# B. Tech with

# MINOR

in

# ENERGY SYSTEMS

Academic Regulations, Course Structure and Syllabus

Effective from 2023-24 admitted batches

Offered by

## Department of Electrical and Electronics Engineering

## KSRM College of Engineering (A) – Kadapa

**(Approved by AICTE, Accredited by NAAC with A+ Grade and NBA and Affiliated to JNTUA, Anantapuramu)**

## ELIGIBILITY / REGISTRATION / AWARD OF MINOR

The primary objective of a minor degree is to provide students with a secondary area of study to broaden their knowledge, enhance their skill set, and potentially improve their career prospects. It allows students to explore interests beyond their major, potentially leading to a more well-rounded and competitive profile.

i) Minor degree is introduced by the respective departments offering B. Tech. programs and is applicable to all B.Tech (Regular and Lateral Entry) students admitted in Engineering & Technology.

ii) There is NO minimum CGPA requirement to register for Minor degree program. However, the student shouldn't have any course backlog **up to III Semester in the major degree.**

iii) A student shall earn **additional 18 credits for award of Minor degree** offered by the department other than parent department. This is in addition to 163 credits by a regular student and 123 Credits by a Lateral Entry student for the award of Major degree.

iv) A student is permitted to register for Minor in IV Semester after the results of III Semester are declared. Students shall register and pass in all the courses prescribed and being offered from V semester under the respective Minor degree.

v) Students have to attend classwork for courses under Minor degree beyond regular academic hours meant for major degree. Students can also undergo the courses under Minor through any proctored online platforms with the prior approval of the BoS Chairman and the HoD of the respective department offering Minor degree.

vi) The attendance for the registered courses under Minor and regular courses offered for Major degree in a Semester will be considered separately.

vii) A student shall have an aggregate of 75% attendance in all courses registered under Minor in that particular semester to become eligible for attending Semester-End examinations.

viii) The registration for the Minor will be cancelled, if the student is detained due to lack of attendance in Major.

ix) The registration for the Minor will be cancelled, if the student fails in any course of either Minor / Major in any semester from V to VIII Semester.

x) A student registered for Minor shall pass in all subjects that constitute the requirement for the Minor degree program. No class/division (i.e., second class, first class and distinction, etc.) will be awarded for Minor degree program.

xi) A separate grade sheet will be issued for the Minor degree courses semester-wise..

xii) If a student drops or is terminated from the Minor program, the additional credits so far earned cannot be converted into open or core electives; they will remain extra.

xiii) The Minor will be mentioned in the degree certificate as Bachelor of Technology in Civil Engineering with Minor in Mechanical Engineering.

xiv) There shall be a minimum enrolment of 20% OR 20 enrollments from the list of

eligible students to offer Minor program.

xv) There is no fee for registration of courses for Minor program offered.

xvi) A student can register for either Minor / Honor but not both.

xvii) Student shall submit an application for either Minor / Honor at least one week before the commencement of the V Semester.

## MINOR PROGRAMS OFFERED

| Offering Department | Title | Who can Register |
|---|---|---|
| Civil Engineering | Civil Engineering | B.Tech. EEE / ME / ECE / CSE / AIML / CSE(AIML) / CSE(DS) |
| Mechanical Engineering | 3D Printing | B.Tech. CE / EEE / ECE / CSE / AIML / CSE(AIML) / CSE(DS) |
| | Industrial Engineering | B.Tech. CE / EEE / ECE / CSE / AIML / CSE(AIML) / CSE(DS) |
| Electrical and Electronics Engineering | Energy Systems | B.Tech. CE / ME / ECE / CSE / AIML / CSE(AIML) / CSE(DS) |
| Electronics and Communication Engineering | Embedded Systems | B.Tech. CE / EEE / ME / CSE / AIML / CSE(AIML) / CSE(DS) |
| Computer Science and Engineering | Computer Science and Engineering | B.Tech. CE / EEE / ME / ECE |
| | Data Science | B.Tech. CE / EEE / ME / ECE |
| | Computer Science and Engineering – Artificial Intelligence and Machine Learning | B.Tech. CE / EEE / ME / ECE |

