SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (AUTONOMOUS)
(Affiliated to JNTUK, Kakinada), (Recognized by AICTE, New Delhi)
UG Programmes CE,CSE,ECE,EEE,IT & ME are Accredited by NBA, Accredited by NAAC with A+
CHINNA AMIRAM (P.O):: BHIMAVARAM :: W.G.Dt., A.P., INDIA :: PIN: 534 204
Estd:1980

Regulation: R20	IV / IV - B.Tech. I - Semester

ELECTRICAL AND ELECTRONICS ENGINEERING

SCHEME OF INSTRUCTION & EXAMINATION
(With effect from 2020-21 admitted Batch onwards)

Course Code	Course Name	Category	Cr	L	T	P	Int. Marks	Ext. Marks	Total Marks
B20HS4102	Managerial Economics and Financial Accountancy	HS	3	3	0	0	30	70	100
#PE-III	Professional Elective -III	PE	3	3	0	0	30	70	100
#PE-IV	Professional Elective -IV	PE	3	3	0	0	30	70	100
#PE-V	Professional Elective -V	PE	3	3	0	0	30	70	100
#OE-III	Open Elective-III	OE	3	3	0	0	30	70	100
#OE-IV	Open Elective-IV	OE	3	3	0	0	30	70	100
B20EE4113	Electric Vehicles Laboratory **(Skill Oriented Course)**	SOC	2	1	0	2	--	50	50
B20EE4114	Industrial/Research Internship 2 Months	PR	3	--	--	--	--	50	50
	TOTAL		**23**	**19**	**0**	**2**	**180**	**520**	**700**

	Course Code	Course
#PE-III	B20EE4101	Electric Vehicles
	B20EE4102	Power System Operation and Control
	B20EE4103	Digital Design and Computer Architecture
	B20EE4104	MOOCS- 1
#PE-IV	B20EE4105	Energy Storage and Battery Management Systems
	B20EE4106	Smart Grid
	B20EE4107	ARM Microcontrollers
	B20EE4108	MOOCS - 2
#PE-V	B20EE4109	Power Electronics for Renewable Energy
	B20EE4110	Switchgear and Protection
	B20EE4111	Introduction to Unmanned Aerial Vehicles
	B20EE4112	MOOCS - 3
#OE-III & #OE-IV	Student has to study one Open Elective each from OE-III & IV offered by AIDS or CE or CSBS or CSE or ECE or IT or ME or S&H from the list enclosed.	

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20HS4102	HS	3	0	0	3	30	70	3 Hrs.

MANAGERIAL ECONOMICS AND FINANCIAL ACCOUNTANCY

(Common to ECE & EEE)

Course Objectives:

1.	To Study Managerial Economics and Demand Analysis
2.	To familiarize about the Concepts of Cost and Break-Even Analysis.
3.	To understand the nature of markets and to know the Pricing Policies
4.	To learn about accounting cycle and preparation of Financial Statements.
5.	To know the concept of Capital and sources of raising and Start-ups

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

S. No	Outcome	Knowledge Level
1.	Equip oneself with the knowledge of estimating the Demand and demand elasticities for a product.	K2
2.	Have knowledge of Cost and its types and ability to calculate BEP	K3
3.	Understand the nature of different markets	K2
4.	Understand Pricing Practices prevailing in today's business world	K2
5.	Prepare Financial Statements and know how to calculate Profit & Loss for a firm	K3
6.	Know Types of capital, their sources & start-ups	K2

SYLLABUS

UNIT-I (10 Hrs)	**Introduction to Managerial Economics and demand Analysis:** **Managerial Economics:** Definition of Economics & Classification of Economics (Micro & Macro), Meaning, Nature, & Scope of Managerial Economics. **Demand Analysis:** Concept of Demand, Determinants of Demand, Demand schedule, Demand curve, Law of Demand and its exceptions. Elasticity of Demand, Types of Elasticity of Demand. Importance of demand forecasting and its Methods.
UNIT-II (10 Hrs)	**Cost Analysis**: Importance of cost analysis, **Types of Cost-** Actual cost Vs Opportunity cost, Fixed cost Vs Variable cost, Explicit Vs Implicit cost, Historical cost Vs Replacement cost, Incremental cost Vs Sunk cost; **Elements of costs** – Material, Labour, Expenses; **Methods of costing** - Job costing, contract costing, Process costing, Batch costing, Unit costing, Service costing, Multiple costing. **Break-even analysis:** Determination of Breakeven point - Applications, Assumptions and Limitations of Break -even analysis (Theory only)
UNIT-III (10 Hrs)	**Introduction to Markets & Pricing Policies** **Market Structures:** Salient Features of Perfect Competition, Monopoly, Monopolistic competition, Oligopoly and Duopoly. **Pricing:** Importance of pricing and its meaning;

	Methods of Pricing: **Cost Based** -Full cost, Mark-up, Marginal &Break-even; **Demand Based** - Penetrating, Skimming; **Competition Based-** Going rate, Sealed Bid, Discount; **Internet Pricing** - Flat-rate, Usage sensitive
UNIT-IV (08 Hrs)	**Introduction to Financial Accounting:** Importance of Accounting - Double Entry System of Accounting - Types of Accounts - Journal, Ledger, Trail Balance, Trading Account, Profit and Loss Account and Balance Sheet (outlines only).
UNIT-V (12 Hrs)	**Capital & Start-ups:** Types of Capital - Fixed capital & Working Capital, Components of Working Capital, Factors influencing Working capital, Methods of Raising Finance. **Business Startups:** Meaning, Definition, Types, Benefits, Challenges, Limitations and Disadvantages of Startups in India; **Ideas-** Sources and Techniques of generating new ideas.

