**Program Name : Civil Engineering Program Group**

**Program Code : CE/CR/CS**

**Semester : Fifth**

**Course Title : Energy Conservation and Green Building (Elective)**

**Course Code : 22506**

## 1. RATIONALE

Today's homebuyers are increasingly interested in green building as it improve the way homes use energy, water, and materials, to reduce negative impacts on human health and the overall environment-both during construction and over its lifetime. Building heating and cooling are the most energy-intensive activities, followed by electricity use for lighting and appliances. Rising standards of living result in more energy services required for heating, cooling, lighting and communicating. Energy being in limited quantum as on date is a very scarce resource nowadays and need to be used optimally. Higher levels of energy efficiency reduce carbon emissions from the home's own energy systems. Therefore, it becomes necessary to be energy–conscious and make every effort for the conservation of energy. The environmental management and audit is necessary to study the impact of various industries on natural resources. Green building use the resources optimally, reduce waste and reduce the cost of life cycle and provide healthy indoor environment for its occupants through restoring/improving the natural environment. Therefore this course will enable the students to face these challenges of today's era in most effective way to build the structures as green one to improve the quality of environment significantly.

## 2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Implement concept of energy conservation in construction practises.**

## 3. COURSE OUTCOMES (COs)

The theory, practical experiences, and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above-mentioned competency:

a. Identify various sources of environmental pollution.
b. Implement the different steps in environmental impact assessment.
c. Relate the construction of green building with the prevailing energy conservation policy and regulations.
d. Construct the building using the principles of Green building and the relevant materials.
e. Select the relevant rating system for assessment of given Green building

## 4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | | | | | | Practical | | | | | | |
| L | T | P | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | | |
| | | | | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | |
| 3 | - | 2 | 5 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25@ | 10 | 25 | 10 | 50 | 20 | |

*(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.*
***Legends:** **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment.*

