge and Determination of its tolerance.	
3.	Measurement of Capacitance using Schering Bridge.	
4.	Measurement of Inductance using Anderson Bridge.	
5.	Calibration of LPF Wattmeter by direct loading.	
6.	Measurement of 3 phase reactive power using single wattmeter method for a balanced load.	
7.	Testing of C.T. using mutual inductor – Measurement of % ratio error and phase angle of given C.T. by Null deflection method.	
8.	P.T. testing by comparison – V.G as Null detector – Measurement of % ratio error and phase angle of the given P.T.	
9.	Determination of the characteristics of a Thermocouple.	
10.	Determination of the characteristics of a LVDT.	
11.	Determination of the characteristics for a capacitive transducer.	

12.	Measurement of strain for a bridge strain gauge.	
13.	Measurement of Choke coil parameters and single phase power using three voltmeter and three ammeter methods.	
14.	Calibration of single phase Energy Meter.	
15.	Dielectric oil Test using HV Kit.	
16.	Calibration of DC ammeter and voltmeter using Crompton DC Potentiometer.	
17.	AC Potentiometer: Polar Form / Cartesian Form - Calibration of AC voltmeter - Parameters of choke.	

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III B.Tech II Semester

COURSE CODE – R2311XXYY	SKILLED ENHANCEMENT COURSE – IOT APPLICATIONS IN ELECTRICAL ENGINEERING LAB	CATEGORY Skilled Enhancement Course	L-T-P 0-1-2	CREDITS 2

Pre-requisite: Concepts of Computer Organisation - Computer Networks.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain the fundamental concepts, architecture, and technologies underlying the Internet of Things, including IoT frameworks, communication protocols, and common IoT devices.	2
CO2	Demonstrate programming and hardware interfacing skills by utilizing Arduino and Raspberry Pi platforms to connect various sensors, actuators, displays, and wireless communication modules.	3
CO3	Analyze sensor and communication system data to design and develop functional IoT applications such as environmental monitoring, home automation, and real-time data transmission to cloud platforms.	4
CO4	Evaluate and synthesize complex IoT solutions by integrating multiple sensors, communication technologies, and cloud services, ensuring optimized performance, reliability, and user interaction in smart systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	1	-	-	-	-	1	3	2	-
CO2	3	2	3	2	3	-	-	1	1	-	-	3	3	2
CO3	2	3	3	3	3	2	-	-	1	-	2	3	3	3
CO4	2	3	3	3	3	3	-	1	2	1	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

<u>Topics to be covered in Tutorials</u>

CONTENTS	Contact Hours
Module–1: The Internet of Things: An Overview of Internet of Things (IoT) – IoT framework –Architecture – Technology behind IoT – Sources of the IoT – M2M Communication – Examples of IoT.	3hrs
Module–2: Programming using Arduino and Raspberry Pi: **Arduino:** Classification of Arduino Boards - Pin diagrams – Arduino Integrated Development Environment (IDE) – Programming Arduino. **Raspberry Pi:** Introduction, Classification of Rasperberry Pi Series - Pin diagrams – Programmi Rasperberry Pi.	5hrs

Module-3: Sensors: Working of temperature sensor, proximity sensor, IR sensor, Light sensor, ultrasonic sensor, PIR Sensor, Colour sensor, Soil Sensor, Heart Beat Sensor, Fire Alarms etc. Actuators: Stepper Motor, Servo Motor and their integration with Arduino/Raspberry Pi.	2hrs
Module–4: Display: Working of LEDs, LED, OLED display, LCDs, Seven Segment Display, Touch Screen etc. Analog Input and Digital Output Converter etc. and their integration with Arduino/Raspberry Pi.	2hrs
Module–5: Wireless Communication Devices: Working of Bluetooth, Wi-Fi, Radio Frequency Identification (RFID), GPRS/GSM Technology, ZigBee, etc and their integration with Arduino/Raspberry Pi. Features of Alexa.	4hrs
Total	

S.No	CONTENTS	Contact Hours
	List of Experiments: **Any TEN of the following Experiments are to be conducted**	
1.	Familiarization with Arduino/Raspberry Pi and perform necessary software installation.	
2.	Interfacing of LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.	
3.	Interfacing of Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.	
4.	Interfacing of sensor (PIR/Ultrasonic sensor) with Arduino/Raspberry Pi and write a program to turn ON LED when a sensor is detected.	
5.	Interfacing of temperature sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.	
6.	Interfacing of Organic Light Emitting Diode (OLED) with Arduino/Raspberry Pi	
7.	Interfacing of Servomotor with Arduino/Raspberry Pi	
8.	Interfacing of IR sensor with LCD using Arduino/Raspberry Pi	
9.	Interfacing and Controlling RGB with Arduino/ Raspberry Pi	
10.	Interfacing of Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.	
11.	Interfacing of Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when ‘1’/’0’ is received from smartphone using Bluetooth.	
12.	Write a program on Arduino/Raspberry Pi to upload and retrieve temperature and humidity data to thingspeak cloud.	
13.	Interfacing of 7 Segment Display with Arduino/Raspberry Pi	
14.	Interfacing of Joystick with Arduino/Raspberry Pi	
15.	Interfacing of Analog Input & Digital Output with Arduino/Raspberry Pi	
16.	Night Light Controlled & Monitoring System	
17.	Fire Alarm Using Arduino	
18.	IR Remote Control for Home Appliances	
19.	A Heart Rate Monitoring System	
20.	Alexa based Home Automation System	

III B.Tech II Semester

COURSE CODE – R2311XXYY	RESEARCH METHODOLOGY	CATEGORY Audit Course	L-T-P 2-0-0	CREDITS 0

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXYY	POWER SYSTEM OPERATION AND CONTROL	CATEGORY Professional Core	L-T-P 3-0-0	CREDITS 3

Pre-requisite:Power Systems, Electrical Machines, Control Systems, Engineering Mathematics

Course Outcomes: After the completion of the course the student should be able to:

CO	Statement	Level#
CO1	Analyze the economic operation of thermal and hydrothermal power systems, including optimal generation allocation, unit commitment, and the effect of transmission line losses.	4
CO2	Develop and evaluate mathematical models for load frequency control in single-area and two-area power systems, incorporating control strategies for stability and economic dispatch coordination.	5
CO3	Assess reactive power compensation techniques and FACTS device applications to improve voltage regulation, stability, and overall power system performance.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	–	–	–	2	1	3	2	1
CO2	3	3	2	3	3	1	–	1	–	2	2	3	3	2
CO3	3	3	3	2	3	2	–	1	–	2	2	3	3	2

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	**Economic Operation of Power Systems** Optimal operation of Generators in Thermal power stations - – Heat rate curve – Cost Curve – Incremental fuel and Production costs – Input–output characteristics – Optimum generation allocation with line losses neglected – Optimum generation allocation including the effect of transmission line losses – Loss Coefficients – General transmission line loss formula.	
UNIT - 2	**Hydrothermal Scheduling** Mathematical Formulation – Short term Scheduling. **Unit Commitment** Need for unit commitment – Constraints in unit commitment – Cost function formulation – Solution methods – Priority ordering – Dynamic programming (Numerical problem for up to 3 units).	
UNIT – 3	**Load Frequency Control-I** Modelling of steam turbine – Generator – Mathematical modelling of speed governing system – Transfer function – Necessity of keeping frequency constant. Definitions of Control area – Single area control system – Block diagram representation of an isolated power system – Steady state analysis –	

	Dynamic response – Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation – Steady state response.	
UNIT – 4	**Load Frequency Control-II** Block diagram development of Load Frequency Control of two area system uncontrolled case and controlled case – Tie-line bias control – Load Frequency Control and Economic dispatch control – State space model – optimal parameter adjustment.	
UNIT – 5	**Compensation in Power Systems** Overview of Reactive Power control – Reactive Power compensation in transmission systems – Advantages and disadvantages of different types of compensating equipment for transmission systems – Load compensation – Specifications of load compensator – compensated transmission lines. Introduction of FACTS devices – Need of FACTS controllers – Types of FACTS devices (Basic concepts only).	
	Total	

Text Books:

1. Power Generation- Operation and Control by Allen J Wood - Bruce F WollenBerg 3rd Edition - Wiley Publication 2014.
2. Electric Energy systems Theory – by O.I.Elgerd- Tata McGraw–hill Publishing Company Ltd. - Second edition.
2. Modern Power System Analysis – by I.J.Nagrath&D.P.Kothari Tata McGraw Hill Publishing Company Ltd- 2nd edition.

Reference Books:

1. Power System Analysis and Stability by S.S.Vadhera - Khanna Publications- 4th edition - 2005.
2. Power System Analysis by Grainger and Stevenson- Tata McGraw Hill.
3. Power System Analysis by HadiSaadat – – Tata McGraw–Hill 3rd edition- 2010.
4. Power System stability & control- Prabha Kundur - TMH - 1994.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXYY	ENERGY MANAGEMENT & AUDITING	CATEGORY Management Course- II	L-T-P 2-0-0	CREDITS 2

Pre-requisite: Electrical Machines, Power Systems, Thermodynamics, Electrical Measurements.
Course Outcomes: After the completion of the course the student should be able to:

CO	Statement	Level #
CO1	Analyze principles and methodologies of energy auditing and management, including assessment tools, conservation schemes, and energy codes for industrial, process, and building applications.	4
CO2	Apply strategies for improving energy efficiency in motors, lighting systems, and power factor correction, using appropriate energy instruments and measurement techniques.	3
CO3	Assess the economic feasibility of energy conservation measures using life cycle costing, payback period, and return on investment methods.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	2	1	1	2	2	3	2	2
CO2	3	3	3	3	3	2	1	1	1	2	2	3	3	2
CO3	3	3	3	2	2	2	1	–	1	3	2	3	2	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**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 - Conservation of Energy Building Codes (ECBC-2017) -	
UNIT - 2	**Energy Management** Principles of energy management - organizing energy management program - initiating - planning - controlling - promoting - monitoring - reporting. Energy manager - qualities and functions - language - Questionnaire – check list for top management.	
UNIT - 3	**Energy Efficient Motors and Lighting** Energy efficient motors - factors affecting efficiency - loss distribution - constructional details - characteristics – variable speed - RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. lighting system design and practice - lighting control - lighting energy audit.	
UNIT - 4	**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.	
UNIT - 5	**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.	
	Total	

Text Books:

1. Energy management by W.R.Murphy&G.Mckay Butter worth - Heinemann publications - 1982.
2. Energy management hand book by W.CTurner - John wiley and sons - 1982.

Reference Books:

1. Energy efficient electric motors by John.C.Andreas - Marcel Dekker Inc Ltd-2nd edition - 1995
2. Energy management by Paul o' Callaghan - Mc-graw Hill Book company-1st edition - 1998
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXXYY	HVAC &DC TRANSMISSION SYSTEMS (Professional Elective – IV)	CATEGORY Professional Elective-IV	L-T-P 3-0-0	CREDITS 3

Pre-requisite:.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Analyze the necessity, advantages, limitations, and design considerations of EHV AC transmission, including power handling capacity, line losses, electrostatic field effects, and voltage gradient distribution in bundled conductors.	4
CO2	Evaluate corona effects in EHV systems by applying corona loss formulae, interpreting audible noise and radio interference characteristics, and demonstrating measurement and mitigation techniques.	5
CO3	Compare and apply principles, configurations, and control strategies of HVDC transmission systems and harmonic filtering, to ensure stability and power quality.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	–	1	1	2	2	3	2	2
CO2	3	3	2	3	3	2	–	1	1	2	2	3	3	2
CO3	3	3	3	3	3	2	–	1	1	2	2	3	3	3

(Please fill the above with Levels of Correlation - viz. - L=1 - M=2 - H=3)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Introduction of EHV AC transmission** Necessity of EHV AC transmission – Advantages and problems– Power handling capacity and line losses– Mechanical considerations in line performance – Electrostatics – Field of sphere gap – Field of line charges and properties – Charge – potential relations for multi–conductors – Surface voltage gradient on conductors – Bundle spacing and bundle radius– Examples – Distribution of voltage gradient on sub conductors of bundle – Examples.	
UNIT - 2	**Corona effects** Power loss and audible noise (AN) – Corona loss formulae – Charge voltage diagram – Generation – Characteristics – Limits and measurements of AN – Relation between 1–phase and 3–phase AN levels – Examples – Radio interference (RI) – Corona pulses and their generation – Properties and limits – Frequency spectrum – Modes of propagation – Excitation function – Measurement of RI, RIV and excitation functions – Examples	
UNIT - 3	**Basic Concepts of DC Transmission** Economics & Terminal equipment of HVDC transmission systems**:** Types of HVDC Links – Apparatus required for HVDC Systems – Comparison of AC &DC transmission – Application of DC Transmission System – Planning & Modern trends in DC transmission – Types of MTDC systems.	

UNIT - 4	**Analysis of HVDC Converters and System Control** Choice of Converter configuration – Analysis of Graetz circuit – Characteristics of 6 Pulse & 12 Pulse converters –– Principal of DC Link Control – Converters Control Characteristics – Firing angle control –Constant Current and extinction angle control –Starting and stopping of DC link – Power Control.	
UNIT - 5	**Harmonics and Filters** Generation of Harmonics – Characteristics harmonics – Calculation of AC Harmonics – Non–Characteristics harmonics – Adverse effects of harmonics – Calculation of voltage & current harmonics – Effect of Pulse number on harmonics. Types of AC filters, Design of Single tuned filters – Design of High pass filters.	
	Total	

Text Books:

1. HVDC Power Transmission Systems: Technology and system Interactions – by K.R.Padiyar, New Age International (P) Limited, and Publishers.
2. Direct Current Transmission – by E.W.Kimbark, John Wiley & Sons.
3. EHVAC Transmission Engineering by R. D. Begamudre, New Age International (p) Ltd.