Text Books:	
1	A R Aryasri, Managerial Economics and Financial Analysis, TMH Pvt. Ltd, New Delhi
2	Dr. N.Appa Rao, Dr.P. Vijayakumar: Managerial Economics and Financial Analysis', Cengage Publications, New Delhi
3	Arya Kumar: "Entrepreneurship", Pearson Publishing House, New Delhi 2012
Reference Books:	
1	Dr.B.Kuberudu & T.V. Ramana : Managerial Economics and Financial anaysis, Himalaya Publishing House
2	Varshney R.L, K.L Maheswari, Managerial Economics, S. Chand & Company Ltd,
3	Shashi K. Gupta & R.K. Sharma Management Accounting, Kalyani Publishers
4	Maheswari S.N, An Introduction to Accountancy, Vikas Publishing House Pvt Ltd
5	VSP Rao, Kuratko: "Entrepreneurship", Cengage Learning, New Delhi

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20EE4101	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

ELECTRIC VEHICLES

(For EEE)

Course Objectives: Students will learn about

1.	The introductory concepts of EVs and dynamic modelling equations of EVs
2.	The various configurations of EVs and HEVs and power train components.
3.	Various Energy storage systems for EVs and understand their characteristics
4.	The Drive systems of EVs and their control
5.	About the charging technology in EVs.

Course Outcomes: Students will be able to

S. No	Outcome	Knowledge Level
1.	**Analyze** and understand dynamic modelling and design considerations of Electrical vehicles.	K4
2.	**Illustrate** the architecture of electric vehicles and power train components.	K3, K4
3.	**Evaluate** battery performance parameters for EVs and understand other energy storage methods for EVs.	K4
4.	**Analyze** and understand the electric drives using power electronic converters for EVs.	K4
5.	**Illustrate** the EV charger infrastructure.	K3, K4

SYLLABUS

UNIT-I (10Hrs)	**INTRODUCTION TO ELECTRIC VEHICLES AND MODELING** Introduction to Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), EV History, EV Advantages, overall Comparison of EV with Internal Combustion Engine vehicles, feasibility of EV, Vehicle Mechanics and Dynamics modelling-Roadway Fundamentals, Laws of Motion, Vehicle Load Forces, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion Power, Force-Velocity Characteristics, Maximum Gradeability, Velocity and Acceleration for Constant Tractive Force on Level Road, General Acceleration for Non-constant Tractive Force, Propulsion System Design, Design Considerations.
UNIT-II (10 Hrs)	**ARCHITECTURE OF EVS AND POWER TRAIN COMPONENTS** Architecture of EVs – 2-motors, 4 motors, and hub motor, Architecture of Hybrid EVs – Series, Parallel, Series parallel, complex, Plug-in Hybrid Electric Vehicles (PHEV), Architecture of Fuel cell EV, Power train components of EVs - EV Transmission Configurations, Transmission Components, Ideal Gearbox: Steady State Model, and EV Motor Sizing, Standard Drive Cycles.
UNIT-III (10 Hrs)	**ENERGY STORAGE FOR EV** Battery- Battery Basics, Different types, Lead Acid Batteries and Lithium Batteries (Li-

	ion, Li-Polymer), Battery Parameters, Battery Power, Battery modelling, Battery Failure and Protection, Battery Management system, Battery Pack Design, Lifetime and Sizing, Fuel cell, Hydrogen Storage Systems, Ultra capacitors, Flywheel.
UNIT-IV (10 Hrs)	**ELECTRIC VEHICLE MOTOR DRIVES** Electric Drive Components of EV, Permanent Magnet Synchronous Motor (PMSM) Drive - PMSM motor operation using simple controller, Brushless DC (BLDC) Motor Drive - BLDC motor operation, model, DC link current control, Comparison of PMSM and BLDC, Switched Reluctance Motor (SRM) Drive - SRM motor operation, Converter topologies for SRM.
UNIT-V (10 Hrs)	**EV CHARGING TECHNOLOGY** Overview of the EV battery charging system, Infrastructure Needed for Charging Electric Vehicles, Basic Requirements for Charging System, Charger Architectures-AC charger, DC Charger, Basics of Wireless charging – Static and Dynamic charging, EV Charging Standards and Technologies, Effects of EV load on the Grid, Introduction to V2G and V2V technologies.
Textbooks:	
1.	Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, Taylor & Francis Group, 2003.
2.	John G. Hayes and G.A. Goodarzi, "Electric Power train - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles" Wiley Publication, 1st edition, 2018
Reference Books:	
1.	James Larminie, John Lowry, "Electric Vehicle Technology Explained" Wiley publication, 2nd Edition, 2012.
2.	M. Ehsani, Y. Gao, and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC Press, 2010.

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20EE4102	PE	3	--	--	3	30	70	3 Hrs.

