KAMARAJ COLLEGE OF ENGINEERING & TECHNOLOGY

(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)

S.P.G.Chidambara Nadar - C.Nagammal Campus

S.P.G.C. Nagar, K.Vellakulam – 625 701 (Near VIRUDHUNAGAR).

B.E. ELECTRCIAL AND ELECTRONICS ENGINEERING

REGULATIONS – 2021

AUTONOMOUS SYLLABUS

CHOICE BASED CREDIT SYSTEM

VII TO VIII SEMESTER CURRICULUM AND SYLLABI

VISION:

To make the Department of Electrical and Electronics Engineering of this Institution the unique of its kind in the field of Research and Development activities in this part of the world.

MISSION:

Department of Electrical and Electronics Engineering is committed to impart highly innovative and technical knowledge in the field of Electrical and Electronics Engineering to the urban and unreachable rural student folks through Total Quality Education

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1: **Technical Knowledge:** To provide basic knowledge in Physics, Chemistry, Mathematics and necessary foundation in various concepts of Electrical and Electronics Engineering

PEO 2: **Problem Solving:** To impart training to enable the students to envisage the real time problems related to the field of Electrical and Electronics Engineering and allied areas faced by the Industries so as to model, analyze and provide appropriate solutions.

PEO 3: **Personality Development:** To provide an academic environment for the students to develop team spirit, leadership qualities, communication skills and soft skills.

PEO 4: **Life Long Learning:** To motivate students to prepare for competitive examinations enabling them to pursue higher studies, thereby, promoting Research and Development activities.

PROGRAM OUTCOMES:

After going through the four years of study, the Electrical and Electronics Engineering graduates will have the ability to

POs	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

POs	Graduate Attribute	Programme Outcome
7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1 : Ability to design and solve engineering problems by applying the fundamental knowledge of Engineering Mathematics, Basic Sciences, Electrical and Electronics Engineering.

PSO2 : Ability to understand the recent technological developments in Electrical & Electronics Engineering and develop products / software to cater the Societal & Industrial needs.

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REGULATIONS - 2021

CHOICE BASED CREDIT SYSTEM

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

VII TO VIII SEMESTER CURRICULUM

SEMESTER VII

S. No.	Course Code	Course Name	Category	Contact Periods	Credits			
					L	T	P	C
Theory								
1.	EE2401	Renewable Energy Systems	PC	3	3	0	0	3
2.	GE2401	Universal Human Values and Ethics	HS	2	2	0	0	2
3.		Management Elective	HS	3	3	0	0	3
4.		Open Elective II*	OE	4	2	0	2	3
5.		Open Elective III*	OE	3	3	0	0	3
6.		Open Elective IV*	OE	3	3	0	0	3
Practical								
7.	EE2402	Renewable Energy Systems Laboratory	PC	4	0	0	4	2
			Total	**22**	**16**	**0**	**6**	**19**

***Open Elective Shall be chosen from the list of open electives offered by other Programmes**

SEMESTER VIII

S. No.	Course Code	Course Name	Category	Contact Periods	Credits			
					L	T	P	C
Practical								
1.	EE2451	Project Work	EM	20	0	0	20	10
			Total	**20**	**0**	**0**	**20**	**10**

MANAGEMENT ELECTIVE

S. No.	Course Code	Course Name	Category	Contact Periods	Credits			
					L	T	P	C
Theory								
1.	GE2491	Principles of Management	HS	3	3	0	0	3
2.	GE2492	Total Quality Management	HS	3	3	0	0	3

OPEN ELECTIVE II

(Offered to CSE, ADS, IT and ECE)

S. No.	Course Code	Course Name	Category	Contact Periods	Credits			
					L	T	P	C
Theory								
1.	OEE701	Disaster Management	OE	3	3	0	0	3

OPEN ELECTIVE III

(Offered to All Department except EEE)