Reference Books:

1. EHVAC and HVDC Transmission Engineering and Practice – S.Rao.
2. Power Transmission by Direct Current – by E.Uhlmann, B.S.Publications
3. HVDC Transmission – J.Arrillaga.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXYY	BATTERY MANAGEMENT SYSTEMS AND EV CHARGING STATIONS (Professional Elective – IV)	CATEGORY Professional Elective-IV	L-T-P 3-0-0	CREDITS 3

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

		Knowledge Level (K)#
CO1	Classify and explain different battery chemistries, their characteristics, performance parameters, and applications in energy storage systems.	2
CO2	Apply suitable charging algorithms, balancing techniques, and charging infrastructure configurations to ensure safe and efficient battery operation.	3
CO3	Analyze battery management system requirements and simulation models to evaluate performance, protection, and operational capabilities of various battery technologies.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	–	1	1	1	2	3	2	2
CO2	3	3	3	3	3	2	–	1	1	2	2	3	3	2
CO3	3	3	3	3	3	2	–	1	1	2	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	**Batteries** Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel. **Lead Acid Batteries:** Lead acid battery basics, special characteristics of lead acid batteries, battery life and maintenance, Li-ion batteries. **Nickel-based Batteries:** Nickel cadmium, Nickel metal hydride batteries. **Sodium-Based Batteries:** Introduction, sodium sulphur batteries, sodium metal chloride (Zebra) batteries. **Lithium Batteries:** Introduction, the lithium polymer battery, lithium ion battery.	
UNIT – 2	**Battery charging strategies** Charging algorithms for a single battery: Basic terms for charging performance evaluation and characterization, CC charging for NiCd/NiMH batteries, CV charging for lead acid batteries, CC/CV charging for lead acid and Li-ion batteries, MSCC charging for lead acid, NiMH and Li-ion batteries, TSCC/CV charging for Li-ion batteries, CVCC/CV charging for Li-ion batteries, Pulse charging for lead acid, NiCd/NiMH and Li-ion batteries, Charging termination techniques, Comparisons of charging algorithms and new development; Balancing methods for battery pack	

	charging: Battery sorting Overcharge for balancing, Passive balancing, Active balancing.	
UNIT – 3	**Charging Infrastructure** Domestic Charging Infrastructure, Public charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.	
UNIT – 4	**Battery-Management-System Requirements** Battery-pack topology, BMS design requirements, Voltage sense, Temperature sense, Current sense, Contactor control, Isolation sense, Thermal control, Protection, Charger control, Communication via CAN bus, Log book, SOC estimation, Energy estimation, Power estimation, Diagnostics .	
UNIT – 5	**Battery Modelling** General approach to modelling batteries, simulation model of rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of NiCd battery model, Simulation examples.	
	Total	**48 Hrs**

Text Books

1. Electric Vehicles Technology Explained by James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., Uk.
2. Energy Systems for Electric and Hybrid Vehicles by K.T. Chau, IET Publications, First edition, 2016.

Reference Books:

1. Modern Electric Vehicles Technology by C.C.Chan, K.T Chau, Oxford University Press Inc., New york , 2001.
2. Battery Management Systems Vol. – II Equivalent Circuits and Methods, by Gregory L.Plett, Artech House publisher, First edition 2016.
3. Battery Management Systems: design by Modelling by Henk Jan Bergveld, Wanda S. Kruijt, Springer Science & Business Media, 2002.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXYY	ELECTRICAL DISTRIBUTION SYSTEMS (Professional Elective – IV)	CATEGORY Professional Elective-IV	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Basic concepts of Electric circuits and power systems.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Analyze distribution system concepts, load characteristics, and feeder design considerations to determine optimal substation location, service area, and system configuration.	4
CO2	Calculate voltage drop, power losses, and design parameters for balanced and unbalanced distribution lines, and apply appropriate protection schemes with coordinated device operation.	3
CO3	Evaluate and recommend power factor improvement and voltage control methods, including capacitor placement and control equipment selection for enhanced system efficiency.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	–	1	1	1	2	3	2	2
CO2	3	3	3	3	3	2	–	1	1	2	2	3	3	2
CO3	3	3	3	2	2	3	–	1	1	2	2	3	2	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**General Concepts** Introduction to distribution systems - Distribution system losses – Coincidence factor – Contribution factor – loss factor – Relationship between the load factor and loss factor – Numerical Problems – Load Modeling and Characteristics – Classification and characteristics of loads (Residential - commercial - Agricultural and Industrial).	
UNIT - 2	**Substations** Selection for location of substations **-** Rating of distribution substation – Service area with 4,6 andn primary feeders - Benefits and methods of optimal location of substations. **Distribution Feeders** Design Considerations of distribution feeders**:** Radial and loop types of primary feeders – Voltage levels – Feeder loading – Basic design practice of the secondary distribution system.	
UNIT - 3	**System Analysis** Voltage drop and power – loss calculations**:** Derivation for voltage drop and power loss in lines – Uniformly distributed loads and non-uniformly distributed loads – Three phase balanced primary linesand Non three phase balanced primary lines.	
UNIT - 4	**Protection** Objectives of distribution system protection –Time current characteristics – Protective devices**:** Principle of operation of fuses – Circuit reclosures – Line	

	sectionaliser and circuit breakers - Earth leakage circuit breakers – Protection schemes of parallel & Ring-main feeders. **Coordination of protective devices** General coordination procedure –Various types of co-ordinated operation of protective devices - Residual Current Circuit Breaker.	
UNIT - 5	**Compensation for Power Factor Improvement** 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 allocation – 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.	
	Total	

Text Book:

1. "Electric Power Distribution system - Engineering" – by Turan Gonen - McGraw–hill - 2nd edition - 2008.

Reference Books:

1. Electrical Distribution Systems by Dale R.Patrick and Stephen W.Fardo - CRC press - 2nd edition.
2. Electric Power Distribution – by A.S. Pabla - Tata McGraw–hill Publishing Company - 4th edition - 1997.
3. Electrical Power Distribution Systems by V.Kamaraju- Right Publishers.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXXYY	ELECTRIC AND HYBRID ELECTRIC VEHICLES (Professional Elective – V)	CATEGORY Professional Elective-V	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts of Electrical Machines - Power Electronics.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Classify and explain electric, hybrid, and plug-in hybrid vehicle architectures, propulsion systems, and their applications.	2
CO2	Analyze the characteristics, control requirements, and suitability of special electric machines and power electronic converters for EV and HEV applications.	4
CO3	Evaluate and compare different energy storage technologies and hybridization strategies for optimal performance in EV and HEV systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	2	1	1	1	1	2	3	2	2
CO2	3	3	3	2	3	2	–	1	1	2	2	3	3	2
CO3	3	3	3	2	2	3	1	1	1	2	2	3	2	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Introduction** Fundamentals of vehicle - components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; History of hybrid vehicles - advantages and applications of Electric and Hybrid Electric Vehicles.	
UNIT - 2	**Hybridization of Automobile** Architectures of HEVs - series and parallel HEVs - complex HEVs. Plug-in hybrid vehicle(PHEV) - constituents of PHEV - comparison of HEV and PHEV; Extended range hybrid electric vehicles(EREVs) - blended PHEVs - Fuel Cell vehicles and its constituents.	
UNIT - 3	**Special Machines for EV and HEVs** Characteristics of traction drive - requirement of electric motors for EV/HEVs. Induction Motor drives - their control and applications in EV/HEVs. Permanent magnet Synchronous motor: configuration - control and applications in EV/HEVs.Brushless DC Motors: Advantages - control of application in EV/HEVs. Switch reluctance motors: Merits limitations - converter configuration - control of SRM for EV/HEVs.	
UNIT - 4	**Power Electronics in HEVs** Boost and Buck-Boost converters - Multi Quadrant DC-DC converters - DC-AC Inverter for EV and HEV applications - Three Phase DC-AC inverters -	

	Voltage control of DC-AC inverters using PWM - EV and PHEV battery chargers.	
UNIT - 5	**Energy Sources for HEVs** Energy Storage - Battery based energy storage and simplified models of battery - fuel cells - their characteristics and simplified models - super capacitor based energy storage - its analysis and simplified models - flywheels and their modeling for energy storage in EV/HEV - Hybridization of various energy storage devices.	
	Total	

Text Books

1. Ali Emadi - Advanced Electric Drive Vehicles - CRC Press - 2014.
2. Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2003.

Reference Books:

1. MehrdadEhsani - YimiGao - Sebastian E. Gay - Ali Emadi - Modern Electric - Hybrid Electric and Fuel Cell Vehicles: Fundamentals - Theory and Design - CRC Press - 2004.
2. James Larminie - John Lowry - Electric Vehicle Technology Explained - Wiley - 2003.
3. H. Partab: Modern Electric Traction - DhanpatRai& Co - 2007.

ResearchBooks:

1. Pistooa G. - “Power Sources - Models - Sustanability - Infrstructure and the market” - Elsevier 2008
2. Mi Chris - Masrur A. - and Gao D.W. - “ Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives” 1995.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXYY	PROGRAMMABLE LOGIC CONTROLLERS (Professional Elective – V)	CATEGORY Professional Elective-V	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts of Digital Electronics- Microprocessors and PID controllers.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Develop and interpret PLC ladder diagrams, Boolean logic programs, and process control sequences for industrial applications.	3
CO2	Implement PLC programming using timers, counters, arithmetic, and data handling functions to control industrial processes and robotic systems.	3
CO3	Analyze analog PLC operations and PID control functions to optimize process performance in automation systems.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	1	3	1	–	1	1	1	2	3	3	2
CO2	3	3	3	2	3	1	–	1	1	2	2	3	3	3
CO3	3	3	3	2	3	2	1	1	1	2	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Introduction to PLC systems:** I/O modules and interfacing - CPU processor - programming Equipment- programming formats- construction of PLC ladder diagrams- Devices connected to I/O Modules. Digital logic gates - programming in the Boolean algebra system - conversion examples Ladder Diagrams for process control: Ladder diagrams & sequence listings - ladder diagram construction and flowchart for spray process system.	
UNIT - 2	**PLC Programming:** Input instructions - outputs - operational procedures- programming examples using contacts and coils. Drill press operation. PLC Registers: Characteristics of Registers - module addressing - holding registers - Input Registers - Output Registers.	
UNIT - 3	**PLC Functions**: Timer functions & Industrial applications - counters- counter function industrial applications - Arithmetic functions - Number comparison functions - number conversion functions.	
UNIT - 4	**Data Handling functions:** SKIP - Master control Relay- Jump- Move - FIFO - FAL - ONS - CLR & Sweep functions and their applications. Bit Pattern and changing a bit shift register- sequence functions and applications - controlling of two-axis & three axis Robots with PLC - Matrix functions.	
UNIT - 5	**Analog PLC operation:** Analog modules & 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.	
	Total	

Textbooks:

1. Programmable Logic Controllers- Principles and Applications by John W. Webb & Ronald A. Reiss - Fifth Edition - PHI
2. Programmable Logic Controllers- Programming Method and Applications –JR.Hackworth &F.D Hackworth Jr. –Pearson - 2004

Reference Books:

1. Introduction to Programmable Logic Controllers-Gary A. Dunning - 3rd edition - Cengage Learning - 2005.
2. Programmable Logic Controllers –W.Bolton- 5th Edition - Elsevier publisher - 2009.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXXYY	VLSI DESIGN (Professional Elective – V)	CATEGORY Professional Elective-V	L-T-P 3-0-0	CREDITS 3

Pre-requisite:

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Analyze MOSFET characteristics, models, and second-order effects to design basic device configurations such as switches, current sources, and current mirrors.	4
CO2	Implement CMOS logic, combinational, and sequential circuits, including memory cells, using appropriate fabrication processes and layout rules.	3
CO3	Evaluate the design flow and implementation of application-specific integrated circuits (ASICs) from design entry to routing and verification.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	1	–	1	1	1	2	3	3	2
CO2	3	3	3	2	3	1	–	1	1	2	2	3	3	3
CO3	3	3	3	3	3	1	–	1	1	2	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT-I	**Introduction to MOS Devices** MOS characteristics: NMOS characteristics, inverter action – CMOS characteristics, inverter action - models and second order effects of MOS transistors – Current equation – MOSFET Capacitances - MOS as Switch, Diode/ resistor – current source and sink – Current mirror.	
UNIT-II	**MOS Fabrication** CMOS Fabrication – n-well, p-well, twin-tub processes – fabrication steps – crystal growth – Photolithography – oxidation – diffusion – Ion implantation – etching – metallization.	
UNIT-III	**CMOS Logic Circuits** CMOS Logic Circuits: Implementation of logic circuits using nMOS and CMOS, Pass transistor and transmission gates – Implementation of combinational circuits – parity generator – magnitude comparator – stick diagram – Design rules and layout design.	
UNIT-IV	**Higher order digital Logic Circuits** Memory design – SRAM cell – 6T SRAM – DRAM – 1T, 3T, 4T cells, CMOS Sequential circuits: Static and Dynamic circuits – True Single-phase clocked registers – Clocking schemes.	
UNIT-V	**Application Specific Integrated Circuits** ASIC - Types of ASICs - Design flow – Design Entry – Simulation – Synthesis	

	– Floor planning – Placement – Routing - Circuit extraction – Programmable ASICs.	

Text Books:

1. Neil Weste, David Harris, 'CMOS VLSI Design: A Circuits and Systems Perspective', Addison Wesley, 4th Edition, 2020.
2. Debaprasad Das, 'VLSI Design', Oxford University Press, 2010.
3. Ken Martin, 'Digital Integrated Circuits', Oxford University Press, 1999.
4. Peter Van, 'Microchip Fabrication', Mc-Graw Hill Professional, 6th Edition, 2014.

Reference Books:

1. M. J. S. Smith, 'Application Specific Integrated Circuits', Addison Wesley, 1997.
2. Uyemura, 'Introduction to VLSI Circuits and Systems', Wiley, 1st Edition, 2012.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXYY	BATTERY MANAGEMENT SYSTEMS AND CHARGING STATIONS (Open Elective – III)	CATEGORY Open Elective - III	L-T-P 3-0-0	CREDITS 3

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

		Knowledge Level (K)#
CO1	Classify and explain different battery chemistries, configurations, and performance characteristics for energy storage applications.	2
CO2	Apply charging algorithms, balancing techniques, and charging infrastructure solutions to ensure safe and efficient battery operation.	3
CO3	Analyze battery management system requirements and simulation models to assess performance, protection, and operational efficiency of various battery technologies.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	2	1	1	1	1	2	3	3	2
CO2	3	3	3	2	3	2	1	1	1	2	2	3	3	3
CO3	3	3	3	3	3	2	1	1	1	2	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	**Batteries** Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel. **Lead Acid Batteries:** Lead acid battery basics, special characteristics of lead acid batteries, battery life and maintenance, Li-ion batteries. **Nickel-based Batteries:** Nickel cadmium, Nickel metal hydride batteries. **Sodium-Based Batteries:** Introduction, sodium sulphur batteries, sodium metal chloride (Zebra) batteries. **Lithium Batteries:** Introduction, the lithium polymer battery, lithium ion battery.	
UNIT – 2	**Battery charging strategies** Charging algorithms for a single battery: Basic terms for charging performance evaluation and characterization, CC charging for NiCd/NiMH batteries, CV charging for lead acid batteries, CC/CV charging for lead acid and Li-ion batteries, MSCC charging for lead acid, NiMH and Li-ion batteries, TSCC/CV charging for Li-ion batteries, CVCC/CV charging for Li-ion batteries, Pulse charging for lead acid, NiCd/NiMH and Li-ion batteries, Charging termination techniques, Comparisons of charging algorithms and new development; Balancing methods for battery pack charging: Battery sorting Overcharge for balancing, Passive balancing, Active balancing.	