POWER SYSTEM OPERATION AND CONTROL

(For EEE)

Course Objectives: Students will learn about

1.	The stability enhancement methods, preventive & emergency control and Contingency Analysis
2.	The optimal dispatch of generation with and without losses
3.	The optimal scheduling of hydrothermal systems and unit commitment
4.	The load frequency control for single area system with and without controllers.
5.	The load frequency control for two area system with Tie-line bias, Economic dispatch control, automatic voltage control, generator constraints and governor dead band.

Course Outcomes: Students will be able to

S. No	Outcome	Knowledge Level
1.	**Explore** stability enhancement methods, preventive & emergency control and **analyze** contingency of power system.	K3, K4
2.	**Optimize** the economic load scheduling of Thermal power plants.	K4
3.	**Illustrate** the concepts of hydro thermal scheduling and unit commitment.	K3
4.	**Analyze** the frequency deviations of a single area power system	K4
5.	**Analyze** the Load frequency control of a two-area system with tie-line bias and **Illustrate** generator constraints, governor dead band and automatic voltage control.	K3,K4

SYLLABUS

UNIT-I (10Hrs)	**Introduction To Power System Operation & Control** Power system operating states, Equality and Inequality constraints, Concepts of preventive and emergency control, Coherent area dynamics, Stability enhancement methods, long term frequency dynamics, Average system frequency, Centre of inertia. Factors affecting the power system security, Contingency analysis, Linear sensitivity factors, Contingency selection.
UNIT-II (10 Hrs)	**Optimal System Operation** Introduction, Optimal operation of generators on a bus bar, Generator operating cost, Optimal generation without considering losses, Optimal generation scheduling using lamda iteration technique, Representation of transmission loss by B-coefficients, Derivation of transmission loss formula.
UNIT-III (10 Hrs)	**Hydro - Thermal Scheduling** Optimal scheduling of Hydrothermal System: Mathematical formulation – Solution of hydrothermal scheduling problem. **Optimal Unit Commitment**

	Need for unit commitment, Constraints in unit commitment, Cost function formulation, Solution methods, Priority ordering, Dynamic programming.
UNIT-IV (10 Hrs)	**Load Frequency Control-I** Introduction, Load frequency control (Single area case), Turbine speed governing system, Model of speed governing system, Turbine model, Generator load model, Complete block diagram representation of an isolated power system, Steady state analysis, Dynamic response, Control area concepts, Proportional plus integral control of single area.
UNIT-V (10 Hrs)	**Load Frequency Control-II** Two area load frequency control and its block diagram, Load Frequency Control of two area system uncontrolled case and tie line bias controlled case. Load frequency control and economic dispatch control. Automatic voltage control, Load frequency control with generation rate constraints, Speed Governor dead band and its effects on AGC.
Textbooks:	
1.	Modern Power System Analysis - by I.J.Nagrath &D. P.Kothari, Tata McGraw-Hill Publishing Company ltd, 2nd edition.
2.	Electrical Energy Systems Theory - by O.I. Elgerd, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.
Reference Books:	
1.	Power Generation, Operation and Control - by A.J. Wood and B.F. Wollenberg, John Wiley& sons Inc. 1984.
2.	Power System Analysis by Hadi Sadat, Third Edition, Tata McGraw Hill publication.

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20EE4103	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

DIGITAL DESIGN AND COMPUTER ARCHITECTURE

(For EEE)

Course Objectives: Student will learn about

1.	System Verilog hardware description language for digital system design.
2.	Thebuilding blocks used in digital systems.
3.	The architecture of a digital computer.
4.	The microarchitecture of a processor.
5.	Memory systems and Input/Output systems.

Course Outcomes: Student will be able to

S. No	Outcome	Knowledge Level
1.	**Acquire** the knowledge for the design of combinational, sequential logic circuits using system Verilog HDL.	K3
2.	**Explore** the arithmetic circuits, counters, shift registers, memory arrays and logic arrays.	K3
3.	**Illustrate** MIPS digital computerarchitecture in terms of instruction set, registers, instruction formats and x86 architecture.	K3
4.	**Explore**the single cycle, multicycle and pipeline microarchitectures for MIPS processor.	K4
5.	**Explore** different memories, input output devices and principles of interfacing I/O devices to a processor.	K3

SYLLABUS

UNIT-I (10Hrs)	**Hardware Description Language (System Verilog)** Introduction-Modules-Language Origins-Combinational Logic-Bitwise Operation-Reduction Operation-Conditional Assignment-Internal Variables-Precedence-Numbers-Z's and X's –Bit Swizzling-Delays-Structural Modelling-Sequential Logic-Registers-Resettable Registers-Enabled registers- Multiple registers- Latches-More combinational Logic-Case statement-If statement- Truth table with Don't Cares-Blocking and nonblocking assignments- Finite state Machine-Data types.
UNIT-II (10 Hrs)	**Digital Building Blocks** Arithmetic circuits -Addition-Subtraction-comparators-ALU-shifters and rotators-Multiplication-Division-Number systems -Fixed point number system-Floating point number system-Sequential building block- Counters-Shift registers-Memory arrays -Dynamic Random Access Memory (DRAM)- Static Random-Access memory-(SRAM)-Areas and delays-Read only memory-Logic using memory arrays-Logic arrays -Programmable logic arrays-Field programmable arrays-array implementation.