S. No.	Course Code	Course Name	Category	Contact Periods	Credits			
					L	T	P	C
Theory								
1.	OEE702	Battery and Energy Storage Technologies	OE	3	3	0	0	3

OPEN ELECTIVE IV

(Offered to All Department except EEE)

S. No.	Course Code	Course Name	Category	Contact Periods	Credits			
					L	T	P	C
Theory								
1.	OEE703	Energy Conservation and Management	OE	3	3	0	0	3

Course Code	Course Name	L	T	P	C
EE2401	RENEWABLE ENERGY SYSTEMS	3	0	0	3

Category: Professional core

a. Preamble

This course introduces the recent technologies for effective utilization of renewable energy sources and various concepts behind renewable energy conversion process.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the importance of various renewable energy sources and its existing scenario in the world.	K2
CO2	Explain the different configurations of the wind energy conversion systems	K2
CO3	Interpret the working and applications of solar energy systems	K2
CO4	Develop a stand-alone photo voltaic system with MPPT algorithm	K3
CO5	Explain the concepts of Ocean and modern energy sources such as fuel cell, batteries etc.	K2

c. Course Syllabus **Total : 45 Periods**

RENEWABLE ENERGY (RE) SOURCES **9**

Environmental consequences of fossil fuel use, Importance of renewable sources of energy, Sustainable Design and development, Types of RE sources(solar, wind, biomass, ocean and geothermal), Limitations of RE sources, Present Indian and international energy scenario of conventional and RE sources.

WIND ENERGY **9**

Basics of wind energy- Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine-Power in the Wind - Types of Wind Power Plants(WPPs) - Components of WPPs-Working of WPPs(DFIG,PMSG & SCIG based WPPs)- Siting of WPPs-Grid Connected and Stand-alone WPPs.

SOLAR THERMAL ENRGY **9**

Solar Radiation, Radiation Measurement, Solar Thermal Power Plant, Central Receiver Power Plants, Solar Ponds- Thermal Energy storage system with PCM.

SOLAR PV SYSTEM **9**

Solar Photovoltaic systems: Basic Principle of SPV conversion - Types of PV Systems - Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array ,PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking (P&O and Incrementalconductance algorithm), Applications of solar energy: solar pumping ,Solar cooking, Solar street light.

OCEAN & MODERN ENERGY SOURCES **9**

Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC)- Hydrogen Production and Storage- Fuel cell : Principle of working- various types - construction and applications. Energy Storage System- Hybrid Energy Systems..

d. Activities

Students shall be exposed to the modern technologies incorporated in Renewable Energy system

e. Learning Resources

Text Books

1. Khan, B. H. *Non-conventional energy resources*. Tata McGraw-Hill Education, 2006.
2. Masters, Gilbert M. Renewable and efficient electric power systems. John Wiley & Sons, 2013.

Reference Books

1. Earnest, Joshua, and Tore Wizelius. *Wind power plants and project development*. PHI Learning Pvt. Ltd., 2011.
2. Kothari, Dwarkadas Pralhaddas, Rakesh Ranjan, and K. C. Singal. *Renewable energy sources and emerging technologies,* PHI Learning Pvt. Ltd., 2021.
3. Scott Grinnell, "*Renewable Energy & Sustainable Design*", CENGAGE Learning, USA, 2016.
4. Bradley A. Striebig, Adebayo A. Ogundipe and Maria Papadakis, *Engineering Applications in Sustainable Design and Development*", Cengage Learning India Private Limited, Delhi, 2016.
5. Solanki, Chetan Singh. *Solar photovoltaics: fundamentals, technologies and applications*. Phi learning pvt. Ltd., 2015.