**COURSE STRUCTURE**

**for**

**MINOR**

**in**

**ENERGY SYSTEMS**

| S.No | COURSE CODE | COURSE TITLE | Semester Offered | L | T | P | IM | EM | CR |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2302571M | Energy Audit and Management | V | 3 | 0 | 0 | 30 | 70 | 3 |
| 2 | 2302572M | Energy Management in Buildings | V | 3 | 0 | 0 | 30 | 70 | 3 |
| 3 | 2302671M | Energy Storage Technologies | VI | 3 | 0 | 0 | 30 | 70 | 3 |
| 4 | 2302672M | Energy Scenario and Energy Policy | VI | 3 | 0 | 0 | 30 | 70 | 3 |
| 5 | 2302771M | Waste Energy Management | VII | 3 | 0 | 0 | 30 | 70 | 3 |
| 6 | 2302571M | Project in Energy systems | VII | 0 | 0 | 6 | 60 | 140 | 3 |
| | | | **Total** | **15** | **0** | **6** | **210** | **490** | **18** |

| 2302571M | MINOR IN ENERGY SYSTEMS ENERGY AUDIT AND MANAGEMENT (CE,ME,ECE,CSE,CSE-DS,CSE-AIML,AIML) | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-Requisites:** NIL

**Course Outcomes:**

On successful completion of the course, student will be able to

**CO1.** apply mass and energy balance techniques to identify and evaluate energy conservation potential in industrial systems. thermal collectors and storage systems.

**CO2.** implement appropriate audit methods and instruments to assess energy usage and identify optimization strategies.

**CO3.** demonstrate the ability to design an effective energy management program and prepare audit reports in line with organizational objectives.

**CO4.** utilize thermal energy management strategies such as cogeneration and waste heat recovery in real-world industrial scenarios.

**CO5.** execute electrical energy conservation techniques including demand-side management and the use of energy-efficient motors and systems.

**SYLLABUS:**

**UNIT - I: INTRODUCTION (08 Periods)**

Basic elements and measurements - Mass and energy balances – Scope of energy auditing industries -Evaluation of energy conserving opportunities.

**UNIT - II: ENERGY AUDIT CONCEPTS (10 Periods)**

Need of Energy audit - Types of energy audit – Energy management (audit) approach – understanding energy costs - Bench marking – Energy performance - Matching energy use to requirement – Maximizing system efficiencies - Optimizing the input energy requirements - Duties and responsibilities of energy auditors- Energy audit instruments - Procedures and Techniques.

**UNIT - III: PRINCIPLES AND OBJECTIVES OF ENERGY MANAGEMENT (08 Periods)**

Design of Energy Management Programmes - Development of energy management systems – Importance - Indian need of Energy Management - Duties of Energy Manager - Preparation and presentation of energy audit reports - Some case study and potential energy savings.

**UNIT - IV: THERMAL ENERGY MANAGEMENT (07 Periods)**

Energy conservation in boilers - steam turbines and industrial heating systems - Application of FBC - Cogeneration and waste heat recovery - Thermal insulation - Heat exchangers and heat pumps – Building Energy Management.

**UNIT - V: ELECTRICAL ENERGY MANAGEMENT (10 Periods)**

Supply side Methods to minimize supply-demand gap- Renovation and modernization of power plants - Reactive power management – HVDC - FACTS - Demand side - Conservation in motors - Pumps and fan systems – Energy efficient motors. Demand side management.

**Total Periods: 43**

**TEXT BOOKS:**


T1. Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, 1980, Hemisphere, Washington.
T2. Energy Management: W.R.Murphy, G.Mckay, 1987, Butterworth-Heinemann.


**REFERENCE BOOKS:**


R1. Energy Management Principles, C.B.Smith, 1993, Pergamon Press.
R2. Efficient Use of Energy, I.G.C.Dryden, 1982, Butterworth Scientific.
R3. Energy Economics, A.V.Desai, 1986, Wiley Eastern Limited / New Age Int'l.