UNIT-III (10 Hrs)	**Architecture** MIPS architecture -Assembly language-Instructions-Operands- Machine language-R type instructions-I type instructions-J type instructions instruction-Interpreting machine language code-The power of stored program-Programming-arithmetic/logical instructions-branching-conditional statement- getting loopy-arrays-functional calls -addressing modes-The memory map-translating and starting a program- odds and ends- Real world perspective: x86 architecture-x86 registers-x86 operands-status flags-x86 instructions-x86 instruction encoding.
UNIT-IV (10 Hrs)	**Micro architecture** Introduction- Architectural state and instruction set-Design procedure-Microarchitecture-Performance analysis-Single cycle processor-single cycle data path-Single cycle control-More instructions-Performance analysis-Multicycle processor- Multicycle data path-Multicycle control-Performance analysis-Pipelined Data path-Pipelined control-Hazards-Mpre instructions-Performance analysis- spatial and temporal parallelism, latency and throughput calculations.
UNIT-V (10 Hrs)	**Memory Systems And Input Output Systems** Introduction-Memory system analysis-Caches-Virtual memory -Address translation-Page table -Translation look a side buffer-Memory protection -Replacement policies -Multilevel page table - Memory mapped I/O-Embedded I/O systems-PC I/O systems.
Textbooks:	
1.	Digital Design and Computer Architecture, ARM Edition, Sarah L. Harris & David Money Harris, Morgan Kaufmann Publishers, 2016 edition.
Reference Books:	
1.	Computer Organization and Design ARM Edition, The Hardware Software Interface, David A Patterson and John L. Hennessy, 2016
2.	Computer Architecture: A Quantitative Approach, David A Patterson and John L. Hennessy Sixth Edition, 2017
e-Resources	
1.	Digital Design and Computer Architecture Course by Prof. Onur Mutlu at ETH Zurich, https://safari.ethz.ch/digitaltechnik/spring2022/doku.php
2.	ARM Graphical Micro-Architecture Simulator, https://github.com/arm-university/Graphical-Micro-Architecture-Simulator

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20EE4105	PE	3	--	--	3	30	70	3 Hrs.

ENERGY STORAGE AND BATTERY MANAGEMENT SYSTEMS

(For EEE)

Course Objectives: Students will learn about

1.	The Energy storage systemsand its techno economical aspects
2.	The classification of Energy Storage Systems (ESS) and their assessment
3.	The battery types and their principles of operation
4.	The battery parameters, components and functionality of Battery Management System (BMS)
5.	The measurement, protection, balancing, thermal management and safety precautions of BMS

Course Outcomes: Students will be able to

S. No	Outcome	Knowledge Level
1.	**Evaluate** the techno-economic characteristics of Energy Storage technologies	K3
2.	**Explore**energy storage systems, assessment and comparison	K3
3.	**Explore** different types of batteries, battery terminology and modelling	K3
4.	**Illustrate** the battery parameters and BMS functionality, technology and topology	K3
5.	**Explore** the measurement, protection, thermal management, communication and safety aspects of BMS	K3

SYLLABUS

UNIT-I (10Hrs)	**TECHNO-ECONOMIC ANALYSIS** Introduction - Electrical Energy Storage (EES)-Definition-Role, Energy storage components, Applications and Technical benefits of energy storage systems, Financial Benefits of energy storage systems, Techno economic characteristics of energy storage systems.
UNIT-II (10 Hrs)	**ENERGY STORAGE SYSTEMS** Classification – Pumped Hydro storage, batteries energy storage, flow batteries energy storage, flywheel energy storage, super capacitor energy storage, Super conducting magnetic energy storage, Fuel cell Hydrogen energy storage, thermal energy storage, compressed air energy storage, assessment and comparison of energy storage technologies.
UNIT-III (10 Hrs)	**ELECTRO CHEMICAL STORAGE** Standard Batteries- Lead Acid- Valve Regulated Lead Acid (VRLA) - Ni-Cd, Modern Batteries- Ni-MH – Li-Ion, Flow Batteries – Br2 Zn-Vanadium Redox, Battery composition, construction, Principle of operation, Types, Advantagesand disadvantages of the above batteries, Battery Terminology, characteristics, Impedance Models - Warburg impedance.

UNIT-IV (10 Hrs)	**BATTERY MANAGEMENT SYSTEMS-I** Battery parameters - Capacities, Depth of Discharge (DOD) -State of Charge (SOC) – State of Estimation (SOE) – State of Health (SOH) – State of Function (SOF), BMS - Functionality – Constant Current Constant Voltage (CCCV) chargers, Regulators, Meters, Monitors, Balancers and Protectors. Technology-Analog, Digital and their comparison. Topology - Centralized, Modular, Master-Slave, Distributed & their comparison
UNIT-V (10 Hrs)	**BATTERY MANAGEMENT SYSTEMS-II** Measurement of Voltage, Temperature & Current, Protection, Balancing & Thermal Management, Evaluation, External Communication, Safety & Precautions.