## 5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

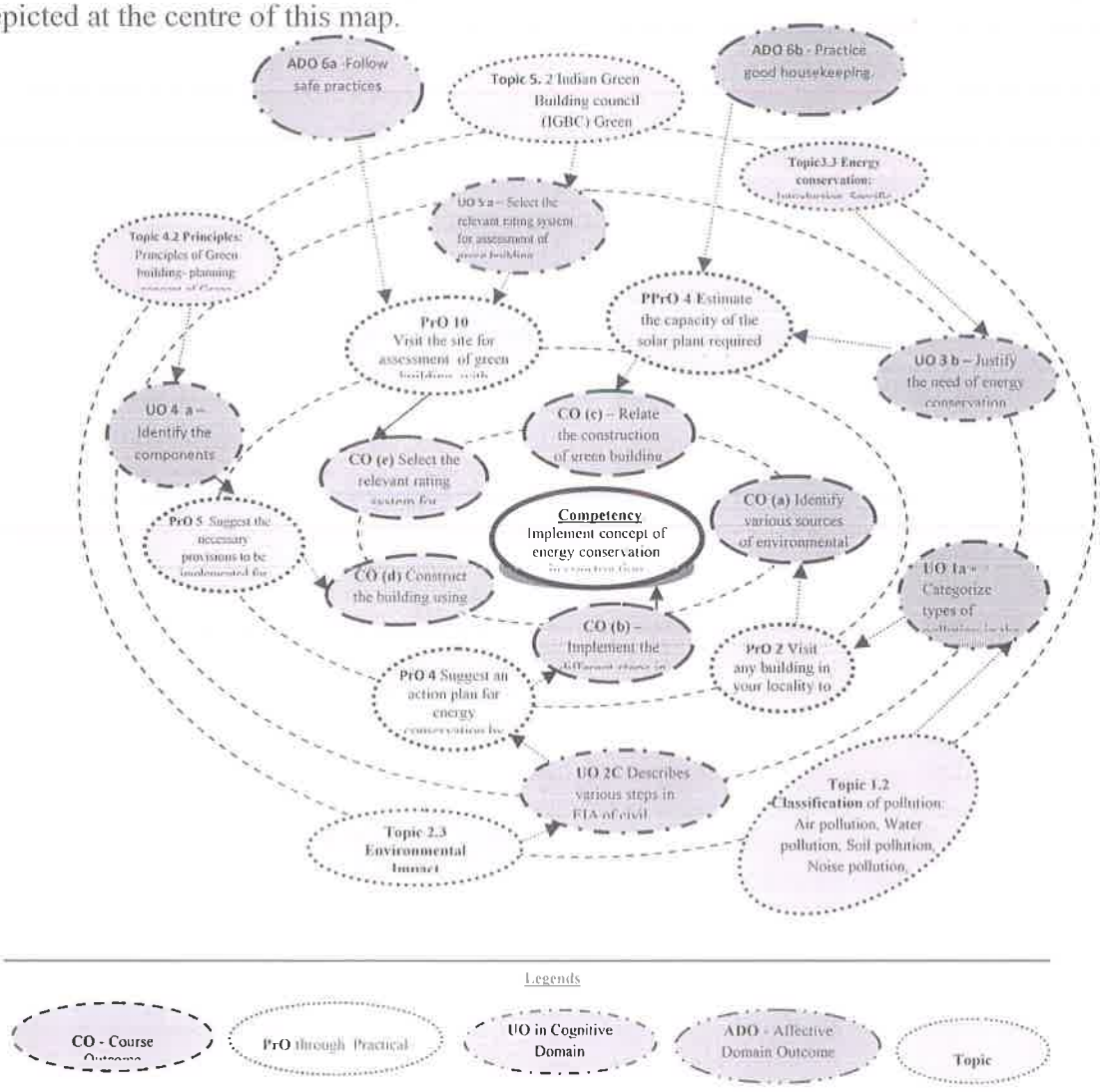


**Figure 1 - Course Map**

## 6. SUGGESTED PRACTICALS / EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|---|---|---|---|
| 1 | Prepare a report on noise levels in various area of your city by | 1 | 02* |

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|---|---|---|---|
| | collecting the relevant data from the concern department with your comments. | | |
| 2 | Visit any building in your locality to identify the relevant legal provisions followed for control of pollution and submit your observations-cum-findings in the form of a report. | I | 02* |
| 3 | Inspect your institute building and submit an action plan for improving the indoor and outdoor environmental quality | II | 02* |
| 4 | Estimate the capacity of the solar plant required for your institute building on the basis of the total electricity consumption data available from concern department. | II | 02* |
| 5 | Identify the impact of number of trees , green belt on the energy level of the building. (By physical verification) | III | 02* |
| 6 | Prepare an action plan for energy conservation by inspecting an existing structure to explore its potential in it. | III | 02* |
| 7 | Conduct the energy audit of your institute building using any rating system. | III | 02 |
| 8 | Visit to the nearby wind mill and prepare a report on your observations w.r.t. generation of energy with relevant sketches wherever required. | III | 02 |
| 9 | Visit to the nearby Hydroelectric power plant and prepare a report on your observations w.r.t. generation of energy with relevant sketches wherever required. | III | 02 |
| 10 | Visit to the nearby solar energy plant and prepare a report on your observations w.r.t. generation of energy with relevant sketches wherever required. | III | 02* |
| 11 | Inspect any conventional building in your area to suggest the action plan for converting it into green building with necessary legal provisions to be followed. | IV | 02* |
| 12 | Visit the site of green building to identify the components of HVAC unit with space calculation and submit the visit report. | IV | 02 |
| 13 | Visit the site for assessment of green building with relevant rating system and submit your findings in the form of a report. (Part 1) | V | 02* |
| 14 | Visit the site for assessment of green building with relevant rating system and submit your findings in the form of a report. (Part 2) | V | 02* |
| 15 | Visit the site for assessment of green building with relevant rating system and submit your findings in the form of a report. (Part 3) | V | 02* |
| 16 | Visit a site for suggesting necessary modifications required for improving green rating and energy conservation in the given building in Local area | V | 02* |
| | **Total** | | **32** |