UNIT – 3	**Charging Infrastructure** Domestic Charging Infrastructure, Public charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.	
UNIT – 4	**Battery-Management-System Requirements** Battery-pack topology, BMS design requirements, Voltage sense, Temperature sense, Current sense, Contactor control, Isolation sense, Thermal control, Protection, Charger control, Communication via CAN bus, Log book, SOC estimation, Energy estimation, Power estimation, Diagnostics .	
UNIT – 5	**Battery Modelling** General approach to modelling batteries, simulation model of rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of NiCd battery model, Simulation examples.	
	Total	**48 Hrs**

Text Books

1. Electric Vehicles Technology Explained by James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., Uk.
2. Energy Systems for Electric and Hybrid Vehicles by K.T. Chau, IET Publications, First edition, 2016.

Reference Books:

1. Modern Electric Vehicles Technology by C.C.Chan, K.T Chau, Oxford University Press Inc., New york , 2001.
2. Battery Management Systems Vol. – II Equivalent Circuits and Methods, by Gregory L.Plett, Artech House publisher, First edition 2016.
3. Battery Management Systems: design by Modelling by Henk Jan Bergveld, Wanda S. Kruijt, Springer Science & Business Media, 2002.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXXYY	CONCEPTS OF SMART GRID TECHNOLOGIES (Open Elective – III)	CATEGORY Open Elective - III	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Basics of Renewable Energy

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain the concepts, functions, and enabling technologies of smart grids, including smart meters, automation systems, and energy storage solutions.	2
CO2	Analyze microgrid operation, renewable energy integration, and demand response strategies, addressing interconnection, control, and protection challenges.	4
CO3	Evaluate power quality management techniques and communication network architectures to enhance reliability and performance of smart grid systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	2	1	1	1	1	2	3	3	2
CO2	3	3	3	2	3	3	1	1	1	2	2	3	3	3
CO3	3	3	3	3	3	2	1	1	1	2	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**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 - 2	**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 - Phase Shifting Transformers - Net Metering.	
UNIT - 3	**Smart Grid Technologies: Part 2** Smart Substations - Substation Automation- Feeder Automation. Geographic Information System(GIS) - Intelligent Electronic Devices (IED) & their application for monitoring & protection. Smart storage like Battery Energy Storage Systems (BESS) - Super Conducting Magnetic Energy Storage Systems (SMES) - Pumped Hydro-Compressed Air Energy Storage (CAES) - Wide Area Measurement System (WAMS) - Phase Measurement Unit (PMU).	

UNIT - 4	**Micro grids and Distributed Energy Resources** Concept of micro grid - need & applications of microgrid - formation of microgrid- Issues of interconnection - protection & control of microgrid - Integration of renewable energy sources - Demand Response.	
UNIT - 5	**Power Quality Management in Smart Grid** Power Quality & 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).	
	Total	

Text Books:

1. Integration of Green and Renewable Energy in Electric Power Systems - by Ali Keyhani - Mohammad N. Marwali- Min Dai Wiley - 2009.
2. The Smart Grid: Enabling Energy Efficiency and Demand Response- by Clark W. Gellings - Fairmont Press- 2009.
3. Smart Grid: Technology and Applications- by Janaka B. Ekanayake - Nick Jenkins - Kithsiri Liyanage- Jianzhong Wu - Akihiko Yokoyama - Wiley publishers - 2012.
4. Smart Grids by Jean-Claude Sabonnadière- NouredineHadjsaïd - Wiley publishers - 2013.
5. Smart Power: Climate Changes- the Smart Grid - and the Future of Electric Utilities- by Peter S. Fox Penner - Island Press; 1st edition - 8 Jun 2010.
1. Microgrids and Active Distribution Networks by S. Chowdhury - S. P. Chowdhury - P. Crossley - Institution of Engineering and Technology - 30 Jun 2009

Reference Books:

1. The Advanced Smart Grid: Edge Power Driving Sustainability:1 by Andres Carvallo - John Cooper - Artech House Publishers July 2011
2. Control and Automation of Electric Power Distribution Systems (Power Engineering) by James Northcote- Green - Robert G. Wilson - CRC Press - 2017.
3. Substation Automation (Power Electronics and Power Systems) by MladenKezunovic - Mark G. Adamiak- Alexander P. Apostolov - Jeffrey George Gilbert - Springer - 2010.
4. Electrical Power System Quality by R. C. Dugan- Mark F. McGranghan - Surya Santoso - H. Wayne Beaty- McGraw Hill Publication - 2nd Edition.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXYY	INTRODUCTION TO INTERNET OF THINGS (Open Elective – III)	CATEGORY Open Elective - III	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Basics of Computer Organisation - Computer Networking

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe IoT architecture, frameworks, communication technologies, and connectivity protocols for designing connected device networks.	2
CO2	Apply design principles, data acquisition methods, and cloud-based services to develop IoT-enabled solutions.	3
CO3	Analyze sensor and actuator technologies to implement IoT applications in domains such as smart homes, smart cities, environmental monitoring, and agriculture.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	2	1	1	1	1	2	3	3	2
CO2	3	3	3	2	3	2	1	1	2	2	2	3	3	3
CO3	3	3	3	3	3	3	1	1	2	2	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**The Internet of Things**: An Overview of Internet of Things (IoT) – IoT framework –Architecture – Technology behind IoT – Sources of the IoT – M2M Communication – Examples of IoT.	
UNIT - 2	**Design Principles For Connected Devices**: Introduction –IoT/M2M systems - Layers and Designs Standardization – Communication Technologies – Data Enrichment - Consolidation and Device Management at Gateway – Ease of designing and affordability.	
UNIT - 3	**Design Principles for the Web Connectivity**: Introduction – Web Communication protocols for Connected Devices - Message Communication protocols for Connected Devices – Web Connectivity for connected devices network. Introduction to Internet Connectivity Principles - Internet connectivity - Internet based communication – IP addressing in the IoT – Application Layer Protocols: HTTP - HTTPS - FTP - Telnet - WAP (Wireless Application Protocol).	
UNIT - 4	**Data Acquiring - Organizing - Processing and Analytics:** Introduction – Data Acquiring and Storage – Organizing the Data – Analytics. **Data Collection - Storage and Computing Using a Cloud Platform:** Introduction – Cloud computing paradigm for data collection - storage and computing – IoTas a service and Cloud Service Models - IoT cloudbased services using the Xively (Pachube/COSM) - Nimbits and other platforms.	

UNIT - 5	**Sensor technology**: Actuator - Sensor data communication protocols - Radio Frequency Identification technology - Wireless Sensor Network Technology. IoT application case studies: Smart Home - Smart Cities - Environment monitoring and Agriculture practices.	
	Total	

Text Books:

1. Internet of Things: Architecture - Design Principles - Raj Kamal - McGraw Hill Education (India) Pvt. Limited - 2017.

Reference Books:

1. Designing the Internet of Things - Adrian McEwen and Hakim Cassimally - Wiley - First Edition - 2013.
2. Getting Started with the Internet of Things - Cuno Pfister - O'Reilly - 2011.
3. Internet of Things: A Hands-on Approach - Arshdeep Bahga - and Vijay Madisetti - 2014.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXYY	CONCEPTS OF POWER QUALITY (Open Elective - IV)	CATEGORY Open Elective - IV	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts of Power Systems

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain power quality concepts, classifications of disturbances, and causes of transients, voltage variations, and waveform distortions.	2
CO2	Apply voltage regulation, harmonic mitigation, and overvoltage protection techniques for improving power quality in utility and end-user systems.	3
CO3	Analyze distributed generation integration and monitoring methods to assess and address power quality issues.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	2	1	–	1	–	2	3	3	2
CO2	3	3	3	2	3	2	1	–	1	1	2	3	3	3
CO3	3	3	3	3	3	3	1	–	2	1	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Introduction - Terms & Definitions** Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations – Voltage Sags – Voltage Swell.	
UNIT - 2	**Transient Over Voltages** Sources of Transient Over voltages - Principles of Over voltage protection- Devices for Over voltage protection – Utility Capacitor Switching Transients - Utility System Lightning Protection – Managing Ferro resonance – Switching Transient Problems with Loads.	
UNIT - 3	**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 - 4	**Harmonic distortion and solutions** Voltage distortion vs. Current distortion –Harmonic indices: THD - TDD and True Power Factor– Sources of harmonics – Effect of harmonic distortion – Impact on capacitors - transformers - motors and meters – Concept of Point of common coupling – Passive and active filtering – Numerical problems.	

UNIT - 5	**Distributed Generation and Monitoring** Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks. **Monitoring** Power quality monitoring and considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data.	
	Total	

Textbooks:

1. Electrical Power Systems Quality - Dugan R C - McGranaghan M F - Santoso S - andBeaty H W - Second Edition - McGraw–Hill - 2012 - 3rd edition.
2. Electric power quality problems –M.H.J.Bollen IEEE series-Wiley india publications - 2011.
3. Power Quality Primer - Kennedy B W - First Edition - McGraw–Hill - 2000.

Reference Books:

1. Understanding Power Quality Problems: Voltage Sags and Interruptions - Bollen M HJ - First Edition - IEEE Press; 2000.
2. Power System Harmonics - Arrillaga J and Watson N R - Second Edition - John Wiley & Sons - 2003.
3. Electric Power Quality control Techniques - W. E. Kazibwe and M. H. Sendaula - Van Nostrad Reinhold - New York.
4. Power Quality c.shankaran - CRC Press - 2001
5. Harmonics and Power Systems –Franciso C.DE LA Rosa–CRC Press (Taylor & Francis)
6. Power Quality in Power systems and Electrical Machines–EwaldF.fuchs - Mohammad A.S.Masoum–Elsevier.

IV B.Tech I Semester

COURSE CODE – R2311XXYY	ELECTRICAL ENERGY UTILIZATION (Open Elective - IV)	CATEGORY Open Elective - IV	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Basics of Electrical Engineering

Course Outcomes: After the completion of the course the student should be able to understand:

		Knowledge Level (K)#
CO1	Explain the principles, methods, and design aspects of illumination systems, electric heating, and electric welding technologies.	2
CO2	Apply the concepts of electric traction to calculate performance parameters such as tractive effort, specific energy consumption, and speed–time characteristics.	3
CO3	Compare and evaluate various energy storage technologies based on their characteristics and applications.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	2	1	–	1	–	2	3	3	2
CO2	3	3	3	2	3	2	1	–	1	1	2	3	3	3
CO3	3	3	3	3	3	3	1	–	2	1	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Illumination fundamentals** Introduction - terms used in illumination–Laws of illumination–Lux meter–Sources of light. **Various Illumination Methods** Tungsten filament lamps and fluorescent lamps - Comparison –Basic principles of light control– Types and design of lighting and flood lighting–LED lighting - Energy conservation.	
UNIT - 2	**Electric Heating** Advantages and methods of electric heating–Resistance heating, induction heating and dielectric heating.	
UNIT - 3	**Electric Welding** Electric welding–Resistance and arc welding–Electric welding equipment–Comparison between AC and DC Welding	
UNIT - 4	**Electric Traction** System of electric traction and track electrification– Review of existing electric traction systems in India– Special features of traction motor–Mechanics of train movement–Speed–time curves for different services – Trapezoidal and quadrilateral speed time curves. Calculations of tractive effort– power –Specific energy consumption for given run–Effect of varying	

	acceleration and braking retardation–Adhesive weight and braking retardation adhesive weight and coefficient of adhesion.	
UNIT - 5	**Introduction to Energy Storage Systems** Need for energy storage - Types of energy storage-Thermal - electrical - magnetic and chemical storage systems - Comparison of energy storage technologies-Applications.	
	Total	

Text Books:

1. Electrical Power Systems (Generation - Transmission - Distribution - Protecection and Utilization of Electrical Energy) – Dr. S.L.Uppal and Prof. Sunil S.Rao – Khanna Publisher - 15th edition - 1987.
2. Electric Power Distribution – A. S. Pabla – McGrawHill - 5th edition - 2004.

Reference Books:

1. Generation Distribution and Utilization of Electrical Energy – C.L.Wadhwa- New Age International Publishers- revised 3rd edition.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXXYY	CONCEPTS OF CONTROL SYSTEMS (Open Elective - IV)	CATEGORY Open Elective - IV	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Mathematics

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Develop mathematical models for electrical and mechanical systems, determine transfer functions, and simplify complex control systems using block diagram algebra and signal flow graphs.	3
CO2	Analyze the time and frequency response of control systems, determine stability using classical techniques, and design basic controllers (P, PI, PID).	4
CO3	Formulate and evaluate control systems using state-space representation, assess controllability and observability, and solve state equations for system behavior.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	–	–	–	1	–	2	3	3	2
CO2	3	3	3	2	3	1	–	–	1	–	2	3	3	3
CO3	3	3	3	3	3	1	–	–	1	–	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Mathematical Modelling of Control Systems** Classification of control systems - open loop and closed loop control systems and their differences - transfer function of linear system - differential equations of electrical networks - translational and rotational mechanical systems - transfer function of DC servo motor – AC servo motor – block diagram algebra – representation by signal flow graph – reduction using Mason's gain formula - Feedback characteristics.	
UNIT - 2	**Time Response Analysis** Standard test signals – time response of first and second order systems – time domain specifications - steady state errors and error constants - P - PI & PID Controllers.	
UNIT - 3	**Stability and Root Locus Technique** The concept of stability – Routh-Hurwitz –limitations of Routh-Hurwitz criterion. Root locus concept – construction of root loci (simple problems).	
UNIT - 4	**Frequency Response Analysis** Introduction to frequency domain specifications – Polar Plot - Bode diagrams – Transfer function from the Bode diagram – phase margin and gain margin – stability analysis from Bode plots.	
UNIT - 5	**State Space Analysis of LTI Systems** Concepts of state - state variables and state model - state space representation of transfer function - diagonalization - solving the time invariant state	

	equations - State Transition Matrix and it's properties - concepts of controllability and observability.	
	Total	

Text Books:

1. Modern Control Engineering by Kotsuhiko Ogata - Prentice Hall of India.
2. Automatic control systems by Benjamin C.Kuo - Prentice Hall of India - 2nd Edition.