Textbooks:	
1.	Energy Storage Technologies and Applications, Ahmed Faheem Zobaa, InTech Publishers, 2013.
2.	Lithium Batteries and Other Electrochemical Storage Systems, Christian Glaize, Sylvie Geniès, ISTE & John Wiley, 2013.
3.	Davide Andrea, Battery Management Systems for Large Lithium-Ion Battery Packs, Artech, 2010.
Reference Books:	
1.	Jiang, J. and Zhang, C., Fundamentals and Applications of Lithium-ion Batteries in Electric Drive Vehicles, 2015, Wiley Publications.
2.	Angel Kirchev, Battery Management and Battery Diagnostics, Ch.20 of Electrochemical Energy Storage for Renewable Sources and Grid Balancing, Elsevier, 2015.
e-Resources	
1.	https://www.coursera.org/learn/battery-management-systems
2.	https://nptel.ac.in/courses/108106170

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20EE4106	PE	3	--	--	3	30	70	3 Hrs.

SMART GRID

(For EEE)

Course Objectives: Students will learn about

1.	The concept of smart grid and its advantages over conventional grid
2.	Different smart grid technologies and wide area monitoring systems
3.	The phasor measurement unit and intelligent electronic devices
4.	The micro grid concept and different storage systems
5.	The advancedmetering infrastructure, communication technologies and cyber security in smart grids

Course Outcomes: Students will be able to

S. No	Outcome	Knowledge Level
1.	**Explore** the evolution and functions of the smart grid.	K3
2.	**Illustrate** the technologies used in smart grid.	K3
3.	**Illustrate** the functions and use of PMUs and IEDs.	K3
4.	**Explore** the conceptof micro grid and integration of renewable energy systems.	K3
5.	**Explore** modern communication technologies and cyber security issues in smart grids	K3,K4

SYLLABUS

UNIT-I (10Hrs)	**Introduction To Smart Grid** Evolution of Electric Grid, Smart Grid-Definition, Concept, Need of Smart Grid, Functions of Smart Grid, Opportunities of Smart Grid, Challenges in Implementation of Smart Grid, Difference between Conventional and Smart Grid, Concept of Resilience and self-healing**.**
UNIT-II (10 Hrs)	**Smart Grid Technologies and Wams** Introduction to Smart Grid Architecture, Components of Smart Grid, Remote Terminal Units (RTU)-Architecture, RTU in Distribution System, Supervisory control and Data Acquisition(SCADA),Distribution Management system(DMS),DMS Functional Layers, Smart Substation, Wide Area Monitoring System(WAMS).Comparison between SCADA and WAMS.
UNIT-III (10 Hrs)	**Phasor Measurement Units** Concept of Phasor Measurement, Phasor Measurement Unit (PMU)-Features – Fundamentals, Global Positioning Satellite (GPS) Systems, Synchro phasor –Definition-Measurements, Applications of PMUs in Power Systems. Intelligent Electronic Devices (IED)-Functions-Advantages

UNIT-IV (10 Hrs)	**Micro-Grid** Concept of Micro grid, need & applications of Micro grid, Structure of Micro grid, Control of micro grid-Master slave mode, Peer-Peer mode and Combined mode, basic concept of fuel cell, Pumped hydro, Compressed air storage, Integration of Renewable Energy Sources.
UNIT-V (10 Hrs)	**Smart Metering And Communication Technologies** Introduction, Smart Meter Systems-Benefits, Advanced Metering Infrastructure (AMI), Local Area Network (LAN), Home Area Network (HAN), Wide Area Network (WAN), Broadband Over Power Lines (BPL)-Objectives & Features, Cyber security for smart grids

Textbooks:	
1.	Bharat Modi, Anu Prakash, Yogesh Kumar, "Fundamentals of Smart Grid Technology",Katson books,2016.
2.	Harsh Tanwar, Bhavishya Mittal, Bhawana Chouhan,"Smart Grid Technology", Genius Publications,2016.
Reference Books:	
1.	Stuart Borlase, "Smart Grid: Infrastructure, Technology and Solutions", CRC Press, 2012.
2.	Li Fusheng,Li Ruisheng, Zhou Fengquan "Microgrid Technology and Engineering Application", Elsevier,2016.
e-Resources	
1.	https://nptel.ac.in/courses/108107113
2.	https://archive.nptel.ac.in/courses/117/107/117107148

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20EE4107	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

ARM MICROCONTROLLERS

(For EEE)

Course Objectives: Students will learn about

1.	The architecture of ARM Microcontroller.
2.	The instruction set of ARM Microcontroller.
3.	The THUMB instruction set.
4.	The handling of exception and interrupts.
5.	The interfacing of peripheral devices to ARM Microcontroller.

Course Outcomes: Students will be able to

S. No	Outcome	Knowledge Level
1.	**Illustrate** thearchitecture of Cortex-M Microcontroller	K3
2.	**Make use of** the instruction set of ARM Microcontroller	K3
3.	**Make use of** the THUMB instruction set	K3
4.	**Demonstrate** the exceptions and interrupt schemes related to microcontrollers	K4
5.	**Interface** the peripheralsto microcontrollers	K4

SYLLABUS

UNIT-I (10Hrs)	**Introduction To Cortex-M Microcontroller** The ARM Cortex-M Processor Architecture-ARM Instruction Set Architecture, Register Set, Processor Operating Modes, Interrupts and Processor Reset Sequence, Pipelined Architecture and Data Path, Memory Address Map.
UNIT-II (10 Hrs)	**The Arm Microcontroller Instruction Set** Introduction, Data processing instructions, Load - Store instruction, Software interrupt instructions, Program status register instructions, Loading constants, Conditional Execution.
UNIT-III (10 Hrs)	**The Thumb Instruction Set** Introduction, THUMB register usage, ARM – THUMB interworking, other branch instructions, Data processing instructions, Stack instructions, Software interrupt instructions.
UNIT-IV (10 Hrs)	**Exceptions And Interrupts** Nested Vectored Interrupt Controller, Exception Types, Exception and Interrupt Priority, Interrupt States, Interrupt Configuration-Basic Interrupt Configuration, Interrupt Masking, Setting Up Interrupt Vector Table, Configuring an Interrupt, Handling of Exceptions or Interrupts-Register Stacking in Response to Interrupt Occurrence, Updating Registers, Exception Exit or Return, Interrupt Latency.