**WEB RESOURCES:**

1. https://www.energy.gov/eere/energybasics
2. https://www.engineeringtoolbox.com/energy-balance-d_574.html
3. https://beeindia.gov.in/sites/default/files/BEE%20Booklet_Energy%20Audit.pdf
4. https://beeindia.gov.in/sites/default/files/Energy%20Auditor%20Guide%20Book.pdf

| 2302572M | MINOR IN ENERGY SYSTEMS ENERGY MANAGEMENT IN BUILDINGS (CE,ME,ECE,CSE,CSE-DS,CSE-AIML,AIML) | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-Requisites:** Environmental Science

**Course Outcomes:**

On successful completion of the course, student will be able to

**CO1.** assess the significance of energy usage in buildings and describe the internal and external factors affecting energy demand, including concepts of energy-efficient building design.

**CO2.** analyze indoor environmental requirements such as thermal comfort, ventilation, air quality, lighting, and their influence on energy consumption, including the concept of sick building syndrome.

**CO3.** examine the impact of climate-related factors—solar radiation, temperature, wind, and shading on building energy performance and the orientation of structures.

**CO4.** evaluate end-use energy requirements in buildings, including lighting, heating, and thermal performance of building envelopes, and estimate energy usage using standard heat transfer analysis.

**CO5.** apply energy management techniques such as energy auditing, targeting, and adoption of technological solutions to improve energy efficiency in buildings, especially for Indian conditions.

**SYLLABUS:**

**UNIT - I: OVERVIEW OF THE SIGNIFICANCE OF ENERGY USE AND ENERGY PROCESSES IN BUILDING (12 Periods)**

Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications – Concepts of energy efficient building.

**UNIT - II: INDOOR ENVIRONMENTAL REQUIREMENT AND MANAGEMENT (08 Periods)**

Thermal comfort – Ventilation and air quality - Air-conditioning requirement - Visual perception – Illumination requirement - Auditory requirement – Concept of sick building syndrome – Significance in energy management in buildings.

**UNIT - III: CLIMATE (10 Periods)**

Solar radiation and their influences - The sun-earth relationship and the energy balance on the earth's surface – Climate – Wind - Solar radiation - Temperature – Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

**UNIT - IV: END-USE** **(08 Periods)**

Energy utilization and requirements – Lighting and day lighting – End-use energy requirements – Status of energy use in buildings – Estimation of energy use in a building - Heat gain and thermal performance of building envelope – Steady and non-steady heat transfer through the glazed window and the wall – Standards for thermal performance of building envelope – Evaluation of the overall thermal transfer – Concepts of window management.

**UNIT - V: ENERGY MANAGEMENT OPTIONS** **(07 Periods)**

Energy audit and energy targeting – Technological options for energy management – Modifications for energy efficient buildings for Indian conditions, Energy Management for large tower buildings.

**Total Periods: 45**

**TEXT BOOKS:**


T1. Heating and Cooling of Buildings – Design for Efficiency, J. Krieder and A. rabl, McGraw Hill, 1994, 1st Edition.

T2. Mechanical and Electrical Equipment for Buildings, S. M. Guinnes and Reynolds, Wiley, 1989, 8th Edition.


**REFERENCE BOOKS:**


R1. Energy Design for Architects, Donald Watson, Kenneth Labs, AEE Energy Books, 1991, 1st Edition.

R2. Energy Conservation in Buildings, Royal Architectural Institute of Canada, Royal Institute of Architecture, Canada, 1993, 1st Edition.

R3. Energy Management in Buildings, Central Building Research Institute (CBRI), Roorkee, CBRI Publication, 2000, Latest Edition Available.