Reference Books:

1. Control Systems principles and design by M.Gopal - Tata Mc Graw Hill education Pvt Ltd. - 4th Edition.
2. Control Systems by Manik Dhanesh N - Cengage publications.
3. Control Systems Engineering by I.J.Nagarath and M.Gopal - Newage International Publications - 5th Edition.
4. Control Systems Engineering by S.Palani - Tata Mc Graw Hill Publications.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXYY	POWER SYSTEMS AND SIMULATION LAB	CATEGORY Skill Enhancement Course	L-T-P 0-0-4	CREDITS 2

Pre-requisite:

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Determine sequence impedances, transmission line parameters, and relay characteristics through experimental methods, and evaluate their significance in power system performance.	4
CO2	Apply numerical and simulation techniques to solve power flow, economic load dispatch, and network matrix formulations for power system analysis.	3
CO3	Analyze dynamic performance of power systems under load frequency and stability conditions, and assess control strategies for system improvement.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	1	–	1	1	–	2	3	3	2
CO2	3	3	3	2	3	1	–	–	1	–	2	3	3	3
CO3	3	3	3	3	3	2	–	1	1	–	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

Any of 5 experiments are to be conducted from each section:

S.No	CONTENTS	Contact Hours
Section I: Power Systems Lab:		
1.	Estimation of sequence impedances of 3-phase Transformer	
2.	Estimation of sequence impedances of 3-phase Alternator by Fault Analysis	
3.	Estimation of sequence impedances of 3-phase Alternator by Direct method	
4.	Estimation of ABCD parameters on transmission line model	
5.	Performance of long transmission line with & without shunt compensation	
6.	Analyze and compensate the Ferranti effect on long transmission line	
7.	Analysing the performance characteristics of generator and transformer relays.	

Section II: Simulation Lab		
1.	Determination of Y_{bus} using direct inspection method	
2.	Load flow solution of a power system network using Gauss-Seidel method	
3.	Load flow solution of a power system network using Newton Raphson method.	
4.	Formation of Z_{bus} by building algorithm.	
5.	Economic load dispatch with & without losses	
6.	Load frequency control of a two area Power System without & with PI controller	
7.	Stability analysis of single machine connected to an infinite bus (SMIB).	

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXYY	CONSTITUTION OF INDIA	CATEGORY Audit Course	L-T-P 2-0-0	CREDITS --

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech I Semester

COURSE CODE – R2311XXYY	EVALUATION OF INDUSTRY INTERNSHIP	CATEGORY Internship	L-T-P --	CREDITS 2

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV B.Tech II Semester

COURSE CODE – R2311XXYY	INTERNSHIP AND PROJECT	CATEGORY PR	L-T-P 24	CREDITS 12

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Minor Engineering Courses offered by EEE Department for Other Branches (Except EEE Branch)

COURSE CODE – R2311XXYY	INTELLIGENT CONTROL SYSTEMS (Minor Course)	CATEGORY Minor Course	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts of Linear and Boolean Algebra - Optimization Techniques.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Understand Summarize the basics of neural networks, fuzzy logic, and genetic algorithms and their main components.	2
CO2	Apply Use neural networks, fuzzy logic, and genetic algorithms to solve engineering problems like load forecasting and control applications.	3
CO3	Evaluate and compare the effectiveness of these techniques in real-world power system scenarios for optimal solutions.	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	1	3	2	-
CO2	3	3	3	2	3	2	-	-	-	-	1	3	3	2
CO3	2	3	3	3	3	2	-	-	-	-	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Introduction to Neural Networks** Introduction, Humans and Computers, Biological Neural Networks, Historical development of neural network, Terminology and Topology, Biological and artificial neuron models, Learning laws-supervised, unsupervised and reinforced learning laws	
UNIT - 2	**Feed Forward Neural Networks** Introduction, Perceptron models: Discrete and continuous training algorithms: Discrete and Continuous Perceptron Networks, Limitations and applications of the Perceptron model, Generalized delta learning rule, error back propagation training-Radial basis function algorithms, kohonen's self-organising maps, BAM, Hope field networks	
UNIT - 3	**Fuzzy Logic** Introduction to classical sets - properties, operations and relations; Fuzzy sets - properties, operations and relations, Uncertainty, cardinalities, membership and types of 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 - 4	**Genetic algorithms &Modelling**-introduction-encoding-fitness function-reproduction operators-genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm.	

UNIT - 5	**Application** **Neural network applications:** Load forecasting, load flow studies **Fuzzy logic applications:** Economic load dispatch- Speed control of DC motor **Genetic Algorithms applications:** Load frequency control-reactive power control.	
	Total	

Text Books:

1. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – Mc Graw Hill Inc, 1997.

Reference Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by RajasekharanandPai – PHI Publication.
2. Modern power Electronics and AC Drives – B.K.Bose -Prentice Hall, 2002
3. Genetic Algorithms- David E Goldberg. Pearson publications.
5. Introduction to Neural Networks using MATLAB 6.0 by S N Sivanandam,SSumathi,S N Deepa TMGH
6. Introduction to Fuzzy Logic using MATLAB by S N Sivanandam,SSumathi,S N Deepa Springer, 2007.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	BASICS OF ELECTRICAL MEASUREMENTS AND INSTRUMENTATION (Minor Course)	CATEGORY	L-T-P 4-0-0	CREDITS 4

Pre-requisite: Basic concepts of Electrical Engineering **Course Outcomes**: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain the construction, working principles, and applications of analog and digital measuring instruments, bridges, and transducers for various electrical parameters.	2
CO2	Apply appropriate analog and digital techniques to measure current, voltage, power, energy, resistance, inductance, and capacitance, and analyze measurement results using suitable bridges and sensors.	3,4
CO3	Evaluate different measurement systems and instruments for accuracy and reliability, and synthesize optimal measurement solutions by integrating analog and digital devices for diverse engineering applications.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	1	-	-	-	-	1	3	2	-	3
CO2	3	3	-	3	3	2	-	-	-	-	-	3	3	-	3
CO3	2	3	3	3	3	2	-	-	-	-	2	3	3	3	2

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Fundamentals of Analog Measurement** Analog Ammeter and Voltmeter: Classification of instruments – Deflecting, controlling, and damping torques.Types of Instruments: PMMC and Moving Iron type – Construction, working principle, advantages, and disadvantages.Applications and simple numerical problems.	
UNIT - 2	**Measurement of Power and Energy** Analog Wattmeter: Electrodynamometer type wattmeters – Low Power Factor (LPF) and Unity Power Factor (UPF) designs, advantages, and disadvantages. Energy Meters: Induction type Energy Meter – Construction and working principle Simple numerical problems.	
UNIT - 3	**Measurement of Electrical Parameters** DC Bridges:Measurement of resistance – Low (Kelvin's double bridge), medium (Wheatstone bridge), and high resistance (Loss of charge method). AC Bridges:Measurement of inductance (Maxwell's Bridge) and capacitance (Schering Bridge), Numerical problems.	
UNIT - 4	**Transducers and Sensors** Classification of Transducers: Basics and applications.Resistive: Strain Gauge. Inductive: Linear Variable Differential Transformer (LVDT). Capacitive:	

	Piezoelectric – Applications	
UNIT - 5	**Introduction to Digital Measurement** Digital Instruments:Digital Voltmeters (Successive approximation type),Digital Frequency Meters and Multimeters, Digital Tachometers and Energy Meters, – Overview and applications.	
	Total	

Text Books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney, DhanpatRai & Co. Publications – 19th revised edition - 2011.
2. Electronic Instrumentation by H.S.Kalsi - THM.

Reference Books:

1. Electrical Measurements and measuring Instruments by E.W. Golding and F.C.Widdis - 5 th Edition - Wheeler Publishing.
2. Modern Electronic Instrumentation and Measurement Techniques by A.D. Helfrick and W.D. Cooper - PHI - 5th Edition - 2002.
3. Electrical and Electronic Measurements and instrumentation by R.K.Rajput - S.Chand - 3rdedition.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/108/105/108105153

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	CONCEPTS OF POWER SYSTEMS ENGINEERING (Minor Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Basics of Power Systems

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe key concepts of power generation, plant types, transmission, distribution, protection, economics, and power factor improvement.	2
CO2	Analyze power system components by solving problems on transmission, distribution, protection, energy cost, and compensation.	3,4
CO3	Evaluate and design efficient, reliable, and economical power systems using principles of generation, transmission, protection, and economics.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	2	-	-	-	-	1	3	2	1
CO2	3	3	2	2	3	2	-	-	-	-	1	3	2	2
CO3	2	3	3	3	3	3	-	-	-	2	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Power Generation Concepts & Types** Generation and sources of Energy – working principle and Schematic diagram approach of Thermal Power Plant – Hydro Power Plant - Nuclear Power Plant – Gas Power Plants – Comparison between Power Plants.	
UNIT - 2	**Transmission and Distribution Concepts** Types of Conductors Materials – Constants of Transmission Line – Classification of Overhead Transmission Lines – Performance of Short Transmission Lines – Simple Problems. Basic concept of Sub Station – Distribution Systems – Connection Schemes of Distribution Systems – Structure of Cables – Differences between Overhead & Underground systems.	
UNIT - 3	**Protection and Grounding** List of Faults – Basic concepts of fuse – Circuit Breakers – Relays – SF_6 Circuit Breakers – Vacuum Circuit Breakers – Operation of Lightning Arrester – Grounding and its advantages - Methods of Neutral Grounding: Resistance - Reactance and Resonant Grounding – Numerical Problems.	
UNIT - 4	**Economic Aspects** Definitions of Load - Load & Load Duration Curves - Load Factor - Demand Factor – Utilization Factor - Loss Factor – Types of Tariff - Cost of Electrical Energy – Expression for Cost of Electrical Energy – Numerical Problems	
UNIT - 5	**Power Factor Improvement and Voltage Control** Power Factor – Effects and Causes of low Power Factor- Shunt & Series Capacitor Compensation - Numerical Problems – Need of Voltage Control –	

	Types of Voltage regulating Devices.	
	Total	

Text Books:

1. Principles of Power System by V.K.Mehata- Rohit Mehata - S.Chand Publishers.

Reference Books:

1. Electrical Power Systems by C.L.Wadwa- New Age International Publishers.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	FUNDAMENTALS OF POWER ELECTRONICS (Minor Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Electrical Circuits- Power Systems-I - Basic concepts of

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the characteristics and operation of power semiconductor devices, AC-DC, DC-DC, AC-AC, and DC-AC converters.	2
CO2	Analyze and solve problems involving the performance, conduction modes, and harmonic content of various power electronic converters in different load conditions.	3,4
CO3	Evaluate, select, and design suitable power converter topologies and gate driver circuits for efficient and reliable power electronic applications.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	1	3	2	-
CO2	3	3	-	3	3	2	-	-	-	-	-	3	3	-
CO3	2	3	3	3	3	2	-	-	-	-	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Power Semi-Conductor Devices** Silicon controlled rectifier (SCR) – Two transistor analogy - Static and Dynamic characteristics Static and Dynamic Characteristics of Power MOSFET and Power IGBT– Gate Driver Circuits for Power MOSFET and IGBT - Numerical problems.	
UNIT - 2	**Single-phase AC-DC Converters** Single-phase half wave controlled rectifiers - R load and RL load with and without freewheeling diode - Single-phase fully controlled bridge converter with R load - RL load and RLE load - Continuous and Discontinuous conduction - Expression for output voltages – Single-phase Semi-Converter with R load - RL load and RLE load – Continuous and Discontinuous conduction - Harmonic Analysis - Numerical Problems.	
UNIT - 3	**Three-phase AC-DC Converters & AC – AC Converters** Three-phase half wave Rectifier with R and RL load - Three-phase fully controlled rectifier with R and RL load - Three-phase semi converter with R and RL load - Expression for Output Voltage - Harmonic Analysis - Numerical Problems. AC-AC power control by phase control with R and RL loads - Expression for rms output voltage-Numerical problems.	
UNIT - 4	**DC–DC Converters** Analysis of Buck - Boost and Buck-Boost converters in Continuous Conduction Mode (CCM) and Discontinuous Conduction Modes (DCM) - Output voltage	

	equations using volt-sec balance in CCM & DCM – Expressions for output voltage ripple and inductor current ripple- Numerical Problems.	
UNIT - 5	**DC–AC Converters** Introduction - Single-phase half bridge and full bridge inverters with R and RL loads – Three-phase square wave inverters - 120^0 conduction and 180^0 conduction modes of operation - PWM inverters - Sinusoidal Pulse Width Modulation - Numerical Problems.	
	Total	

Text Books:

1. Power Electronics: Converters - Applications and Design by Ned Mohan - Tore M Undeland- William P Robbins - John Wiley & Sons.
2. Power Electronics: Circuits - Devices and Applications – by M. H. Rashid - Prentice Hall of India - 2nd edition - 1998
3. Power Electronics: Essentials & Applications by L.Umanand - Wiley- Pvt. Limited - India - 2009.