UNIT-V (10 Hrs)	**Serial Communication Interfaces** UARTs, I2C Interface, Serial Peripheral Interface (SPI), Controller Area Network (CAN) Interface.
Textbooks:	
1.	ARM® Microprocessor Systems, Cortex®-M Architecture, Programming, and Interfacing, Muhammad Tahir and Kashif Javed, CRC Press Taylor & Francis Group.
2.	ARM System Developer's guide –Andrew N. SLOSS, ELSEVIER Publications,ISBN 978-81-8147-646-3, 2016.
3.	Fundamentals of System-on-Chip Design on Arm Cortex-M Microcontrollers, René Beuchat, Florian Depraz, Andrea Guerrieri, Sahand Kashani, Arm Education Media.
Reference Books:	
1.	ARM Assembly Language – William Hohl, CRC Press, ISBN:978-81-89643-04-1
2.	Embedded Microcomputer Systems- Real Time Interfacing, Third Edition, Jonathan W. Valvano, University of Texas at Austin
e-Resources	
1.	www.Arm.com
2.	ARM University Program- https://www.arm.com/resources/education/education-kits/introduction-to-soc.

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20EE4109	PE	3	--	--	3	30	70	3 Hrs.

POWER ELECTRONICS FOR RENEWABLE ENERGY

(For EEE)

Course Objectives: Students will learn about

1.	The importance of renewable energy sources and need of Power Electronics for their use.
2.	The Power electronic topologies in PV systems and their importance.
3.	The Power electronics for Type - 3 and Type - 4 wind energy system.
4.	The basic configurations of power conversion system for Fuel cells.
5.	The requirements and issues of grid integration of renewables.

Course Outcomes: Students will be able to

S. No	Outcome	Knowledge Level
1.	**Identify** the use of power electronics to renewable energy sources.	K3
2.	**Apply** the fundamentals of Power Electronics to enhance the PV system efficiency	K3
3.	**Choose** power electronic topologies for Type – 3 and Type – 4 wind energy systems.	K3
4.	**Apply** DC – DC converters for fuel cells	K3
5.	**Explore** the grid integration issues of PV and Wind energy systems	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction To Renewable Energy** Classification of Energy Sources – Importance of renewable energy sources - impacts of renewable energy generation on environment - Qualitative study of renewable energy resources: Photovoltaic Systems-Wind Energy Systems-Fuel Cells – Proton Exchange Membrane Fuel Cell (PEMFC) - Renewable Energy sources and their Interconnections-Attributes of power electronics for renewable energy systems.
UNIT-II (10 Hrs)	**Photovoltaic Power Electronics** PV cell- PV modules- Strings-Array- Mismatch losses-PV system configurations- Power electronic topologies in PV Standalone systems (Single stage and two stage)- Design of photovoltaic array for single and two stage standalone system based on the Sine PWM technique for inverter- MPPT operation with various DC-DC Converters(non-isolated)-Importance of inverter for two stage and single stage system-advantages and disadvantages of single stage and two stage systems.
UNIT-III (10 Hrs)	**Wind Power Electronics** Power flow in wind turbine, Power Characteristics of wind turbine,Control of wind turbines, Wind generators, Principle of operation PMSG, Power electronics for Type-III and IV systems, Back-to-Back PWM VSI for Full Converter using DFIG and PMSM.

UNIT-IV (10 Hrs)	**Fuel Cell Power Electronics** Power Electronic Converter for Fuel Cell, Basic configurations of power conversion system (PCS) for FC, DC-DC converters: non-isolated, isolated (flyback converter), Bidirectional converters.
UNIT-V (10 Hrs)	**Power Electronics For Grid Integration** Power electronics requirement forGrid connected system, Grid connected and Islanding mode, Grid synchronization, PLLs(basic PLL operation),Grid connection Issues, Grid control strategy for PV and Wind systems (dq current control of voltage source converters)

Textbooks:	
1.	Sudipta Chakraborty, Marcelo G. Simões, William E. Kramer, "Power Electronics for Renewable and Distributed Energy Systems" Springer 2013.
2.	Mukund R Patel, "Wind and Solar Power Systems", CRC Press, 1stEdition, 1999.
3.	SN Bhadra, D. Kastha, S. Banerjee, "wind electrical systems", OXFORD higher education, 2018
Reference Books:	
1.	Solar Photovoltaics, Fundamentals, Technologies and Applications, Chetan Singh Solanki, Third Edition
2.	Power Electronics: Circuits Devices and Applications – M.H. Rashid,Prentice Hall of India, 4thedition.