Course Code	Course Name	L	T	P	C
GE2401	UNIVERSAL HUMAN VALUES AND ETHICS	2	0	0	2

Category: Science and Humanities

Preamble

This course is intended to provide much-needed orientational input in value education to the young, enquiring minds.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Define the essential complementarily between 'VALUES' and 'SKILLS' for ensuring happiness and prosperity.	K2
CO2	Explore Human being as the Co-existence of the Self and the Body.	K3
CO3	Develop holistic perspective towards value-based living in a natural way.	K3
CO4	Explain the interconnectedness of the four orders of Nature and existence.	K2
CO5	Comprehend the ethics of human values, Humanistic education and constitution, strategies of value-based life and profession.	K2

c. Course Syllabus **Total : 30 Periods**

INTRODUCTION TO VALUE EDUCATION **6**

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity - the Basic Human Aspirations, Happiness and Prosperity - Current Scenario, Method to Fulfil the Basic Human Aspirations.

HARMONY IN THE HUMAN BEING **6**

Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.

HARMONY IN THE FAMILY AND SOCIETY **6**

Harmony in the Family - the Basic Unit of Human Interaction, 'Trust' - the Foundational Value in Relationship, 'Respect' - as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order.

HARMONY IN THE NATURE/EXISTENCE **6**

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence.

IMPLICATIONS OF THE HOLISTIC UNDERSTANDING – A LOOK AT PROFESSIONAL ETHICS **6**

Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.

d. Activities

Practice Sessions - Introduction to Value Education

1 Sharing about Oneself

2 Exploring Human Consciousness

3 Exploring Natural Acceptance

Practice Sessions– Harmony in the Human Being

4 Exploring the difference of Needs of Self and Body

5 Exploring Sources of Imagination in the Self

6 Exploring Harmony of Self with the Body

Practice Sessions– Harmony in the Family and Society

7 Exploring the Feeling of Trust

8 Exploring the Feeling of Respect

9 Exploring Systems to fulfil Human Goal

Practice Sessions– Harmony in the Nature (Existence)

10 Exploring the Four Orders of Nature

11 Exploring Co-existence in Existence

Practice Sessions– Implications of the Holistic Understanding – a Look at Professional Ethics

12 Exploring Ethical Human Conduct

13 Exploring Humanistic Models in Education

14 Exploring Steps of Transition towards Universal Human Order

e. Learning Resources

https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php

https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

Text Books

1. R R Gaur, R Asthana, G P Bagaria., *The Textbook A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019.
2. R R Gaur, R Asthana, G P Bagaria., *The Teacher's Manual A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi,2019.

Reference Books

1. EkParichaya, A Nagaraj., *JeevanVidya*, JeevanVidyaPrakashan, Amarkantak, 1999.
2. A.N. Tripathi ., *Human Values*, New Age Intl. Publishers, New Delhi, 2004.
3. Mohandas Karamchand Gandhi ., *The Story of My Experiments with Truth*. 2009.
4. J C Kumarappa., *Economy of Permanence*.2017.
5. Maulana Abdul Kalam Azad., *India Wins Freedom*.1988.

Course Code	Course Name	L	T	P	C
GE2491	PRINCIPLES OF MANAGEMENT	3	0	0	3

Category: Management Elective

a. Preamble

This course introduces fundamental principles of management, emphasizing their universal applicability in diverse organizations. It covers core managerial functions, explores organizational structures, and provides insights into effective global leadership qualities and skills.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Discuss the trends and challenges of management in global scenario, the different types of organization and its effectiveness.	K2
CO2	Describe the strategies and policies which are involved in process planning and decision making.	K2
CO3	Illustrate the structure, purpose, selection and recruitment process in organizations.	K2
CO4	Elucidate the various motivational theories and processes of management including its functions.	K2
CO5	Explain the process and control techniques for budgeting and inventory management.	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS **9**

Definition of Management - Nature, Scope and Functions of Management - Evolution of Management - Contributions of FW Taylor (14 principles of Management), Henri Fayol, Elton Mayo, Roethilisberger, H.A.Simon and P.F Drucker - Management theories - Science or Art - Manager Vs Entrepreneur- types of managers managerial roles and skills - Evolution of Management - Scientific, human relations, system and contingency approaches - Current trends and issues in Management.