***Note***

*i.A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical*

*LOs/tutorials need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *Hence, the 'Process' and 'Product' related skills associated with each PrO of the laboratory/workshop/field work are to be assessed according to a suggested sample given below:*

| S. No. | Performance Indicators | Weightage in % |
|---|---|---|
| a. | Preparation of experimental set up | 20 |
| b. | Setting and operation | 20 |
| c. | Safety measures | 10 |
| d. | Observations and Recording | 10 |
| e. | Interpretation of result and Conclusion | 20 |
| f. | Answer to sample questions | 10 |
| g. | Submission of report in time | 10 |
| **Total** | | **100** |

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a.Follow safety practices.
b.Practice good housekeeping.
c.Demonstrate working as a leader/a team member.
d.Maintain tools and equipment.
e.Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

## 7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

| S. No. | Equipment Name with Broad Specifications | PrO. S. No. |
|---|---|---|
| 1 | All practicals are based on Field visits, survey, and report writing. No specific equipments are required. | |

## 8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|

| | | |
|---|---|---|
| **Unit – I Environmental Pollution** | 1a.Categorize types of pollution in the given situation.<br>1b.Explain the term, "air pollution" in the given context.<br>1c.Justify the need to control environmental pollution of the given area.<br>1d.Describe the relevant process of reducing noise pollution in the given situation.<br>1e.Use the different legal provisions pertaining to environmental and pollution in the given situation. | 1.1 **Introduction:** Definition of Environment and environmental pollution, Ecology, control of environmental pollution.<br>1.2 **Classification** of pollution: Air pollution, Water pollution, Soil pollution, Noise pollution, Environmental laws for controlling pollution. |
| **Unit – II Environmental Audit and Environmental Impact Assessment (EIA)** | 2a.Justify the necessity of Environmental audit for the given purposes.<br>2b.Set the norms for Environmental audit of the given building.<br>2c.Describes various steps in EIA of the given civil engineering projects.<br>2d.Relate the findings of EIAfor reducing the Pollution in the given situation. | **2.1 Environmental Audit :** Meaning, Necessity, Norms<br>**2.2 Types:** Objective-based types: Liabilities audit, Management audit, Activities audit<br>Client-driven types: Regulatory external audit, Independent external audit, Internal environmental audit, Third party audit<br>**2.3 Environmental Impact Assessment(EIA):**Introduction, EIA regulations, Steps in environmental impact assessment process, Benefits of EIA, Limitations of EIA, Environmental clearance for the civil engineering projects. |
| **Unit– III Energy and Energy conservation** | 3a.Use the given source of renewable and Non-renewable energy for energy conservation.<br>3b.Justify the need of energy conservation in the given civil project.<br>3c.Describe present practices adopted in energy conservation in the country.<br>3d.Justify the role of MEDA in energy conservation in the given city/town.<br>3e. Implement the relevant provisions of Energy conservation act 2001 for the purpose of energy conservation in the given project. | 3.1 **Renewable Energy Resources :** Solar Energy, wind Energy, Ocean Energy, Hydro Energy, Biomass Energy<br>**3.2 Non-renewable Energy Resources:** Coal, Petroleum, Natural Gas, Nuclear Energy, Chemical Sources of Energy, Fuel Cells, Hydrogen, Biofuels<br>**3.3 Energy conservation:** Introduction, Specific objectives, present scenario, Need of energy conservation, LEED India Rating System and Energy Efficiency.<br>**3.4 Functions** of Government organization working for Energy conservation and Audit(ECA)-<br>•National Productivity council(NPC)<br>•Ministry of New and Renewable Energy (MNRE) |