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20EE4110	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

SWITCHGEAR AND PROTECTION

(For EEE)

Course Objectives: Students will learn about

1.	The need for protection and basic principles of arc interruption.
2.	The principle of operation, constructional features and testing of circuit breakers.
3.	The principle of operation and protective relays.
4.	The protection of power system components.
5.	The basics of numerical relays and substations.

Course Outcomes: Students will be able to

S. No	Outcome	Knowledge Level
1.	**Illustrate** the need for protection, rating of circuit breakers and **analyzing** the arcing phenomenon.	K3, K4
2.	**Explore** different circuit breakers and their testing.	K3
3.	**Illustrate** the behaviour of different types of electromagnetic relays and **compute** the operating times by using time-current characteristics.	K3, K4
4.	**Apply** electromagnetic relays to alternator, transformer, feeder and busbar protection and **illustrate**surge protectors.	K3
5.	**Explore** protection with numerical relays and **illustrate** substation components.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Introduction To Protection & Circuit Breakers** Need for protective systems, Nature and causes of faults, Types and effects of faults, Essential qualities of protection, Switchgear Equipment-Isolating Switches. Formation of arc, Methods of arc extinction, Restriking voltage, Recovery voltage, Rate of Rise of Restriking Voltage (RRRV), Resistance switching, Current chopping, Ratings of circuit breakers.
UNIT-II (10 Hrs)	**Types Of Circuit Breakers And Testing** Principle of operation of circuit breakers, Classification of circuit breakers, Construction and working of Air Blast Circuit Breakers, Minimum Oil Circuit Breaker (MOCB), Puffer type SF-6 Circuit Breakers and Auto reclosure, Testing procedure and Indirect testing of Circuit Breakers.
UNIT-III (10 Hrs)	**Protective Relays** Types of relays, Classification of protective Schemes, Primary and Back-up protection, Basic relay terminology. Time–Current characteristics, Calculation of relay operating time-Simple problems, Principle of operation & construction of induction type over current relay, Directional over-current relay, Differential relays (Current balanced protection) & percentage differential relays. Universal torque equation, Distance relays – Impedance, Reactance and Mho relays **[only basics].**

UNIT-IV (10 Hrs)	**Apparatus Protection** Percentage differential protection and Protection against stator inter-turn faults ofAlternators, Percentage differential protection and Protection against magnetizing inrush current of Transformers, Protection of Single and parallel feeders, Bus-Bar Protection, Protection against Surges.
UNIT-V (10 Hrs)	**Numerical Relaying And Sub - Stations** Numerical Protection - Block diagram of a typical numerical relay, Advantages and disadvantages of numerical relays, Block diagrams of Numerical over current, distance, differential relays. Introduction to substation, Classification of substations, Substation equipment, key diagram of 11KV/400V indoor substation, Substation earthing.
Text Books:	
1.	Power System Protection and Switchgear by Badri Ram and D. N. Vishwakarma, Tata McGraw-Hill Education, Second Edition, 2017.
2.	Switchgear and Protection by J.B Gupta, S.K Kataria& sons, 3rd edition, 2013, reprint 2023.
Reference Books:	
1.	Principles of Power System by V.K Mehta and Rohit Mehta, S. Chand publication, 3rd edition,2005.
2.	Protection and Switchgear by Bhavesh R. Bhalja R. P. Maheshwari Nilesh Chothani, Oxford University Press, Second Edition, 2018.

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20EE4111	PE	3	--	--	3	30	70	3 Hrs.

INTRODUCTION TO UNMANNED AERIAL VEHICLES

(For EEE)

Course Objectives: Students will learn about

1.	The overview of UAVs
2.	The components and classification of UAVs
3.	The concepts of Autonomous UAVs & Communication Infrastructure
4.	The UAV Data Collection and Regulatory systems
5.	The applications of UAVs

Course Outcomes: Students will be able to

S. No	Outcome	Knowledge Level
1.	**Explore** the history, characteristics and working of UAVs.	K3
2.	**Identify** various components of UAVs and **illustrate** their purpose.	K3
3.	**Illustrate** the Autonomous UAVs and Communication Infrastructure.	K3
4.	**Explore** UAVs Data Collection and Regulatory systems.	K3
5.	**Explore** the applications of UAV technology	K3

SYLLABUS

UNIT-I (10Hrs)	**OVERVIEW OF UNMANNED AERIAL VEHICLES** Introduction, Historical Developments, Uses of UAVs, Technical Terms, Characteristics of UAVs–Photogrammetry UAVs, LiDAR UAVs, Working of a UAV–Altitude, Vertical and Oblique Photographs, Positioning, Advantages and Disadvantages of UAVs
UNIT-II (10 Hrs)	**COMPONENTS OF UAVS** Basic Aerodynamics–Lift, Drag, Thrust, Stability and Control of UAV–Roll, Pitch, Yaw, Throttle, UAVs Classification–Operation & Use, Size, Altitude, Wings type. Transmitter, Receiver, Body Frame, Motors, Electronic Speed Controller (ESC), Propellers, Flight Controller, The Payloads, Gimbals and Tilt Control, Sensors, Global Positioning System (GPS), Remote Sensing Sensors, Battery, Ground Control Station (GCS).
UNIT-III (10 Hrs)	**AUTONOMOUS UAVS & COMMUNICATION INFRASTRUCTURE** The Automatic and Autonomous UAVs, Architecture of an Autonomous System, The Concept of Autonomy, Various Measures of UAV Autonomy- Fully Autonomous Operations, Semi-autonomous Operations, Fully Human Operated, UAV Communication System, Types of Communication– Wireless Sensor Network (WSN) System, Free Space Optical (FSO) Approach.
UNIT-IV (10 Hrs)	**UAV DATA COLLECTION AND REGULATORY SYSTEMS** Data Products– Aerial Remote Sensing Data, LiDAR Data, Issues of Concern for UAVs–