PLANNING **9**

Nature and purpose of planning - Planning process - Types of planning - Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

ORGANISING **9**

Nature and purpose - Formal and informal organization - Organization chart - Organization structure - Types - Line and staff authority - Departmentalization - delegation of authority - Centralization and decentralization - Job Design - Human Resource Management - HR Planning, Recruitment, selection, Training and Development, Performance Management , Career planning and management.

DIRECTING **9**

Directing meaning - importance - principles of directing - Motivation - Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership - 14 types and theories of leadership - Communication - Process of communication, types of communication and its uses - Barrier in communication - Effective Communication - Communication and IT.

CONTROLLING **9**

System and process of controlling - Budgetary and non - Budgetary control techniques - Use of computers and IT in Management control - Productivity problems and management - Inventory Management - PERT, CPM - Application - Control and performance - Direct and preventive control.

d. Activities

Students shall be given exposure to various concepts of delegation of authority, centralization, and decentralization within the college premises.

e. Learning Resources

Text Books

1. Harold Koontz and Heinz Weihrich, *Essentials of Management*, Tata McGraw Hill,2020.
2. Stephen P. Robbins and Mary Coulter, *Management*, Pearson ,2019.

Reference Books

1. Robert Kreitner and Mamata Mohapatra, *Management*, Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, *Fundamentals of Management*, Pearson Education, 9th Edition,2016.

3. Tripathy PC and Reddy PN, *Principles of Management*, Tata McGraw Hill, 2021.

Course Code	Course Name	L	T	P	C
GE2492	TOTAL QUALITY MANAGEMENT	3	0	0	3

Category: Management Elective

a. Preamble

Quality is the mantra for success or even for the survival of any organization in this competitive global market. Total Quality Management (TQM) is an enhancement to the traditional way of doing business. It is a proven technique to guarantee survival in world class competition. It integrates fundamental management techniques, existing improvement efforts, and technical tools under a disciplined approach. At the end of the course the students are expected to recognize the quality issues in an organization and analyze the ways to solve those using TQM techniques, and demonstrate skills in using modern TQM tools.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe the concepts of TQM for an enterprise.	K2
CO2	Comprehend the TQM principles and its implementation.	K2
CO3	Discuss the various traditional and new TQM tools.	K2
CO4	Examine the fundamental concepts of QFD and TPM with applications.	K3
CO5	Apply QMS and EMS in business organization.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Concept of Quality and Quality Management - Determinants of quality of a product & Service - Reliability - Definition of TQM - Basic concepts of TQM - TQM Framework - Barriers to TQM - Benefits of TQM - Gurus of TQM (Brief Introduction) - Quality statements - vision, mission, and policy.

TQM PRINCIPLES **9**

Continuous Improvement Process - Deming Philosophy - Juran Trilogy - PDSA cycle - Kaizen - Concepts of Quality circle - Japanese 5S principles and 8D methodology.

TQM TOOLS & TECHNIQUES I **9**

The seven traditional tools of quality - New management tools - Six-sigma Process Capability - Bench marking: Reasons for benchmarking , Benchmarking process, Understanding Current Performance, Planning, Pitfalls and Criticisms of Benchmarking - FMEA: Intent, Documentation, Stages: Design FMEA and Process FMEA.

TQM TOOLS & TECHNIQUES II **9**

Quality circles - Quality Function Deployment: QFD Team - Benefits of QFD - Voice of the customers - Organization of Information - House of Quality - QFD Process - Taguchi quality loss function - TPM: Concepts, improvement needs - Performance measures - Cost of Quality - Applications.

