Energy Efficient Buildings (Green Cement, Sustainability)

Course Learning Objectives	• Understand climatology and design a climate responsive building. • Learn about the energy efficient thermal and visual comfort in buildings. • Implement the fundamental knowledge on Life cycle assessment and Energy conservation.
Course Outcomes	• Apply the knowledge of climatology and design climate responsive buildings. • Calculate the heat gain in the building through its elements and determine heating and cooling loads required. • Assess design consideration and parameters for energy efficient lighting. • Develop solution for energy efficient HVAC system. • Implement energy conservation in a building through LCA.

Course Duration: 45 Hours

Unit 1: Design aspects of Energy Efficient Buildings

Introduction to Energy Efficient Buildings, Selection of Site, Sun path diagram, Basics of heat transfer – Conduction, Convection and Radiation, Psychrometric chart and its applications, Basics of Energy – Energy Conservation Building Code (ECBC), Fundamentals of Lighting.

Unit 2: Climatology, Passive Solar heating and cooling

Climatic building design – Indian climatic conditions, Earth Sun relationship, Design of buildings for climatic zones, Determinants of shading devices, Design of Shading

systems. General principles of passive solar heating and cooling – key design elements and case studies.

Unit 3: Heat gain in Buildings and Thermal Comfort

Introduction to Building heat gain, Internal heat gain, External heat gain through building elements – Roof, Wall and Fenestrations, External heat gain through ventilation and air leakage. Thermal comfort – Psychrometry, calculation of heating and cooling loads, Basics of thermal comfort and thermal comfort models, outdoor thermal comfort.

Unit 4: Lighting in Buildings

Daylighting – Daylighting and visual comfort metrics, Strategies for daylighting, Daylight control strategies. Artificial lighting – Control strategies for artificial lighting, Design of artificial lighting.

Unit 5: Energy Efficient Buildings

Energy efficiency – Building energy simulation, Energy efficiency in building envelope, Energy efficiency in HVAC systems, Energy efficient lighting system. Energy management system, Energy Audit. Life Cycle Assessment – LCA perspective, LCA methodology, Life cycle energy analysis.

Test Projects:

Use Cases:

S.NO	PROJECT TITLE
1	Design of an energy efficient Infotech Park at Delhi
2	Design of an energy efficient residential apartment at Bangalore.
3	Design of an energy efficient Hotel at Mumbai, Maharashtra
4	Design of an energy efficient School Administration Building at Hyderabad, Telangana
5	Design of an energy efficient hotel at Chennai, Tamil Nadu.
6	Design of an energy efficient residential building at Jaipur, Rajasthan.
7	Design of an energy efficient hotel at Manali, Himachal Pradesh
8	Design of an energy efficient office building in Kolkata, West Bengal.
9	Design an energy efficient institutional building that is located at Aurangabad.
10	Design an energy efficient tech park that is in Bhopal.
11	Design an energy efficient residential apartment that is in Nagpur.
12	Design an energy efficient hotel that is in Panaji, Goa.

13	**Design an energy efficient villa that is in Jodhpur.**
14	**Design an energy efficient residential school that is in Patna.**
15	**Design an energy efficient 12 floor residential apartment that is in Raipur.**
16	**Design a building that is to be used as commercial space which is located at Jodhpur.**
17	**Design a building for a school that is to be located at Pune and incorporate all strategies for energy efficiency.**
18	**Design a residential complex at Bhubaneshwar that must be energy efficient.**
19	**Design an energy efficient hotel that is to be constructed at Gulmarg.**
20	**Design an energy efficient tech park that is to be constructed at Bangalore.**

Task for Projects:

Task 1:

Orient the building and design shading systems with the help of sun path diagram.

Task 2:

Design the building with respect to the climatic zones, provide methods for passive solar heating or cooling required for the proposed building.

Task 3:

Calculate the heat ingress into building elements and recommend suitable insulation materials, while determining the heating or cooling load using a psychrometric chart.

Task 4:

Daylighting strategies and Artificial lighting design calculation.

Task 5:

Perform energy audit and provide strategies for energy efficiency in lighting and HVAC systems.

Project 1:

A residential apartment G+4 is to be commissioned at a space located in Chennai. Design a climate responsive energy efficient building with respect to the climatic zone in which it is located and propose passive heating or cooling strategy that is required. Orient the building with respect to sun path diagram and design the appropriate shading devices. Design the building with proper visual and thermal comfort with energy efficiency.

***Task for Project*:**

***Task 1*:**

Align the building strategically with the cardinal points and devise shading systems by leveraging sun path diagrams to intelligently harness solar angles, thereby optimizing natural light exposure and mitigating heat gain for enhanced energy efficiency and occupant comfort.

***Task 2*:**

Tailor the building design to suit specific climatic zones, integrating methods for passive solar heating or cooling through considerations such as proper orientation, thermal mass utilization, natural ventilation systems, and optimized fenestration, ensuring a sustainable and energy-efficient approach to climate-responsive architecture.

***Task 3*:**

Perform analysis involving the computation of heat ingress into building elements, recommending suitable insulation materials based on thermal conductivity and resistance factors, and further determine the precise heating or cooling load through the utilization of a psychrometric chart, ensuring an informed and energy-efficient approach to climate control in the building.

***Task 4*:**

Implement effective daylighting strategies in the building design, considering factors such as window placement, glazing types, and light shelves to optimize natural light penetration; complement this with an artificial lighting design calculation that integrates energy-efficient fixtures, lighting controls, and illuminance levels to create a balanced and sustainable lighting scheme for enhanced occupant comfort and energy conservation.

***Task 5*:**

Conduct a comprehensive energy audit encompassing lighting and HVAC systems, evaluating energy consumption patterns, and subsequently formulate tailored strategies for enhancing energy efficiency, encompassing the adoption of LED lighting technologies, implementation of occupancy sensors, integration of smart HVAC controls, and the incorporation of energy-efficient equipment, aiming to optimize overall energy performance and reduce environmental impact.

Student Assessment Plan:

Each of the above-mentioned test projects will be divided into tasks by the training partner for each specific institution. Such tasks will be jointly evaluated by the faculty and the training partner and the following weightage is to be followed.

- 70% weightage to the external practical assessment.
- 30% weightage to the internal assessment.

Final Test Project/External Assessment Plan:

The Final Test Project will be chosen from the list given above, jointly by the college faculty and the Training Partner. The Final Test Project will be assessed on the following tasks, for 70%

Details	**Marks**
Task: 1	20
Task: 2	20
Task: 3	20
Task: 4	20
Task: 5	20

Employment Potential:

This course shall enable mechanical, automobile and allied domain Engineers to get employment in sectors like Manufacturing, Assembly, Logistics, Maintenance, Warehouse, Packaging, Data Analytics, Robotics and Cloud Computing.