	Air Traffic Control, Wi-Fi/Bluetooth Security Issues, Privacy Issues, Moral and Ethical Issues, Safety Issues, Legal Issues, Aviation Regulations—India.
UNIT-V (10 Hrs)	**APPLICATIONS OF UAVS** Overview of applications, Power sector, Construction sector, Agriculture, Surveying and Mapping, Industrial Applications, Inspection and Monitoring, Traffic monitoring and management, Search and rescue, Smart Cities.
Textbooks:	
1.	Garg PK, "Unmanned aerial vehicles: An introduction", Mercury Learning and Information; 2021
2.	Garvit Pandya, "Basics of Unmanned Aerial Vehicles Time to start working on UAV Technology", 2021.
Reference Books:	
1.	Avtar R, Watanabe T, editors. Unmanned aerial vehicle: Applications in agriculture and environment. Springer International Publishing; 2020.

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20EE4113	SOC	1	--	2	2	--	50	3 Hrs.

ELECTRIC VEHICLES LABORATORY
(Skill Oriented Course)

(For EEE)

Course Objectives: Students will learn to conduct experiment on

1.	The basic components of EV.
2.	Different types of converters and PWM techniques used for EV.
3.	Modes of Charging in EVs.
4.	Battery performance in EVs.
5.	Speed control of Induction motor / BLDC motor.

Course Outcomes: Students will be able to experimentally

S. No	Outcome	Knowledge Level
1	**Analyze** the performance of electric vehicles (EVs).	K4
2	**Explore** the working ofdifferent types of converters used for EVs.	K4
3	**Analyze** the performance of EV charging system.	K4
4	**Evaluate**the battery performance of EVs	K4
5	**Explore** the speed control of Induction motor / BLDC motor.	K4

SYLLABUS

	Simulation Experiments
1	Simulation of Buck, Boost and Buck-Boost converter
2	Simulation of bidirectional power converter for EV vehicle.
3	Simulation of gating pulses for inverter using sine PWM pulse generation (PD, POD, APOD).
4	Simulation of EV charging using PWM voltage source inverter.
5	Simulation of EV battery system (SOC /SOH).
6	Simulation of Open loop speed control of induction motor / BLDC motor.
	Hardware Experiments
7	E-Vehicle two-wheeler complete set up.
8	Bidirectional power converter for electric vehicles.
9	PWM pulse generation using ARM Cortex-M4 Microcontroller.
10	Study of EV Charger using PWM Voltage Source Converter.
11	Estimation of SOC/SOH of EV Battery Systems.
12	Open loop speed control of three phase induction motor (V/f control).
13	Performance verification of speed control of BLDC motor / EV charging station.

Reference Books:

1	John G. Hayes and A. Goodarzi, "Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles" Wiley Publication, 1st edition, 2018.
2	Y. Gao, S. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press, 2005.

Regulation: R20	IV / IV - B.Tech. II - Semester

ELECTRICAL AND ELECTRONICS ENGINEERING

SCHEME OF INSTRUCTION & EXAMINATION
(With effect from 2020-21 admitted Batch onwards)

Course Code	Course Name	Category	Cr	L	T	P	Int. Marks	Ext. Marks	Total Marks
B20EE4201	Project Work (Project work, seminar and internship in industry)	PR	8	0	0	16	60	140	200
	TOTAL		**8**	**0**	**0**	**16**	**60**	**140**	**200**

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20EE4201	PR	--	--	16	8	60	140	3 Hrs.

PROJECT WORK

(For EEE)

Course Objectives:

1	To Survey and study the published literature on the selected problem and identify the objective.
2	Identify the necessary tools and components in order to initiate the project.
3	The Design, build and test a system with hardware /software.
4	To Develop a prototype/model of the project work.
5	To Prepare documentation in standard format and communicate technical concepts

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

S.No.	Outcome	Knowledge Level
1	**Identify** the objectives from the gaps through literature survey and propose solution for solving objective	K4
2	**Identify** the required tools & components to initiate the project/process at the laboratory level.	K4
3	**Design** solutions to complex electrical engineering problems utilizing software/hardware approach.	K5
4	**Develop** the project within the available resources, in stipulated time and with ethical values & social responsibility.	K5
5	**Write** the documentation in standard format and communicate proposed solution orally in a professional manner enhancing self-study and lifelong learning abilities.	K6

*The object of Project Work is to enable the student to take up investigative study in the broad field of Electrical and Electronics Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or a group of students, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) in R&D work.

The assignment to normally include:

a) Survey and study of published literature on the assigned topic.

b) Working out a preliminary approach to the problem relating to the assigned topic.

c) Conducting preliminary Analysis/Modeling/Simulation/Experiment/Design/ Feasibility.

d) Preparing a written report on the study conducted for presentation to the department.

e) Final Seminar, as oral Presentation before a departmental committee.