QUALITY AND ENVIRONMENTAL MANAGEMENT SYSTEM **9**

Introduction - Benefits of ISO Registration - ISO 9000 Series of Standards - Sector Specific Standards: AS 9100, TS16949 and TL 9000 - ISO 9001 Requirements - Implementation - Documentation - Internal Audits - Registration - ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction - ISO 14000 Series Standards - Concepts of ISO 14001 - Requirements of ISO 14001 - Benefits and applications of EMS.

d. Activities

Students shall be exposed to learn the knowledge and skills necessary to drive organizational excellence through the implementation of effective quality management strategies.

e. Learning Resources

Text Books

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield, Mary B.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe., *Total Quality Management*, Revised 3rd Edition, Pearson Education Asia, 2013.
2. Suganthi L & Anand Samuel., *Total Quality Management*, Prentice Hall Publications, 2004.

Reference Books

1. Kiran. D.R., *Total Quality Management: Key concepts and case studies*, Butterworth – Heinemann Limited, 2016.
2. Shridhara Bhat K., *Total Quality Management: Text and Cases*, Himalaya Publishing House India, 2nd Edition, 2016.

Course Code	Course Name	L	T	P	C
OEE701	DISASTER MANAGEMENT	3	0	0	3

Category: Open Elective

a. Preamble

This course introduces the disasters, risks, the impacts and its management techniques.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Identify the types of disasters, causes and their impact on environment and society.	K2
CO2	Identify vulnerability and various methods of risk reduction measures as well as mitigation.	K2
CO3	Outline the inter-relationship between disasters and development.	K2
CO4	Identify the disaster risk management in India.	K3
CO5	Organize the hazard and vulnerability profile of India, Scenarious in the Indian context, Disaster damage assessment and management.	K3

Total: 45 Periods

c. Course Syllabus

INTRODUCTION TO DISASTERS **9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks - Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

APPROACHES TO DISASTER RISK REDUCTION **9**

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community,

Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority (SDMA) - Early Warning System - Advisories from Appropriate Agencies.

INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation - Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster - Disaster Damage Assessment.

DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

d. Activities

Students shall be exposed to assess vulnerability and various methods of risk reduction measures as well as mitigation. Draw the hazard and vulnerability profile of India, Scenarious in the Indian context, Disaster damage assessment and management.

e. Learning Resources

Text Book

1. Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423.

Reference Books

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011.

Course Code	Course Name	L	T	P	C
OEE702	BATTERY AND ENERGY STORAGE TECHNOLOGIES	3	0	0	3

Category: Open Elective

a. Preamble

This course introduces the concepts and characteristics of energy storage systems such as batteries, super capacitors and fuel cells.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the construction and working of various types of commonly used batteries	K2
CO2	Identify the principle of operation & design of advanced energy storage batteries.	K3
CO3	Identify the basics for using fuel cells for power storage and production applications.	K3
CO4	Apply the concepts of battery pack in EV's.	K3
CO5	Infer the performance of battery charge controllers and their applications.	K2

c. Course Syllabus **Total: 45 Periods**

INTRODUCTION TO BATTERIES **9**

Construction and working of Basic Electrochemical cell & Batteries -Theoretical cell voltage and capacity-Losses in a cell-Battery parameters: Battery capacity, Battery Voltage, Depth of discharge-Battery life cycle-Discharge/charge rate - Classification of Batteries-Constructions and working principle of Lead Acid battery - Advances in lead-acid batteries.

ADVANCED ENERGY STORAGE BATTERIES **9**

Principle of operation, components & design, Electrode, cell and battery fabrications & Applications of Li-ion batteries, Nickel Cadmium batteries, Nickel Metal Hydride Battery, Ni-Hydrogen batteries, Super capacitors.

FUEL CELLS **9**

Introduction-Classification of fuel cells - Construction and working of Phosphoric Acid fuel cell-Alkaline Fuel cell-Polymer Electrolyte Membrane Fuel cell-Efficiency of Fuel cell-VI characteristics of Fuel Cell- Advantages-Applications.