| | | |
|---|---|---|
| | | •Bureau of Energy efficiency (BEE)<br>• Maharashtra Energy Development Agency (MEDA)<br>3.5 Salient features of Energy Conservation Act – 2001 |
| **Unit– IV Green Building** | 4a.Identify the components of the given green building.<br>4b. Explain the principles of green building used in the given building.<br>4c.Improve the quality of environment in the given civil structure.<br>4d. Suggest the strategies for design of the given building to have green building construction.<br>4e.Identify the relevant Materials required for the given building to have green building construction. | **4.1 Introduction:** Definition of Green building, Benefits of Green building,<br>**4.2 Principles:** Principles of Green building- planning concept of Green Building<br>4.3 **Features:** Salient features of Green Building, Environmental design (ED) strategies for building construction<br>**4.4 Process:** Improvement in environmental quality in civil structure<br>**4.5 Materials:** Green building materials and products- Bamboo, Rice husk ash concrete, plastic bricks, Bagasse particle board, Insulated concrete forms. reuse of waste material-Plastic, rubber, Newspaper wood, Non toxic paint, Green roofing, |
| **Unit– V Rating System for Green Building** | 5a. Select the relevant rating system for assessment of given green building<br>5b. Compare the different rating systems such as GRIHA , IGBC, EDGE, BEE adopted in the country.<br>5c.Explain salient provisions used in IGBC green rating system for the given building.<br>5d. Explain the role of HVAC unit in the given type of green building. | 5.1 Leadership in Energy and Environmental Design (LEED) criteria,<br>5.2 Indian Green Building council (IGBC) Green rating,<br>5.3 Green Rating for Integrated Habitat Assessment. (GRIHA) criteria,<br>5.4 HVAC unit in green Building |

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

## 9.SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|---|---|---|---|---|---|---|
| | | | R Level | U Level | A Level | Total Marks |
| I | Environmental Pollution | 4 | -- | 4 | 4 | |

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|---|---|---|---|---|---|---|
| | | | R Level | U Level | A Level | Total Marks |
| II | Environmental Audit and Environmental Impact Assessment | 8 | 2 | 4 | 6 | 12 |
| III | Energy and Energy conservation | 10 | 4 | 6 | 6 | 16 |
| IV | Green Building | 14 | 2 | 8 | 6 | 16 |
| V | Rating System for Green Building | 12 | 2 | 4 | 12 | 18 |
| **Total** | | 48 | **10** | **26** | **34** | **70** |

***Legends:*** *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note****: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

## 10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Identify renewable and non renewable energy sources
b. Identify the sources of pollution in your area
c. Visit to construction site to identify energy resources
d. Make a model of solar energy plant.
e. Search software/freeware for the course content and write the report stating their applications.

## 11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Procure various materials required for practical exercises.
g. Arrange visit to nearby industries and workshops for understanding various construction materials.
h. Use video/animation films to explain various processes like Manufacturing of construction materials, concrete mixing, and base preparation for painting, mortar laying, carpentry work, false ceiling.

i. Use different instructional strategies in classroom teaching.
j. Demonstrate different samples of various construction materials like Stone, aggregate of different sizes, timber, lime, bitumen, Bricks, tiles, precast concrete products, Water proofing material, Termite proofing material, Thermal insulating material, plaster of Paris, paints, distemper, and varnishes.
k. Display various technical brochures of recent building materials.

## 12. SUGGESTED MICRO-PROJECTS

***Only one micro-project*** is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Prepare a report by taking case study to classify the terms and the construction methodologies between Traditional building and Green building.
b. Collect the relevant information of recent technologies in green building construction and prepare a report on it.
c. Make a model of hydroelectric power plant and prepare a report.
d. Prepare a questionnaires for environmental audit
e. Prepare questionnaires for assessment of environmental impact

## 13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book | Author | Publication |
|---|---|---|---|
| 1. | Sustainable construction: Green Building design and Delivery. | Kibert, C.J. | John Wiley Hoboken, New Jersey, Nov. 2007, ISBN: 978-0-470-11421-6. |
| 2. | Non conventional Energy Resources– | Chauhan, D S Sreevasthava, S K | New Age International Publishers, New Delhi 2014 ISBM13 : 9788122433999 |
| 3. | Alternative Building Materials and Technologies – – | Jagadeesh, K S, Reddy Venkatta Rama Nanjunda Rao, K S | New Age International Publishers, Delhi, 2008 ISBN 8122420370, 9788122420371 |
| 4. | Handbook of Green Building Design and Construction | Sam Kubba | Butterworth-Heinemann,2012 **eBook ISBN:**9780123851291 |

## 14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.moef.nic.in/environmental_clearancegeneralhttp://www.sustainable.doe.gov
b. https://www.mahaurja.com/
c. https://mnre.gov.in/
d. https://www.mahaurja.com/meda/energy_conservation/energy_conservation_program
e. http://web.ccsu.edu/faculty/kyem/GEOG473/10TheWeek/IMPACT%20ASSESSMENT.htm