**WEB RESOURCES:**

1. https://www.energy.gov/eere/buildings
2. https://www.ashrae.org/
3. https://beeindia.gov.in/
4. https://energyplus.net/

| 2302671M | MINOR IN ENERGY SYSTEMS ENERGY STORAGE TECHNOLOGIES (CE,ME,ECE,CSE,CSE-DS,CSE-AIML,AIML) | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-Requisites:** Basic Electrical Engineering

**Course Outcomes:**

On successful completion of the course, student will be able to

**CO1.** analyze the characteristics and performance factors of various batteries and assess the role of Battery Management Systems (BMS) in energy storage applications analyse magnetic circuits and coupled magnetic circuits.

**CO2.** assess the construction, chemistry, and performance ratings of different types of primary batteries used in electronic and industrial applications.

**CO3.** compare the design and operation of advanced battery technologies including Li-ion, Na-ion, and flow batteries for transportation and storage.

**CO4.** analyze battery energy storage systems with renewable sources and assess their impact on micro grid and smart grid performance using advanced storage methodologies.

**CO5.** demonstrate hybrid energy storage systems by combining supercapacitors and fuel cells for transportation and high-performance energy applications

**SYLLABUS:**

**UNIT - I: BATTERIES** **(08 Periods)**

Types-battery characteristics - voltage, current, capacity, volumetric energy density, specific energy density, charge rate, cycle life, internal resistance, energy efficiency, shelf life, battery management system, SoC, SoH estimation techniques. Testing of batteries, battery charging method, Factors affecting the battery performance.

**UNIT - II: PRIMARY BATTERIES** **(09 Periods)**

Fabrication, performance aspects, packing and rating of alkaline manganese, silver oxide cells. Lithium primary batteries-Lithium/Manganese Dioxide, Lithium/Carbon Monofluoride, Lithium/ Thionyl chloride, Lithium/Sulphur Dioxide, Lithium/Iodine, Lithium-Aluminium/Iron Disulfide.

**UNIT - III: ADVANCED BATTERIES** **(09 Periods)**

Advanced Lead Acid Battery -design, performance aspects, Pb-Acid batteries for transportation, nickel-metal hydride batteries, zinc- alkaline batteries, ZEBRA Battery (Na/NiCl2) -NaS Battery-Lithium-Ion Battery-Lithium- Polymer Battery, Li-air batteries, Li-S batteries, Sodium -ion batteries.

**UNIT - IV: STORAGE FOR RENEWABLE ENERGY SYSTEMS (09 Periods)**

Solar energy, Wind energy, pumped hydro energy, Energy storage in Micro-grid and Smart grid, Energy Management with storage systems, Battery SCADA, Increase of energy conversion efficiencies by introducing energy storage. Superconducting Magnetic Energy Storage (SMES), charging methodologies, Photo galvanic cells, semiconductor solar batteries (SC-SB), thermo-ionic converter s, dye-sensitized solar cells (DSSC).

**UNIT - V: SUPERCAPACITORS AND FUEL CELLS (10 Periods)**

Fundamentals of electrochemical Supercapacitors, electrode and electrolyte interfaces and their capacitances, charge-discharge characteristics, energy/power density, design, fabrication, operation and evaluation, thermal management, Supercapacitors for transportation applications - aqueous and organic based supercapacitors, Pseudo and asymmetric supercapacitors. Advance battery-supercapacitors hybrids for auto, space and marine applications. Fuel Cells working Principle and Construction.

**Total Periods: 45**

**TEXT BOOKS:**


T1. Understanding Batteries, Dell, Ronald M. Rand and David A. J., Royal Society of Chemistry, 2001.

T2. Electrochemical power sources: Batteries, fuel cells, and super capacitors, Vladimir S. Bagotsky, Alexander M. Skundin, Yurij VM. Volfkovich, John Wiley & Sons, Inc., 2015.


**REFERENCE BOOKS:**


R1. Handbook of Batteries, Lindon David, McGraw Hill, 2002.

R2. Battery Technology Handbook, Kiehne H. A., Expert Verlag, RenningenMalsheim, 2003.

R3. Fuel Cells – Principles and Applications, AuliceScibioh M. and Viswanathan B., University Press, 2006.