Reference Books:

1. Elements of Power Electronics–Philip T.Krein. Oxford University Press; Second edition
2. Power Electronics – by P.S.Bhimbra- Khanna Publishers.
3. Thyristorised Power Controllers – by G. K. Dubey - S. R. Doradla - A. Joshi and R. M. K.Sinha - New Age International (P) Limited Publishers - 1996.
4. Power Electronics: by Daniel W.Hart- Mc Graw Hill.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	BASICS OF ELECTRIC DRIVES AND APPLICATIONS (Minor Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Electrical Machines - Fundamentals of Power Electronics

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain the fundamental components, operating principles, torque equations, and control methods of electric drives, including braking, stability, and four-quadrant operation.	2
CO2	Analyze and apply converter and chopper-based control schemes for DC and induction motor drives, interpret speed–torque characteristics, and solve related numerical problems.	3,4
CO3	Evaluate and synthesize advanced drive control strategies—such as closed-loop and multi-quadrant operations—for DC, induction, and synchronous motor drives to achieve efficient and reliable industrial performance.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
3	1	-	-	1	1	-	-	-	-	2	3	2	-	3
3	3	2	3	3	1	-	-	-	-	1	3	3	2	3
2	3	3	3	3	2	-	-	-	1	2	3	3	3	2

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Fundamentals of Electric Drives** Electric drive and its components– Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods**:** Dynamic – Plugging – Regenerative methods.	**(10hrs)**
UNIT - 2	**Controlled Converter Fed DC Motor Drives** 3-phase half and fully-controlled converter fed separately and self-excited DC motor drive – Output voltage and current waveforms – Speed-torque expressions – Speed-torque characteristics -Numerical problems.	**(10hrs)**
UNIT - 3	**DC–DC Converters Fed DC Motor Drives** Single quadrant – Two quadrant and four quadrant DC-DC converter fed separately excited and self-excited DC motors – Continuous current operation - Output voltage and current waveforms – Speed–torque expressions and characteristics.	**(10hrs)**
UNIT - 4	**Stator and Rotor side control of 3-phase Induction motor Drive** Stator voltage control using 3-phase AC voltage regulators – Waveforms – Speed torque characteristics– Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter. Static rotor resistance control– Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics.	**(10hrs)**

UNIT - 5	**Control of Synchronous Motor Drives** Separate control of synchronous motor – self-control of synchronous motor employing load commutated thyristor inverter - closed loop control of synchronous motor drive (qualitative treatment only).	**(8hrs)**
	Total	

Text Books:

1. Fundamentals of Electric Drives – by G K Dubey- Narosa Publications - 2nd edition 2002.
2. Power Semiconductor Drives- by S.B.Dewan - G.R.Slemon - A.Straughen - Wiley-India - 1984.

Reference Books:

1. Electric Motors and Drives Fundamentals- Types and Apllications - by Austin Hughes and Bill Drury - Newnes.4th edition - 2013.
2. Thyristor Control of Electric drives – Vedam Subramanyam Tata McGraw Hill Publications- 1987.
3. Power Electronic Circuits- Devices and applications by M.H.Rashid - PHI - 3rd edition - 2009.
4. Power Electronics handbook by Muhammad H.Rashid- Elsevier - 2nd edition - 2010.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	ELECTRICAL SAFETY AND ENERGY CONSERVATION (Minor Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

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

CO	Statement	Knowledge Level
CO1	Describe electrical safety hazards, protective devices, safe work practices, and fundamental principles of energy conservation and efficiency.	2
CO2	Apply electrical safety standards, use safety devices correctly, implement emergency procedures, and analyze energy management techniques for reducing consumption.	3,4
CO3	Evaluate safety and energy conservation practices and synthesize optimized strategies for electrical hazard prevention and efficient energy use in industrial and domestic settings.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	3	2	-	-	-	1	3	-	-
CO2	3	3	-	2	2	3	3	-	2	-	2	3	-	2
CO3	2	3	3	3	3	3	3	-	2	2	2	3	2	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
Unit 1:	**Introduction to Electrical Safety:** Importance of electrical safety in industrial and domestic environments, Basic electrical hazards: shock, burns, fire, arc flash-Types of electrical accidents and common causes-Personal protective equipment (PPE) and safe handling of electrical equipment-Electrical safety signs and labels.	
Unit 2:	**Electrical Safety Devices and Standards:** Earthing and grounding: purpose and methods- Circuit protection devices: fuses, Miniature Circuit Breakers (MCB), Earth Leakage Circuit Breakers (ELCB)/Residual Current Breakers (RCB)-Safety standards and regulations (overview ofIEEE 1584 and IEEE C2)-Safety practices during maintenance and repair.	
Unit 3:	**Safe Work Practices and Emergency Procedures:** Lockout/Tagout (LOTO) procedures-Safe use of electrical tools and portable equipment Fire prevention: causes and types of electrical fires-First aid for electrical shock and burns-Emergency response and evacuation protocols.	
Unit 4:	**Fundamentals of Energy Conservation:** Importance and benefits of energy conservation-Overview of energy sources and consumption patterns-Energy efficiency vs energy conservation-Basic energy auditing and monitoring techniques-Introduction to energy-saving appliances and equipment.	
Unit 5:	**Energy Conservation Techniques:** Electrical load management and demand-side management- Lighting efficiency: use of LED, CFL, and daylighting-Motors and drives: energy-efficient motors, Bureau of Energy Efficiency (BEE) star rating system, overview of IS 16102 -Role of individuals and organizations in promoting energy conservation	

Text Books:

1. ***Electrical Safety Handbook***, *John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, McGraw-Hill Education*
2. ***Energy Management Principles***, *Craig B. Smith, Butterworth-Heinemann*
3. ***Electrical Power Systems***, *C.L. Wadhwa, New Age International*

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	ELECTRICAL SIMULATION LAB (Minor Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

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

CO	Statement	Knowledge Level
CO1	Explain fundamental circuit concepts, device characteristics, and MATLAB/Simulink simulation techniques for electrical and control systems.	2
CO2	Perform simulations and experiments on electrical circuits, power measurement, control system responses, and power electronic devices using MATLAB and hardware setups.	3
CO3	Analyze transient, steady-state, and control behaviors of electrical circuits, verify network theorems, and evaluate power factor correction and converter operation through simulation results.	4
CO4	Evaluate experimental data and simulation outputs to synthesize optimized control strategies, power management techniques, and circuit designs for efficient electrical system performance.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	1	3	2	-
CO2	3	3	-	3	3	1	-	1	1	-	-	3	3	-
CO3	2	3	-	3	3	2	-	-	1	-	2	3	3	2
CO4	2	3	3	3	3	3	-	-	2	1	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

List of experiments
Any 10 of the following experiments are to be conducted

1.	Step response plot of a first-order transfer function Using MATLAB.
2.	Simulation of Ohm's Law and Series/Parallel Circuits.
3.	Transient Analysis of RL, RC, and RLC Circuits.
4.	Thevenin and Norton Theorem Verification using MATLAB Simulation.
5.	DC Motor Speed Control Using PID Controller.
6.	Simulation of 1-phase Controlled Rectifier.
7.	Simulation of Op-Amp as Voltage Follower and Inverter.
8.	Simulation of Voltage Regulator using Zener Diode.
9.	Generation of Triangular, Square, and Sinusoidal Waveforms Using MATLAB Programming.
10.	Measurement of 3-∅ Power for balanced and unbalanced loads using MATLAB Simulink.
11.	Simulation of Power Factor Correction.
12.	Simulation of basic DC-DC converters (Buck and Boost Converters).

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	ELECTRICAL SYSTEMS LAB (Minor Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

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

CO	Statement	Knowledge Level
CO1	Describe key electrical circuit principles, device behaviors, and MATLAB/Simulink simulation methods relevant to control and power systems.	2
CO2	Conduct simulations and practical experiments on electrical circuits, power measurement, control responses, and power electronic devices using MATLAB and hardware tools.	3
CO3	Analyze transient and steady-state performance, verify foundational network theorems, and assess power factor correction and converter functionality through simulation and experimentation.	4
CO4	Evaluate experimental and simulation data to develop optimized control strategies, improve power management, and design efficient electrical and electronic systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	1	3	2	-
CO2	3	3	-	3	3	1	-	1	1	-	-	3	3	-
CO3	2	3	-	3	3	2	-	-	1	-	2	3	3	2
CO4	2	3	3	3	3	3	-	-	2	1	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

List of experiments
Any 10 of the following experiments are to be conducted

1.	Measurement of Voltage, Current, and Power in Series and Parallel Circuits.
2.	Verification of superposition theorem.
3.	Verification of Thevenin's and Norton's Theorems.
4.	Speed Control of DC Shunt Motor.
5.	Determination of Performance Characteristics of a Synchro Pair as an Error Detector.
6.	Performance analysis of Magnetic Amplifiers.
7.	Performance analysis of AC servo motor.
8.	Measurement of Capacitance and Dissipation Factor Using Schering Bridge.
9.	Basic AC-DC Rectifier Circuits.
10.	Single-Phase Controlled Rectifier using SCR.
11.	Basic DC Chopper Operation.
12.	Single phase inverter circuit operation.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Honors Engineering Courses offered EEE Branch students (Need to Acquire 18 credits)

Power Systems

COURSE CODE – R2311XXXYY	ELECTRIC POWER QUALITY (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts of Power Systems

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe concepts, terms, and principles of power quality issues, mitigation methods, DG impacts, and monitoring across all disturbance types.	2
CO2	Analyze causes, effects, and control methods for power quality problems using protection, regulation, filtering, DG integration, and monitoring techniques.	3,4
CO3	Evaluate and model solutions for improving system reliability and compliance with power quality standards through advanced mitigation and monitoring strategies.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	–	–	–	–	–	–	–	-	3	2	1
CO2	3	3	2	2	2	–	–	–	–	–	1	3	3	3
CO3	2	3	3	3	2	2	–	–	–	–	1	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Introduction - Terms & Definitions** Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations – Voltage Sags – Voltage Swell.	
UNIT - 2	**Transient Over Voltages** Sources of Transient Over voltages - Principles of Over voltage protection- Devices for Over voltage protection – Utility Capacitor Switching Transients- Utility System Lightning Protection – Managing Ferro resonance – Switching Transient Problems with Loads.	
UNIT - 3	**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 - 4	**Harmonic distortion and solutions** Voltage distortion vs. Current distortion –Harmonic indices: THD - TDD and	

	True Power Factor– Sources of harmonics – Effect of harmonic distortion – Impact on capacitors - transformers - motors and meters – Concept of Point of common coupling – Passive and active filtering – Numerical problems.	
UNIT - 5	**Distributed Generation and Monitoring** Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks. **Monitoring** Power quality monitoring and considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data.	
	Total	

Textbooks:

4. Electrical Power Systems Quality - Dugan R C - McGranaghan M F - Santoso S - andBeaty H W - Second Edition - McGraw–Hill - 2012 - 3rd edition.
5. Electric power quality problems –M.H.J.Bollen IEEE series-Wiley india publications - 2011.
6. Power Quality Primer- Kennedy B W - First Edition - McGraw–Hill - 2000.

Reference Books:

4. Understanding Power Quality Problems: Voltage Sags and Interruptions- Bollen M HJ - First Edition - IEEE Press; 2000.
5. Power System Harmonics- Arrillaga J and Watson N R - Second Edition - John Wiley & Sons - 2003.
6. Electric Power Quality control Techniques - W. E. Kazibwe and M. H. Sendaula - Van Nostrad Reinhold- New York.
4. Power Quality c.shankaran- CRC Press - 2001
5. Harmonics and Power Systems –Franciso C.DE LA Rosa–CRC Press (Taylor & Francis)
6. Power Quality in Power systems and Electrical Machines–EwaldF.fuchs- Mohammad A.S.Masoum–Elsevier.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	SMART GRID TECHNOLOGIES (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

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

		Knowledge Level (K)#
CO1	Describe the concepts, technologies, and components of smart grids, microgrids, renewable integration, and ICT infrastructure, along with power quality considerations.	2
CO2	Analyze smart grid functions, technologies, control methods, microgrid operations, and renewable integration impacts to assess performance, reliability, and quality.	3,4
CO3	Evaluate and model smart grid solutions, microgrid configurations, and power quality management strategies to synthesize efficient, sustainable, and resilient power systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	2	–	–	–	–	–	3	2	2
CO2	3	3	3	2	3	2	–	2	–	–	–	3	3	3
CO3	2	3	3	3	3	3	2	2	–	–	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	**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 – 2	**Smart Grid Technologies: Part 1:** Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.	
UNIT – 3	**Smart Grid Technologies: Part 2:** Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & 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 – 4	**Microgrids and Distributed Energy Resources:** Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.	
UNIT – 5	**Power Quality Management in Smart Grid:** Power Quality & 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).	
	Total	**48 Hrs**

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

Reference Books:

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", Wiley
2. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell
3. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
4. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
5. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press
6. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	POWER SYSTEM DEREGULATION (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

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

		Knowledge Level (K)#
CO1	Describe the concepts, structures, and operational aspects of deregulated electricity markets, including market types, pricing mechanisms, transmission, and ancillary services.	2
CO2	Analyze market models, pricing strategies, congestion management, and ancillary service mechanisms to assess efficiency, reliability, and competition in deregulated power systems.	3,4
CO3	Evaluate and model deregulated market operations, transmission cost allocation, and ancillary service strategies to synthesize optimal, secure, and competitive electricity market solutions.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	–	–	–	–	–	3	2	2	2
CO2	3	3	3	3	2	–	–	–	–	–	3	3	3	3
CO3	3	3	3	3	3	2	–	–	–	–	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Need and conditions for deregulation. Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. Review of Concepts marginal cost of generation, least-cost operation, incremental cost of generation. Power System Operation.	
UNIT – 2	Electricity sector structures and Ownership /management, forms of Ownership and management. Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.	
UNIT – 3	Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices	
UNIT – 4	Transmission network and market power. Power wheeling transactions and marginal costing, transmission costing. Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices	
UNIT – 5	Ancillary Services and System Security in Deregulation. Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.	
	Total	

Text Books:

1. Power System Economics: Designing markets for electricity – S. Stoft, wiley.
2. Operation of restructured power systems – K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, Springer.

Reference Books:

1. Power generation, operation and control, -J. Wood and B. F. Wollenberg, Wiley.
2. Market operations in electric power systems – M. Shahidehpour, H. Yaminand Z. Li,Wiley.
3. Fundamentals of power system economics – S. Kirschen and G. Strbac, Wiley.
4. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry – N. S. Rau, IEEE Press series on Power Engineering.
5. Competition and Choice in Electricity – Sally Hunt and Graham Shuttleworth

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	REAL TIME CONTROL OF POWER SYSTEMS (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Power systems, Power System Analysis and Protection

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

		Knowledge Level (K)#
CO1	Describe the principles of state estimation, power system security, voltage stability, computer control systems, and deregulated market structures.	2
CO2	Apply state estimation techniques, perform security and contingency analyses, utilize SCADA-based control methods, and analyze voltage stability and power market operations.	3,4
CO3	Evaluate power system security, voltage stability, and market challenges, and synthesize integrated strategies for reliable, stable, and economical power system operation under deregulation.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	–	–	–	–	–	3	2	2
CO2	3	3	3	3	3	2	–	–	–	1	–	3	3	3
CO3	2	3	3	3	3	3	2	–	–	1	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	State Estimation: Different types of State Estimations, Theory of WLS state estimation, sequential and non-sequential methods to process measurements. Observability, Pseudo measurements, Bad data detection, identification and elimination.	
UNIT – 2	Security and Contingency Evaluation : Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line outages by iterative linear power flow method, Fast Decoupled model, and network sensitivity methods.	
UNIT – 3	Computer Control of Power Systems: Need for real time and computer control of power systems, operating states of a power system, Supervisory Control And Data Acquisition (SCADA) systems implementation considerations, energy control centers, software requirements for implementing the above functions.	
UNIT – 4	Voltage Stability, voltage collapse, and voltage security, relation of voltage stability to rotor angle stability. Voltage stability analysis Introduction to voltage stability analysis `P-V’ curves and `Q-V’ curves, voltage stability in mature power systems, long-term voltage stability, power flow analysis for voltage stability, voltage stability static indices and Research Areas.	

UNIT – 5	Need and conditions for deregulation. Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. Review of Concepts marginal cost of generation, least-cost operation, incremental cost of generation. Power System Operation.	
	Total	**48 Hrs**

Text Books:

1. Allen J.Wood and Bruce F.Wollenberg: Power Generation operation and control, John Wiley & Sons, 1984.
2. John J.Grainger and William D.Stevenson, Jr.: Power System Analysis, McGraw-Hill, 1994, International Edition
3. PrabhaKundur : Power System Stability and Control -, McGraw Hill, 1994
4. Steven stoft : Power System Economics-Designing Markets for Electricity, IEEE Press and Wiley – interscienc -2002

Reference Books:

1. R.N.Dhar : Computer Aided Power Systems Operation and Analysis, Tata McGraw Hill, 1982
2. L.P.Singh : Advanced Power System Analysis and Dynamics, Wiley Eastern Ltd. 1986

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	STATIC RELAYS FOR POWER SYSTEM PROTECTION (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Basic Concepts of Power Electronics, Electronic circuits, and Power Systems.

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

		Knowledge Level (K)#
CO1	Describe the classification, principles, and key components of static relays, amplitude and phase comparators, pilot relaying schemes, and numerical protection techniques.	2
CO2	Analyze the operation and characteristics of static overcurrent, distance, directional, and microprocessor-based relays, and interpret pilot and carrier protection schemes for power system faults.	3,4
CO3	Evaluate numerical relay algorithms and microprocessor-based protections, and synthesize effective relay protection strategies integrating static and numerical relays for reliable fault detection and system stability.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	–	–	–	–	–	–	3	2	2
CO2	3	3	3	3	3	–	–	–	–	–	–	3	3	3
CO3	2	3	3	3	3	–	–	–	–	–	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Static Relays classification and Tools: Basic Electromagnetic Relay Connection, Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multivibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays.	
UNIT – 2	Amplitude and Phase Comparators (2 Input): Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators. Phase Comparison: Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices.	
UNIT – 3	Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings.	

UNIT – 4	Pilot Relaying Schemes: Wire Pilot Protection: Circulating current scheme – Balanced voltage scheme – Transley scheme – Half-wave comparison scheme - Carrier Current Protection Schemes, relative merits & demerits: Phase comparison protection – Carrier aided distance protection – transfer scheme, blocking scheme and acceleration scheme.	
UNIT – 5	Microprocessor based relays and Numerical Protection: Over current relays – impedance relay – directional relay – reactance relay. Numerical Protection: Numerical relay - numerical relaying algorithms - mann-morrison technique - Differential equation technique and discrete fourier transform technique - numerical over current protection - numerical distance protection.	
	Total	**48 Hrs**

Text Books:

1. Power System Protection with Static Relays – by TSM Rao, TMH.
2. Power system protection & switchgear by Badri Ram & D N viswakarma, TMH.

Reference Books:

1. Protective Relaying Vol-II Warrington, Springer.
2. Art & Science of Protective Relaying - C R Mason, Willey.
3. Power System Stability KimbarkVol-II, Willey.
4. Electrical Power System Protection –C.Christopoulos and A.Wright- Springer
5. Protection & Switchgear –Bhavesh Bhalaja, R.PMaheshwari, NileshG.Chothani-Oxford publisher

Online Learning Resources:

https://nptel.ac.in/courses/108104191

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	FLEXIBLE AC TRANSMISSION SYSTEMS (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Fundamentals of Electrical Engineering, Power systems, Power Electronics

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

		Knowledge Level (K)#
CO1	Describe the principles, components, and operating characteristics of FACTS controllers including shunt, series, and combined devices, and their role in enhancing power system performance.	2
CO2	Analyze converter topologies, control strategies, and compensation methods to assess the impact of FACTS devices on voltage stability, transient stability, and power flow regulation.	3,4
CO3	Evaluate and model FACTS-based solutions to design optimal control schemes for improving stability, reliability, and loading capability of AC transmission networks.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	–	–	–	–	–	3	2	2
CO2	3	3	3	3	3	2	–	–	–	1	–	3	3	3
CO3	2	3	3	3	3	3	2	–	–	1	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	FACTS concepts, Transmission interconnections, power flow in an AC System, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.	
UNIT – 2	Basic concept of voltage and current source converters, comparison of current source converters with voltage source converters. 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 generation, switching converter type VAr generation, hybrid VAr generation.	
UNIT – 3	**SVC** and STATCOM: The regulation slope, transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control.	
UNIT – 4	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.	
UNIT – 5	Unified Power Flow Controller: Basic operating principle, conventional transmission control capabilities, independent real and reactive power flow control, comparison of the UPFC to series compensators and phase angle regulators. Introduction to Inter line Power Flow Controller (IPFC).	
	Total	**48 Hrs**

Text Books:

1. “Understanding FACTS Devices” N.G.Hingorani and L.Guygi, IEEE Press.
   Indian Edition is available:--Standard Publications

Reference Books:

1. Sang.Y.Hand John.A.T, “Flexible AC Transmission systems” IEEE Press (2006).
2. HVDC & FACTS Controllers: applications of static converters in power systems- Vijay K.Sood- Springer publishers.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisites: Power Electronics, Electrical Machines Control Systems.

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

		Knowledge Level (K)#
CO1	Explain the operating principles, components, and characteristics of solar PV, wind energy systems, and their associated power conversion and grid integration technologies.	2
CO2	Analyze PV and wind energy system performance under varying operating conditions, applying MPPT, converter control, and grid synchronization techniques.	3,4
CO3	Design and evaluate hybrid renewable energy systems for optimal efficiency, stability, and compliance with grid codes and standards.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	2	–	–	–	–	3	2	2
CO2	3	3	3	3	3	2	2	–	–	–	–	3	3	3
CO3	2	3	3	3	3	3	3	–	–	1	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT– 1	Solar spectrum, PV materials, Equivalent Circuit for PV cell, effect of series and shunt resistance, fill factor, Cells to Modules to Arrays, I–V Curves, standard test condition, Impacts of Temperature and Insolation on I–V curves, series and parallel connection of PV modules, Shading impacts on I–V curves, Bypass diodes and Blocking diodes for shade mitigation, I–V Curves for different loads.	
UNIT– 2	Perturb and observe MPPT method for solar PV inverter, Central inverters, String inverters, Micro inverters, leakage current issue, Transformer for leakage current elimination, Transformer less PV inverters. Battery charger, Characteristics of Batteries, Charge control, Battery charging using DC-DC converter, Dual Active Bridge converter for battery charging.	
UNIT– 3	Wind turbine technologies- horizontal axis and vertical axis turbines, power in the wind, wind turbine power curves, Betz limit ratio, advantages and disadvantages of wind energy system. Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Doubly Fed Induction Generator, Permanent Magnet Synchronous Generators and their characteristics.	
UNIT– 4	Converters for wind generators: AC-DC-AC converters, matrix converters, multilevel converter, Maximum power point tracking for wind turbines, fault ride through capabilities.	

UNIT– 5	Grid connection principle, Clarke's and Park's transformation, Grid connected photovoltaic system, Grid connected wind energy system, Filters, Grid synchronization & PLL, operation & control of hybrid energy systems, IEEE & IEC codes and standards for renewable energy grid integrations.	
	Total	

Text Books:

1. Renewable and Efficient Electric Power Systems, G. Masters, IEEE- John Wiley and Sons Ltd. Publishers, 2013, 2nd Edition.
2. Grid Converters for Photovoltaic and Wind Power Systems, Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Wiley, 2011, 2nd Edition.
3. Integration and Control of Renewable Energy in Electric Power System, Ali Keyhani Mohammad Marwali and Min Dai, John Wiley publishing company, 2010, 2nd Edition.

Reference Books:

1. Solar Photovoltaic: Fundamentals, technologies & Applications, C. S. Solanki, PHI Publishers, 2019.
2. Integration of Renewable Sources of Energy, F. A. Farret, M. G. Simoes, Wiley, 2017, 2nd Edition.

Online resources:

1. https://onlinecourses.nptel.ac.in/noc22_ee71/preview
2. https://nptel.ac.in/courses/103103206

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	ELECTRIC AND HYBRID ELECTRIC VEHICLES (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts of Electrical Machines - Power Electronics.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain the fundamentals, architectures, components, and energy storage technologies of electric and hybrid electric vehicles.	2
CO2	Analyze the performance, control strategies, and power electronic interfaces for motors and converters in EV/HEV systems.	3,4
CO3	Design and evaluate EV/HEV propulsion and energy management systems for efficiency, reliability, and optimal energy utilization.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	2	–	–	–	–	3	2	2
CO2	3	3	3	3	3	2	2	–	–	–	–	3	3	3
CO3	2	3	3	3	3	3	3	–	–	1	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Introduction** Fundamentals of vehicle - components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; History of hybrid vehicles - advantages and applications of Electric and Hybrid Electric Vehicles.	
UNIT - 2	**Hybridization of Automobile** Architectures of HEVs - series and parallel HEVs - complex HEVs. Plug-in hybrid vehicle(PHEV) - constituents of PHEV - comparison of HEV and PHEV; Extended range hybrid electric vehicles(EREVs) - blended PHEVs - Fuel Cell vehicles and its constituents.	
UNIT - 3	**Special Machines for EV and HEVs** Characteristics of traction drive - requirement of electric motors for EV/HEVs. Induction Motor drives - their control and applications in EV/HEVs. Permanent magnet Synchronous motor: configuration - control and applications in EV/HEVs.Brushless DC Motors: Advantages - control of application in EV/HEVs. Switch reluctance motors: Merits limitations - converter configuration - control of SRM for EV/HEVs.	
UNIT - 4	**Power Electronics in HEVs** Boost and Buck-Boost converters - Multi Quadrant DC-DC converters - DC-AC Inverter for EV and HEV applications - Three Phase DC-AC inverters - Voltage control of DC-AC inverters using PWM - EV and PHEV battery chargers.	

UNIT - 5	**Energy Sources for HEVs** Energy Storage - Battery based energy storage and simplified models of battery - fuel cells - their characteristics and simplified models - super capacitor based energy storage - its analysis and simplified models - flywheels and their modeling for energy storage in EV/HEV - Hybridization of various energy storage devices.	
	Total	

Text Books

3. Ali Emadi - Advanced Electric Drive Vehicles - CRC Press - 2014.
4. Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2003.

Reference Books:

4. MehrdadEhsani - YimiGao - Sebastian E. Gay - Ali Emadi - Modern Electric - Hybrid Electric and Fuel Cell Vehicles: Fundamentals - Theory and Design - CRC Press - 2004.
5. James Larminie - John Lowry - Electric Vehicle Technology Explained - Wiley - 2003.
6. H. Partab: Modern Electric Traction - DhanpatRai& Co - 2007.

ResearchBooks:

3. Pistooa G. - "Power Sources - Models - Sustanability - Infrstructure and the market" - Elsevier 2008
4. Mi Chris - Masrur A. - and Gao D.W. - " Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives" 1995.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	HIGH VOLTAGE ENGINEERING (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts on Electric Supply Systems

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe breakdown phenomena in gases, liquids, and solids, and explain the principles of high voltage and impulse voltage generation.	2
CO2	Analyze the design and operation of high voltage generation circuits and impulse generators, and apply measurement techniques for high DC, AC, and impulse voltages and currents.	3,4
CO3	Evaluate high voltage insulation performance and measurement methods, and synthesize appropriate high voltage testing and generation strategies for electrical equipment and systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	–	–	–	–	–	3	2	2
CO2	3	3	3	3	3	2	–	–	–	–	–	3	3	3
CO3	2	3	3	3	3	3	–	–	–	–	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Break down phenomenon in Gaseous:** Insulating Materials: Types - applications and properties. Gases as insulating media – Collision process – Ionization process – Townsend's criteria of breakdown in gases and its limitations – Streamers Theory of break down – Paschen's law- Paschens curve.	
UNIT - 2	**Break down phenomenon in Liquids:** Liquid as Insulator – Pure and commercial liquids – Breakdown in pure and commercial liquids. **Break down phenomenon in Solids:** Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown – Breakdown of composite solid dielectrics.	
UNIT - 3	**Generation of High DC voltages:** Voltage Doubler Circuit - Voltage Multiplier Circuit – Vande- Graaff Generator. **Generation of High AC voltages**: Cascaded Transformers – Resonant Transformers –Tesla Coil	
UNIT - 4	**Generation of Impulse voltages:** Specifications of impulse wave – Analysis of RLC circuit only- Marx Circuit. **Generation of Impulse currents:** Definitions – Circuits for producing Impulse current waves – Wave shape control - Tripping and control of impulse generators.	

UNIT - 5	**Measurement of High DC & AC Voltages:** Resistance potential divider - Generating Voltmeter - Capacitor Voltage Transformer (CVT) - Electrostatic Voltmeters – Sphere Gaps. **Measurement of Impulse Voltages & Currents:** Potential dividers with CRO - Hall Generator - Rogowski Coils.	
	Total	

Text Books:

3. High Voltage Engineering: Fundamentals by E.Kuffel - W.S.Zaengl - J.Kuffel by Elsevier - 2nd Edition.
4. High Voltage Engineering and Technology by Ryan - IET Publishers - 2nd edition.

Reference Books:

2. High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications - 3rd Edition.
2. High Voltage Engineering by C.L.Wadhwa - New Age Internationals (P) Limited - 1997.
3. High Voltage Insulation Engineering by RavindraArora - Wolfgang Mosch - New Age International (P) Limited - 1995.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	HIGH VOLTAGE ENGINEERING LAB (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Concepts of High Voltage Engineering

Course Outcomes: At the end of the course - student will be able to

		Knowledge Level (K)#
CO1	Describe the principles of high voltage testing and measurement techniques for various insulating materials and configurations.	2
CO2	Perform experiments to measure leakage current, insulation resistance, voltage distribution, and breakdown voltages of different insulators and gaps.	3
CO3	Analyze breakdown characteristics and voltage distribution data to assess insulation performance and high voltage behavior of tested components.	4
CO4	Evaluate experimental results from high voltage tests and synthesize testing methodologies for reliable insulation assessment and design improvements in high voltage equipment.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	1	–	–	–	–	–	3	2	2	3
CO2	3	3	3	3	3	2	–	–	–	–	–	3	3	3	3
CO3	2	3	3	3	3	3	–	–	–	–	–	3	3	3	2
CO4	2	3	3	3	3	3	–	–	–	–	3	3	3	3	2

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

List of experiments
Any 10 of the following experiments are to be conducted

S.No	CONTENTS	Contact Hours
1.	Millivolt drop test and Tong tester calibration	
2.	Breakdown characteristics of sphere-sphere gap	
3.	Measurement of leakage current and breakdown voltage of pin insulator	
4.	Breakdown test of transformer oil	
5.	Breakdown characteristics of rod-rod gap	
6.	Measurement of leakage current and insulation resistance of polypropylene scale	
7.	Measurement of leakage current and insulation resistance of polypropylene rope	
8.	Breakdown characteristics of plane-rod-gap	
9.	Measurement of leakage current and breakdown voltage of suspension insulator	
10.	Breakdown characteristics of point-sphere gap	
11.	Measurement of voltage distribution for suspension insulator string	
12.	Lightning impulse testing on insulator string	

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	RENEWABLE ENERGY & BATTERY TECHNOLOGIES LABORATORY (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Simulate PV cell/module models and analyze I–V & P–V performance under different configurations and conditions (temperature, irradiation, resistance, shading, tilt).	2
CO2	Implement and assess MPPT algorithms (P&O, INC) and evaluate PV efficiency under varying operating conditions.	3
CO3	Measure and analyze wind turbine parameters – cut-in speed, coefficient of performance, and power-speed characteristics.	4
CO4	Fabricate, test, and evaluate Li-ion battery packs for SoC, charge/discharge behavior, and DC fast charging.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	2	3	2	-	-	-	-	1	3	3	-
CO2	3	3	2	3	3	2	-	-	-	-	1	3	3	2
CO3	3	3	-	3	2	3	-	1	1	-	-	3	2	-
CO4	2	3	3	3	3	3	2	1	2	1	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

List of experiments
Any 10 of the following experiments are to be conducted

S.No.	CONTENTS
1.	Simulate the Mathematical Model of a PV cell using Single Diode model and Two Diode model equivalent circuits.
2.	Simulate the performance curves (I-V & P-V) for PV modules connected in series and parallel and their variation with temperature and irradiation.
3.	Simulate the performance curves (I-V & P-V) for the effect of varying the series resistance on the fill factor of the PV cell.
4.	Simulate the Maximum Power Point tracking of PV module using P & O and INC Algorithms.
5.	Single PV module I-V and P-V characteristics with radiation and temperature changing effect.
6.	Effect of shading on PV Module.
7.	Analyze the effect of tilt angle on PV Module.
8.	Evaluation of cut-in speed of wind turbine.
9.	Evaluation of Coefficient of performance of wind turbine.
10.	Characteristics of turbine (power variation) with wind speed.
11.	Power curve of turbine with respect to the rotational speed of rotor at fix wind speeds.
12.	Grading and fabrication of Li-ion battery pack
13.	State of Charge (SoC) estimation of Li-ion battery pack
14.	Characteristics of charging and discharging of Li-ion battery pack
15.	DC fast charging of Li-ion battery pack

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

POWER ELECTRONICS

COURSE CODE – R2311XXYY	SPECIAL ELECTRICAL MACHINES (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite:Concepts of Electrical Machines

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the principles, construction, and key characteristics of permanent magnet materials, PMDC motors, stepper motors, switched reluctance motors, brushless DC motors, and linear induction motors.	2
CO2	Analyze the operating principles, torque-speed characteristics, and control circuits of special electrical machines and interpret their performance for various applications.	3,4
CO3	Evaluate design and performance aspects of permanent magnet and special motors, and synthesize suitable machine and control strategies for efficient, high-performance electromechanical drives.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	–	–	–	–	–	–	3	2	2
CO2	3	3	3	2	3	–	–	–	–	–	–	3	3	3
CO3	2	3	3	3	3	–	–	–	–	1	–	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**Permanent Magnet Materials and PMDC motors** Introduction-classification of permanent magnet materials used in electrical machines-minor hysteresis loop and recoil line-Stator frames of conventional dc machines-Development of electronically commutated dc motor from conventional dc motor – Permanent magnet materials and characteristics-B-H loop and demagnetization characteristics-high temperature effects-reversible losses-Irreversible losses- Mechanical properties - handling and magnetization-Application of permanent magnets in motors-power density-operating temperature range-severity of operation duty.	
UNIT - 2	**Stepper Motors** Principle of operation of Stepper Motor – Constructional details - Classification of stepper motors – Different configuration for switching the phase windings - Control circuits for stepper motors – Open loop and closed loop control of two phase hybrid stepping motor.	
UNIT - 3	**Switched Reluctance Motors** Construction and Principle of operation of Switched Reluctance Motor –	

	Comparison of conventional and switched reluctance motors – Design of stator and rotor pole arcs. Torque producing principle and torque expression – Different converter configurations for SRM – Drive and power circuits for SRM – Position sensing of rotor – Applications of SRM.	
UNIT - 4	**Permanent Magnet Brushless DC Motor** Principle of operation of BLDC motor - Types of constructions - Surface mounted and interior type permanent magnet DC Motors - Torque and EMF equations for Square wave & Sine wave for PMBLDC Motor – Torque - Speed characteristics of Square wave & Sine wave for PMBLDC Motor - Merits & demerits of Square wave & Sine wave for PMBLDC Motor - Performance and efficiency – Applications.	
UNIT - 5	**Linear Induction Motors (LIM)** Construction– principle of operation–Double sided LIM from rotating type Induction Motor – Schematic of LIM drive for traction – Development of one sided LIM with back iron- equivalent circuit of LIM.	
	Total	

Text Books:

1. Brushless Permanent magnet and reluctance motor drives, Clarenden press, T.J.E. Miller, 1989, Oxford.
2. Special electrical Machines, K.Venkata Ratnam, University press, 2009, New Delhi.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	MACHINE MODELING AND ANALYSIS (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisites: Electrical Circuits and Electrical Machines

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe mathematical modeling principles and reference frame theories for DC motors, 3-phase induction, synchronous, and special electric machines.	2
CO2	Apply state-space and transfer function models to analyze dynamic behavior of DC motors, induction motors in various reference frames, synchronous motors, and special machines.	3,4
CO3	Evaluate machine performance through model-based simulations and synthesize advanced modeling approaches for control and analysis of electrical machines including PMSM, BLDC, and switched reluctance motors.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	–	2	–	–	–	–	–	–	3	3	2
CO2	3	3	3	2	3	–	–	–	–	–	–	3	3	3
CO3	3	3	3	3	3	–	–	–	–	–	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	**DC Motor Modeling :** Importance of mathematical modeling of electrical machines, Mathematical model of separately excited D.C. motor and D.C. Series motor in state variable form – Mathematical model of D.C. shunt motor and D.C. Compound motor in state variable form, Steady state analysis – Transient state analysis, Transfer function of the D.C. motor, Sudden application of inertia load.	
UNIT - 2	**Reference Frame Theory & 3-phase Induction Motor dq model:** Linear transformation – Phase transformation (abc to αβ0) – Power equivalence, Active transformation (αβ0 to dq0), transformations in complex plane, Commonly used reference frames and transformation between reference frames, Circuit model of a 3 phase Induction motor – Flux linkage equation – dq transformation of flux linkages in the complex plane – voltage equations	
UNIT - 3	**Modeling of 3-phase Induction motor in various reference frames** Voltage equation transformation to a synchronous reference frame, dq model of induction motor in the stator reference frame, rotor reference frame and arbitrary reference frame, power equation, electromagnetic torque equation, state space model in induction motor with flux linkages as variables and current-flux variables	
UNIT - 4	**Modeling of 3-phase Synchronous Motor** Synchronous machine inductances – Circuits model of a 3-phase synchronous motor – derivation of voltage equations in the rotor's dq0 reference frame	

	electromagnetic torque – State space model with flux linkages as variables.	
UNIT - 5	**Special Machines:** Modeling of Permanent Magnet Synchronous motors – Modeling of Brushless DC Motor, Analysis of Switch Reluctance Motors.	
	Total	

Text Books

1. Generalized theory of Electrical Machines - Fifth edition, Khanna Publishers P. S. Bimbhra, 1985.
2. AC Motor control and electric vehicle applications – Kwang Hee Nam – CRC press, Taylor & Francis Group, 2010

Reference Books:

1. Electric Motor Drives - Modeling, Analysis& control - R. Krishnan- Pearson Publications- 1st edition -2002.
2. Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications - R.Krishnan , CRC Press, Year: 2001
3. Analysis of Electric Machinery and Drive Systems, 3rd Edition-Wiley-IEEE Press- Paul Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven Pekarek, Junr 2013..

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/108/106/108106023/

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	POWER ELECTRONIC CONVERTERS (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the characteristics of switching devices, basic DC-DC converters, PWM inverter techniques, and multilevel inverter topologies.	2
CO2	Analyze the operation and control methods of various DC-DC converters, single-phase and three-phase PWM inverters, and multilevel inverter modulation schemes.	3,4
CO3	Evaluate and synthesize advanced inverter modulation strategies and switching device applications for efficient, high-performance power conversion systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	–	–	–	–	–	1	3	2	2
CO2	3	3	3	3	3	–	–	–	–	-	1	3	3	3
CO3	2	3	3	3	3	–	–	–	–	–	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT– 1	**Overview of Switching Devices &AC-DC converters:** Power MOSFET, IGBT, GTO, GaN devices-static and dynamic characteristics, gate drive circuits for switching devices.	
UNIT– 2	**Non-Isolated DC-DC Converters:** Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converter, CUK Converter, continuous and discontinuous operation, relation between input and output voltages, design of filter inductor and capacitors, Converter realization with non-ideal components.	
UNIT– 3	**PWM Inverters:** Voltage control of single-phase inverters employing phase displacement Control, Bipolar PWM, Unipolar PWM. Three-phase Voltage source inverters: Six stepped VSI operation-Voltage Control of Three-Phase Inverters employing Sinusoidal PWM, Third Harmonic PWM, Space Vector Modulation- Comparison of PWM Techniques- Three phase current source inverters.	
UNIT– 4	**Multilevel Inverters:** Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter- Improved Diode Clamped Inverter-Cascaded H-bridge Multilevel Inverter, Principle of Operation, Features of Cascaded H-bridge Inverter- Comparisons of DCMLI & CHB- Modular multilevel converters – principle of operation.	

UNIT– 5	**PWM Multilevel Inverters:** CHB Multilevel Inverter: Stair case modulation-SHE PWM- Phase shifted Multicarrier modulation-Level shifted PWM- Diode clamped Multilevel inverter: SHE PWM-Sinusoidal PWM- Space vector PWM-Capacitor voltage balancing.	
	Total	**48 Hrs**

Text Books

1. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First IndianReprint-2008.
2. High-power converters and AC drives -Wu, Bin, and Mehdi Narimani-John Wiley & Sons, 2017.

Reference Books:

1. Elements of Power Electronics – Philip T. Krein, Oxford University press, 2014.
2. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003.
3. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee CRC Press, 2004.
4. Power Electronics Daniel W. Hart - McGraw-Hill, 2011.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	POWER QUALITY AND CUSTOM POWER DEVICES (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Basic knowledge in power systems and power electronics.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain power quality concepts, problems, causes, and their effects on electrical systems.	2
CO2	Analyze voltage variations, harmonics, and system responses using relevant standards and mitigation techniques.	3,4
CO3	Design and evaluate custom power devices and their control for improving power quality in distribution systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	–	–	–	–	–	–	3	2	2
CO2	3	3	3	3	3	–	–	–	–	-	–	3	3	3
CO3	2	3	3	3	3	–	–	–	–	–	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT– 1	**Introduction to power quality:** Overview of Power Quality, Concern about the Power Quality, General Classes of Power Quality Problems, Voltage Unbalance, Waveform Distortion, Voltage fluctuation, Power Frequency Variations, Power Quality Terms, Voltage Sags, swells, flicker and Interruptions – Sources of voltage and current interruptions, Nonlinear loads.	
UNIT– 2	**Transient and Long Duration Voltage Variations** 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. 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 generation	
UNIT– 3	**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– 4	**Custom Power Devices:** Custom power and custom power devices, voltage source inverters, reactive power	

	and harmonic compensation devices, compensation of voltage interruptions and current interruptions, static series and shunt compensators, compensation in distribution systems, interaction with distribution equipment, installation considerations.	
UNIT– 5	**Application of custom power devices in power systems:** Static and hybrid Source Transfer Switches, Solid state current limiter – Solid state breaker. P-Q theory – Control of P and Q, Dynamic Voltage Restorer (DVR): Operation and control – Interline Power Flow Controller (IPFC): Operation and control of Unified Power Quality Conditioner (UPQC); Generalized power quality conditioner	
	Total	**48 Hrs**

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. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000.
3. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000
4. Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, Arindam Ghosh, Kluwer Academic Publishers, 2002.

Reference Books:

1. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.
2. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.
3. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
4. Power Quality c.shankaran, CRC Press, 2001

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	INDUSTRIAL APPLICATIONS OF POWER ELECTRONIC CONVERTERS (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisites:

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the principles, types, and applications of power converters for LED driving, UPS, SMPS, high/low voltage power supplies, AC drives, and renewable energy systems.	2
CO2	Analyze and apply power converter designs, control methods, and grid synchronization techniques for efficient operation in LED systems, electric drives, micro-grids, and renewable integration.	3,4
CO3	Evaluate advanced power converter technologies including multilevel and solid-state transformer converters, and synthesize integrated solutions for reliable, efficient, and flexible power conversion across diverse applications.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	–	–	–	–	–	1	3	2	2
CO2	3	3	3	3	3	–	–	–	–	–	1	3	3	3
CO3	2	3	3	3	3	–	–	–	–	–	3	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT– 1	**Power Converters for LED Driving:** LED Characteristics, Driving LEDs, Converters (Buck, Boost & Buck-Boost) for LED lightning systems, PFC based LED drivers, Selecting Components for LED Drives, Applications of LEDs.	
UNIT– 2	**UPS and SMPS:** Components of UPS, operation and applications of UPS, Basic operation and applications of SMPS, Difference between UPS and SMPS. **Bi-directional DC-DC (BDC) converters:** Electric traction, Automotive Electronics, Battery charging converters, Line Conditioners and Solar Charge Controllers.	
UNIT– 3	**High Voltage Power Supplies -** Power supplies for X-ray applications, Power supplies for radar applications, Power supplies for space applications. **Low Voltage High Current Power Supplies:** Power converters for modern Microprocessor and Computer loads.	
UNIT– 4	**Power converters for AC Drives:** Two-Level VSI-Based Medium Voltage (MV) drives, NPC/H-Bridge inverter fed drive, ANPC inverter fed drive, Modular Multi level inverter fed drive, and Multi-Module Cascaded Matrix Converter fed MV drive, power converters for PMSM & BLDC motors.	
UNIT– 5	**Power converters for micro-grid and grid connection of renewable energy sources:** Design, control of converters, grid synchronization and filtering requirements, Solid State Transformers technologies in Distribution system.	

Text Books:

1. Steve Winder, Power Supplies for LED Driving, Newnes, 2016, 2nd Edition.
2. Abraham I. Pressman, Keith Billings &Taylor Morey, Switching Power Supply Design, McGraw Hill International, 2009, 3rd Edition.
3. Ali Emadi, A. Nasiri, and S. B. Bekiarov, Uninterruptible Power Supplies and Active Filters, CRC Press, 2004, 1st Edition.
4. Ali Keyhani Mohammad Marwali ,Min Dai, Integration and Control of Renewable Energy in Electric Power System, , John Wiley publishing company, 2010, 2nd Edition.

Reference Books:

1. Muhammad H. Rashid ,Power Electronics Handbook, Butterworth-Heinemann, 2023, 5th Edition
2. M Singh, K Khanchandani, Power Electronics, McGraw-Hill Education, 2006, 2nd Edition.
3. B.L. Theraja, A Textbook of Electrical Technology - Volume III, 2007,1st Edition.
4. William Ribbens, Understanding Automotive Electronics: An Engineering Perspective, ButterworthHeinemann, 2017, 8th Edition.
5. Paul C. Krause, Oleg W, Scott D. Sudhoff, Analysis of Electric Machinery & Drive systems, IEEE Press, 2013, 3rd Edition.
6. High-power Converters and AC Drives, Bin-Wu, Wiley-Blackwell, 2017, 2nd Edition.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	ADVANCED ELECTRICAL DRIVES (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Knowledge of Power Electronics, Electrical Machines and Control Systems

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the principles, configurations, and key characteristics of vector/DTC-controlled induction motors, synchronous, SRM, and BLDC motor drives, including torque, flux, and converter control methods.	2
CO2	Analyze control strategies, modulation schemes, and performance parameters for induction, synchronous, SRM, and BLDC drives, applying concepts to assess efficiency and torque-speed behavior.	3,4
CO3	Evaluate and model advanced motor drives to synthesize optimized control strategies for high-performance applications using vector control, DTC, SRM, and BLDC control techniques.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	-	1	1	3	2
CO2	3	3	2	2	2	-	-	-	-	-	2	2	3	3
CO3	3	3	3	3	2	-	-	-	-	-	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	**Vector Control of Induction Motor Drives** Principles of scalar and vector control, principle of direct vector control, indirect vector control, implementation-block diagram; estimation of flux, flux weakening operation.	
UNIT – 2	**Direct Torque Control of Induction Motor Drives** Principle of Direct torque control (DTC), concept of space vectors, DTC control strategy of induction motor, comparison between vector control and DTC, applications, space vector modulation-based DTC of induction motors.	
UNIT – 3	**Control of Synchronous Motor Drives** Synchronous motor and its characteristics- Control Strategies-Constant torque angle control- power factor control, constant flux control, flux weakening operation, load commutated inverter fed synchronous motor drive, motoring and regeneration, phasor diagrams.	
UNIT – 4	**Control of Switched Reluctance Motor Drives** SRM Structure-Stator Excitation-techniques of sensor less operation-convertor topologies-SRM Waveforms-SRM drive design factors-Torque controlled	

	SRM-Torque Ripple-Instantaneous Torque control -using current controllers-flux controllers.	
UNIT – 5	**Control of BLDC Motor Drives** Principle of operation of BLDC Machine, Sensing and logic switching scheme, BLDM as Variable Speed Synchronous motor-methods of reducing Torque pulsations -Three-phase full wave Brushless dc motor -Sinusoidal type of Brushless dc motor - current controlled Brushless dc motor Servo drive.	
	Total	**48 Hrs**

Text Books:

1. Bose B. K., "Power Electronics and Variable Frequency Drives‟, IEEE Press, Standard Publisher Distributors. 2001.
2. Krishnan R., "Electric Motor Drives – Modelling, Analysis and Control", Prentice Hall of India Private Limited.

Reference Books:

1. Switched Reluctance Motors and Their Control-T. J. E. Miller, Magna Physics, 1993.
2. Power electronic converters applications and design-Mohan, Undeland, Robbins-Wiley Publications
3. De Doncker, Rik W., Pulle, Duco W.J., Veltman, Andre, "Advanced Electrical Drives", Springer, 2020.
4. Ned Mohan, "Advanced Electric Drives: Analysis, Control, and Modeling Using MATLAB/Simulink®", John Wiley & Sons, Inc, 2014.

Online Learning Resources:

1. https://nptel.ac.in/courses/108104011
2. https://nptel.ac.in/courses/108102046

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	FACTS CONTROLLERS (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Knowledge of Power Electronics, Electrical Machines

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the concepts, principles, and operating characteristics of FACTS devices including shunt, series, and combined controllers such as SVC, STATCOM etc.	2
CO2	Analyze control strategies, compensation methods, and performance impacts of FACTS controllers on voltage stability, transient stability, and power flow enhancement in AC transmission systems.	3,4
CO3	Evaluate and model FACTS-based power system solutions to synthesize optimal compensation and control strategies for improving stability, reliability, and loading capability of transmission networks.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	-	1	1	3	2
CO2	3	3	2	2	3	-	-	-	-	-	2	2	3	3
CO3	3	3	3	3	3	-	-	-	-	-	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	FACTS concepts, Transmission interconnections, power flow in an AC System, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.	
UNIT – 2	Basic concept of voltage and current source converters, comparison of current source converters with voltage source converters. 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 generation, switching converter type VAr generation, hybrid VAr generation.	
UNIT – 3	**SVC** and STATCOM: The regulation slope, transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control.	
UNIT – 4	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.	
UNIT – 5	Unified Power Flow Controller: Basic operating principle, conventional transmission control capabilities, independent real and reactive power flow control, comparison of the UPFC to series compensators and phase angle regulators. Introduction to Inter line Power Flow Controller (IPFC).	
	Total	**48 Hrs**

Text Books:

1. "Understanding FACTS Devices" N.G.Hingorani and L.Guygi, IEEE Press. Indian Edition is available:--Standard Publications

Reference Books:

1. Sang.Y.Hand John.A.T, "Flexible AC Transmission systems" IEEE Press (2006).
2. HVDC & FACTS Controllers: applications of static converters in power systems- Vijay K.Sood- Springer publishers

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	SWITCHED MODE POWER CONVERSION (Honors Course)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Power electronics - Control Systems.

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Describe the principles, types, and operating modes of non-isolated, isolated, and resonant switch mode converters along with their control schemes.	2
CO2	Analyze converter topologies, magnetic designs, and control methods, and apply modeling techniques to predict the performance of various switch mode power converters.	3,4
CO3	Evaluate converter behaviors using large and small signal models, and synthesize optimized controller designs based on linearization for efficient and stable power conversion.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	-	-	-	-	-	2	3	2	2
CO2	3	2	2	1	1	-	-	-	-	-	2	3	3	2
CO3	3	2	2	2	1	-	-	-	-	-	2	2	2	2

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	**Non-Isolated Switch Mode Converters** Control of DC-DC converters: Buck converters - Boost converters - Buck-Boost converter - CUK Converter - continuous and discontinuous operation - Converter realization with non-ideal components.	
UNIT – 2	**Isolated Switched Mode Converters** Forwarded converter - flyback converter - push-pull converter - half-bridge converter - full bridge converter.	
UNIT – 3	**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 – 4	**Control Schemes of Resonant Converters** Voltage control - Current mode control - Current control mode instability. **Magnetic Design:** Transformer design - inductor and capacitor design.	
UNIT – 5	**Modelling of Converters and Controller Design Based On Linearization:** Formulation of large signal models for buck and boost converters using state space analysis-derivation of average large signal model using circuit averaging method-small signal model derivation- average switch modelling technique to	

	obtain small signal models of buck and boost converters- Transfer function of converters-Controller design based on linearization.	
	Total	

Text Books:

2. Fundamentals of Power Electronics-Erickson - Robert W. - Maksimovic - Dragan - Springer - 2011.
3. Power switching converters-Simon Ang - Alejandro Oliva - CRC Press - 2010.
4. Elements of Power Electronics – Philip T. Krein - Oxford University press - 2014.
5. Design of Magnetic Components for Switched Mode Power Converters- Z Umanand - S.P. Bhat - John Wiley & Sons Australia - 1992.

Reference Books:

1. Switching Power Supply Design-Abraham I. Pressman - McGraw-Hill Ryerson - Limited - 1991.
2. Power Electronics – Issa Batareseh - Jhon Wiley publications - 2004.
3. Power Electronics: converters Applications & Design – Mohan - Undeland - Robbins-Wiley publications.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	ELECTRIC DRIVES LABORATORY (Honors Course)	CATEGORY	L-T-P 0-0-3	CREDITS 1.5

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

		Knowledge Level (K)#
CO1	Describe the principles and operation of various motor drive control techniques including DC drives, induction motors, PMSM, BLDC, and switched reluctance motors.	2
CO2	Perform experiments to implement and control speed and torque in DC and AC motor drives using converters, PWM techniques, and field-oriented control methods.	3
CO3	Analyze experimental data from open loop and closed loop control of motor drives to evaluate dynamic performance, speed regulation, and torque control efficiency.	4
CO4	Evaluate different motor drive control strategies and synthesize optimized control schemes for enhanced motor performance, sensorless operation, and energy-efficient drive systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	-	-	-	-	3	2	1	1
CO2	2	3	2	2	3	-	-	-	-	-	2	3	2	2
CO3	1	2	2	3	2	-	-	-	-	-	2	2	2	3
CO4	1	3	3	3	2	-	-	-	-	-	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

List of experiments

Any 10 of the following experiments are to be conducted

S.No.	CONTENTS
1.	Speed control of separately excited DC drive with single-phase semi converter.
2.	Speed control of separately excited DC drive with three-phase full converter.
3.	Soft starting of three-phase induction motor.
4.	Open loop V/f control of a three-phase induction motor.
5.	Closed loop V/f control of a three-phase induction motor.
6.	V/f control of induction motor using SINAMICS G120 module.
7.	Field oriented control of three phase induction motor.
8.	Sensorless Field oriented control of three-phase induction motor with MRAS based speed estimation.
9.	Direct Torque control of three-phase induction motor.
10.	Speed control of PMSM drive with three-phase inverter by using Sine-PWM in open loop.
11.	Speed control of PMSM drive with three-phase inverter by using Sine-PWM in closed loop.
12.	Speed control of PMSM drive with three-phase inverter by using Field Oriented Control.
13.	Speed control of BLDC drive with three-phase inverter in open loop.
14.	Speed control of BLDC drive with three-phase inverter in closed loop.
15.	Speed control of switched reluctance motor drive.

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (AUTONOMOUS) :: JNTUK,KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE – R2311XXYY	RENEWABLE ENERGY & BATTERY TECHNOLOGIES LABORATORY (Honors Course)	CATEGORY	L-T-P 0-0-3	CREDITS 1.5

Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Simulate PV cell/module models and analyze I–V & P–V performance under different configurations and conditions (temperature, irradiation, resistance, shading, tilt).	2
CO2	Implement and assess MPPT algorithms (P&O, INC) and evaluate PV efficiency under varying operating conditions.	3
CO3	Measure and analyze wind turbine parameters – cut-in speed, coefficient of performance, and power-speed characteristics.	4
CO4	Fabricate, test, and evaluate Li-ion battery packs for SoC, charge/discharge behavior, and DC fast charging.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	2	3	2	-	-	-	-	1	3	3	-
CO2	3	3	2	3	3	2	-	-	-	-	1	3	3	2
CO3	3	3	-	3	2	3	-	1	1	-	-	3	2	-
CO4	2	3	3	3	3	3	2	1	2	1	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

List of experiments

Any 10 of the following experiments are to be conducted:

S.No.	CONTENTS
1.	Simulate the Mathematical Model of a PV cell using Single Diode model and Two Diode model equivalent circuits.
2.	Simulate the performance curves (I-V & P-V) for PV modules connected in series and parallel and their variation with temperature and irradiation.
3.	Simulate the performance curves (I-V & P-V) for the effect of varying the series resistance on the fill factor of the PV cell.
4.	Simulate the Maximum Power Point tracking of PV module using P & O and INC Algorithms.
5.	Single PV module I-V and P-V characteristics with radiation and temperature changing effect.
6.	Effect of shading on PV Module.
7.	Analyze the effect of tilt angle on PV Module.
8.	Evaluation of cut-in speed of wind turbine.
9.	Evaluation of Coefficient of performance of wind turbine.
10.	Characteristics of turbine (power variation) with wind speed.
11.	Power curve of turbine with respect to the rotational speed of rotor at fix wind speeds.
12.	Grading and fabrication of Li-ion battery pack
13.	State of Charge (SoC) estimation of Li-ion battery pack
14.	Characteristics of charging and discharging of Li-ion battery pack
15.	DC fast charging of Li-ion battery pack