ENERGY STORAGE SYSTEM FOR ELECTRIC VEHICLE **9**

Selection of battery for EVs & HEVs, Traction Battery Pack design, Requirement of Battery Monitoring, Battery State of Charge Estimation methods, Battery Cell equalization problem, thermal control, protection interface, SOC Estimation, Energy & Power estimation, Battery thermal management system- Introduction to Lead Acid Batteries and Nickel based batteries.

BATTERY CHARGING AND CHARGE CONTROLLERS **9**

Factors affecting battery performance - Factors affecting Choice of a battery-Battery charging and discharging methods - Power stage and control scheme for battery charging using DC-DC converter-Flow chart for battery charging.

d. Activities

Students shall be exposed to the knowledge of energy storage systems and their characteristics.

e. Learning Resources

Text Books

1. Khan, B.H., *Non-conventional energy resources,* Tata McGraw-Hill Education, 2006.
2. Dhameja, S., *Electric vehicle battery systems,* Elsevier, 2001.

Reference Books

1. Kiehne, H.A., *Battery Technology Handbook*, Marcel Dekker Inc., 2003.
2. Kwade, A. and Diekmann, J., 2018. Recycling of lithium-ion batteries. *The LithoRec Way, Sustainable Production, Life Cycle Engineering and Management*, p.53.

Course Code	Course Name	L	T	P	C
OEE703	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3

Category: Open Elective

a. Preamble

This course introduces the various energy conservation and management techniques for efficient power handling.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Illustrate the need of energy auditing and the role of energy auditors & instruments in energy auditing.	K2
CO2	Make use of energy conservation techniques in electrical machines and light illumination.	K3
CO3	Utilize energy conservation techniques in thermal systems to improve thermal efficiency.	K3
CO4	Construct efficient utilization of basic domestic & industrial electrical systems.	K3
CO5	Illustrate the cost calculation of various parameters in energy economics.	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO ENERGY AUDITING **9**

Energy, Power - World Scenario (Past & Present) - National Energy Consumption Data – Environmental aspects associated with energy utilization - Types of Energy Auditing - Need, Methodology and Barriers. Role of Energy Managers - Instruments for energy auditing & its operation.

ELECTRICAL SYSTEMS **9**

Components of EB billing - HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency

Computation, Energy Efficient Motors, Illumination - Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Energy conservation in Illumination.

THERMAL SYSTEMS **9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters - Efficiency computation and energy conservation measures. Steam: Distribution & Usage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories.

ENERGY CONSERVATION IN MAJOR UTILITIES **9**

Energy Saving Opportunities: Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems - Cooling Towers - D.G. sets - Domestic appliances - BEE & Star rating.

ECONOMICS **9**

Energy Economics - Discount Rate, Payback Period, Internal Rate of Return, Present Value, Life Cycle Costing - ESCO concept.

d. Activities

Students shall be exposed to the energy audit, conservation measures in thermal and electrical systems and the economics beyond it.

e. Learning Resources

Text Books

1. Energy Manager Training Manual (4 Volumes) available at www.energymanagertraining.com. a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

Reference Books

1. Witte. L.C., P.S. Schmidt, D.R. Brown, *Industrial Energy Management and Utilisation* Hemisphere Publication, Washington, 1988.
2. Callaghn, P.W., *Design and Management for Energy Conservation*, Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., *The Efficient Use of Energy*, Butterworths, London, 1982.
4. Turner. W.C., *Energy Management Hand book*, Wiley, New York, 1982.
5 Murphy. W.R. and G. Mc KAY, *Energy Management*, Butterworths, London 1987.

Course Code	Course Name	L	T	P	C
EE2402	RENEWABLE ENERGY SYSTEMS LABORATORY	0	0	4	2

Category: Professional Core

a. Preamble

Upon successful course completion, students will be proficient in applying experimental techniques to analyze and optimize renewable energy systems, including solar PV, wind, and fuel cells, while demonstrating practical problem-solving skills.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Apply experimental and simulation techniques to analyze solar PV, wind, and fuel cell systems in renewable energy technology.	K3
CO2	Implement diode-based solutions and optimize solar PV systems, demonstrating competency in voltage-current (VI) and power-voltage (PV) characteristics.	K3
CO3	Assess, troubleshoot, and enhance the performance of grid-connected, standalone, and hybrid renewable energy systems for practical applications.	K3
CO4	Utilize simulation studies to design and evaluate solar PV grid systems, wind energy generators, and hybrid power systems, enhancing problem-solving skills.	K3
CO5	Apply experimental methods to evaluate fuel cell performance and analyze energy storage technologies' role in renewable energy applications.	K3

c. Course Syllabus **Total: 60 Periods**

1. Simulation study on Solar PV Energy System.
2. Experiment on “VI & PV Characteristics of Solar PV System”.
3. Experiment on “Shadowing effect & diode based solution in Solar PV System”.
4. Simulation study of Solar power system for home application.
5. Experiment on Performance assessment of Grid connected Solar Power System.
6. Experiment on Performance assessment of Standalone Solar Power System.
7. Simulation study on Wind Energy Generator.

8. Experiment on Performance assessment of micro Wind Energy Generator.
9. Simulation study on Hybrid (Solar-Wind) Power System.
10. Experiment on Performance Assessment of Hybrid (Solar-Wind) Power System.
11. Experiment on Performance Assessment of Fuel Cell.
12. Simulation study of Energy storage technologies for RE Applications.

d. Activities

Students will design and conduct a comprehensive simulation study comparing the performance of solar PV and wind energy systems under varying environmental conditions. They will analyze data to recommend optimal renewable energy solutions for specific locations.

e. Learning Resources

Text Books

1. Sorensen, B., *Renewable energy: physics, engineering, environmental impacts, economics and planning*, Academic Press, 2017.
2. Duffie, J.A. and Beckman, W.A., *Solar engineering of thermal processes. John Wiley & Sons*, 2013.

Reference Books

1. Manwell, J.F., McGowan, J.G. and Rogers, A.L., *Wind energy explained: theory, design and application. John Wiley & Sons*, 2010.
2. O'Hayre, R., Cha S W, Colella W, Prinz FB, *Fuel Cell Fundamentals*, John Wiley & Sons, 2016.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 80 GB, 2 GB RAM)	15 Nos.
2.	CRO	10 Nos.
3.	Digital Multimeter	10 Nos.
4.	PV panels - 100W, 24V	1
5.	Battery storage system with charge and discharge control 40Ah	1
6.	PV Emulator	1
7.	Micro Wind Energy Generator module	1
8.	Potentiometer	5

S.No.	Description of Equipment	Quantity Required
9.	Step-down transformer	5
10.	Component data sheets to be provided	-

Course Code	Course Name	L	T	P	C
EE2451	PROJECT WORK	0	0	20	10

Category: Employability Enhancement Course

a. Preamble

The main objective is to develop the ability of the student to solve a specific problem right from its identification and literature review till the successful solution of the same. The course will nurture the skill of the students in preparing project reports and to face reviews and viva voce examination.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Identifying a potential problem based on literature survey impending industrial/real time needs.	K3
CO2	Categorizing various solution methodologies to solve problem taken for study.	K4
CO3	Design engineering solutions to complex problems utilizing a systematic approach.	K6
CO4	Justify the design/experimental results based on hardware & software implementation.	K5
CO5	Conclude the solution based on analysis and prepare a detailed technical report.	K5

Total: 300 Periods

The students will be working in single or group of 3 to 4 on a scientific problem approved by the Head of the Department under the guidance of the faculty member and prepare a comprehensive report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on project evaluation process as recommended in the respective regulation

The student can also be permitted to work on the project in Industry/Research organization with the due permission from Head of the Department. The Engineer/Scientist from Industry/

Research Organization can jointly act as supervisor in addition to the Project Supervisor. The student should undergo project evaluation process as recommended in the respective regulations.