R4. Energy Storage for Power Systems, A.G.Ter-Gazarian, the Institution of Engineering and Technology (IET) Publication, UK, 2011.


**WEB RESOURCES:**

1. https://batteryuniversity.com/article/bu-808-state-of-health
2. https://batteryuniversity.com/article/bu-808-battery-management-system
3. https://www.energy.gov/eere/vehicles/articles/how-do-lithium-ion-batteries-work
4. https://www.energy.gov/eere/fuelcells/fuel-cell-technologies-office

| 2302672M | MINOR IN ENERGY SYSTEMS<br>ENERGY SCENARIO AND ENERGY POLICY<br>(CE,ME,ECE,CSE,CSE-DS,CSE-AIML,AIML) | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-Requisites:** NIL

**Course Outcomes:**

On successful completion of the course, student will be able to

**CO1.** analyze the interrelationship between energy consumption and economic growth, and interpret changing energy usage patterns.

**CO2.** compare international energy policies and evaluate their impact on global energy dynamics.

**CO3.** apply national and state-level energy policies and assess their implications on energy development.

**CO4.** analyze key global energy issues and formulate perspectives on energy pricing and productivity.

**CO5.** demonstrate key features of energy acts and propose sustainable energy solutions for the future.

**SYLLABUS:**

**UNIT - I: GLOBAL ENERGY SCENARIO (12 Periods)**

Role of energy in economic development and social transformation - Energy and GDP - GNP and its dynamics - Energy sources and overall Energy demand and availability - Energy consumption in various sectors and its changing pattern - Depletion of energy sources and impact exponential rise in energy consumption on economies of countries.

**UNIT - II: ENERGY POLICIES (08 Periods)**

International Energy Policies of G-8 Countries, G-20 Countries - OPEC Countries - EU Countries - International Energy Treaties (Rio, Montreal, Kyoto) - INDO-US Nuclear Deal.

**UNIT – III: INDIAN ENERGY SCENARIO (09 Periods)**

Energy resources and Sector wise energy Consumption pattern Impact of energy on economy and development - National and State Level Energy policies and Issues - Status of Nuclear and Renewable Energy and Power Sector reforms. Energy policy 2030

**UNIT - IV: ENERGY POLICY** **(08 Periods)**

Global Energy issues - Energy Security - Energy Vision Energy Pricing and Impact of Global Variations Energy Productivity (National and Sector wise productivity).

**UNIT - V: ENERGY CONSERVATION** **(08 Periods)**

Act – 2001 and its features - Electricity Act – 2003 and its features - Energy Crisis - Future energy options - Need for use of new and renewable energy sources - Energy for Sustainable development.

**Total Periods: 45**

**TEXT BOOKS:**


T1. Energy for a sustainable World: Jose Golden berg, Thomas Johan son, AKN. Reddy, Robert Williams (Wiley Eastern).
T2. Energy Policy, B.V. Desai (Wiley Eastern)


**REFERENCE BOOKS:**


R1. Modelling approach to long term demand and energy implication, J.K.Parikh
R2. Energy Policy and Planning, B.Bukhootsow
R3. World Energy Resources, Charles, TEDDY Year Book Published by Tata Energy Research Institute (TERI).
R4. International Energy Outlook, E. Brown, EIA annual Publication.


**WEB RESOURCES:**

1. https://www.eia.gov/outlooks/ieo/
2. https://www.rff.org/publications/reports/global-energy-outlook-2024/
3. https://www.teriin.org/project/teddy

| 2302771M | MINOR IN ENERGY SYSTEMS<br>WASTE ENERGY MANAGEMENT<br>(CE,ME,ECE,CSE,CSE-DS,CSE-AIML,AIML) | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-Requisites:** Environmental Science, Engineering Chemistry and Biology

**Course Outcomes:**

On successful completion of the course, student will be able to

**CO1.** apply classification and characterization techniques to identify the properties of agricultural, industrial, and municipal solid wastes for effective handling and processing.

**CO2.** analyze the mechanisms and efficiencies of incineration, pyrolysis, and gasification processes in converting waste into usable forms of energy.

**CO3.** apply biochemical conversion techniques like anaerobic digestion and fermentation to convert organic waste into energy products such as biogas and biofuels.

**CO4.** analyze the effectiveness of waste heat recovery and plastic waste-to-energy methods in improving energy conversion efficiency.

**CO5.** analyze environmental and health impacts associated with various waste-to-energy technologies and evaluate real-world case studies for sustainable solutions.

**SYLLABUS:**

**UNIT - I: CHARACTERIZATION OF WASTES (09 Periods)**

Agricultural residues and wastes including animal wastes; industrial wastes; municipal solid wastes. Waste processing types and composition of various types of wastes; Characterization of Municipal Solid Waste, Industrial waste and Biomedical Waste, waste collection and transportation; waste processing-size reduction, separation; waste management hierarchy, waste minimization and recycling of Municipal solid waste.

**UNIT - II: THERMO CHEMICAL CONVERSION (09 Periods)**

Incineration, pyrolysis, gasification of waste using gasifiers, environmental and health impacts of incineration; strategies for reducing environmental impacts, Energy production from wastes through incineration, energy production through gasification of wastes, Energy production through pyrolysis and gasification of wastes, syngas utilization.

**UNIT - III: BIO-CHEMICAL CONVERSION (09 Periods)**

Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, anaerobic digestion biogas production, and present status of technologies for conversion of waste into energy,

design of waste to energy plants for cities, small townships and villages. Energy production from wastes through fermentation and transesterification, Cultivation of algal biomass from waste water and energy production from algae, Energy production from organic wastes through anaerobic digestion and fermentation.

**UNIT - IV: ENERGY PRODUCTION FROM WASTE PLASTICS, GAS CLEANUP WASTE, HEAT RECOVERY (05 Periods)**

Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices.

**UNIT - V: ENVIRONMENTAL AND HEALTH IMPACTS-CASE STUDIES (13 Periods)**

Environmental and health impacts of waste to energy conversion, Industrial waste management – Hazardous waste management – E-waste management -EV Batteries – Mobile Chargers - case studies of commercial waste to energy plants, waste to energy- potentials and constraints in India, eco- technological alternatives for waste to energy conversions.

**Total Periods: 45**

**TEXT BOOKS:**


T1. Fundamentals of Solid Waste Management, S.A. Abbasi, NaseemaAbbasi, New Age International,2007, 1st Edition.

T2. Waste to Energy Conversion Technology, B.K. Sharma, Khanna Publishers,2017, 1st Edition.


**REFERENCE BOOKS:**


R1. Waste to Energy: Opportunities and Challenges for Developing Economies ,Avraam Karagiannidis, Springer ,2012, 1st Edition.

R2. Energy from Waste – Current Trends and Future Perspectives , Christian Felsmann, Martin Faulstich, Elsevier, 2020,1st Edition.


**WEB RESOURCES:**

1 https://nptel.ac.in/courses/121106014
2 https://cpcb.nic.in/waste-to-energy/
3 https://www.epa.gov/smm/sustainable-management-materials-energy-recovery

| 2302772M | MINOR IN ENERGY SYSTEMS<br>PROJECT IN ENERGY SYSTEMS<br>(CE,ME,ECE,CSE,CSE-DS,CSE-AIML,AIML) | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 6 | 3 |

**Pre-Requisites:** Energy Audit and Management and Energy Storage Technologies

**Course Outcomes:**

On successful completion of the course, student will be able to

CO1. conduct energy audits and apply management techniques to optimize energy use in industrial and building systems.
CO2. analyze and integrate energy storage and waste energy recovery technologies for improving overall system efficiency.
CO3. evaluate national and global energy scenarios and policies to support sustainable energy planning and decision-making.
CO4. apply appropriate tools and techniques to understand and analyze the problems following professional ethics with focus on societal and environmental aspects.
CO5. work as a team and communicate results in an effective way.
CO6. make decisions as an individual or as a team member to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes.