GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester – V

Elective Course Title: **SUSTAINABLE AND GREEN BUILDINGS**
(Course Code: 41056307)

Diploma Programme in which this course is offered	Semester in which offered
63 – Architecture	Fifth

1. RATIONALE

Our natural environment is significantly impacted by the expansion and development of our communities. Many of our natural resources are used in the production, planning, construction, and maintenance of the buildings where we live and work. This course is developed to acquaint the learner about the increasing effectiveness with which buildings and their sites utilize energy, water, and materials while minimizing impacts on human health and environment. Green Buildings are designed to have reduced environmental impacts in terms of energy, water, transportation, waste and the indoor environment. Beyond the confines of buildings, green-building principles also apply to site, community, and land-use planning concerns. Therefore this course will enable the learner to understand the challenges of today's era in an effective way to design the building as green for sustainable development.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competency:

- **Will be able to apply prevailing green building concepts for architectural design**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Explore appropriate environmentally friendly building materials and technology.
b) Green building using the principles of green building design and the relevant materials. (rating)
c) Conceptualize green building design for a given site.
d) Develop the design using various concepts of green building.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P/S	C	CA*	ESE	CA	ESE	
-	-	4	2	-	-	25*	25	50

*(*): For this practical/studio only course, 25 marks under the practical CA should be done by assessment of process of landscape drawings with all parameters. This is designed to facilitate attainment of COs holistically. Thus, this course should be considered as an **Applied 'Theory' Course** where the theory portion has to be taught during the practical/studio hours.*
***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice;**P/S** -Practical Studio as applied theory ; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. Some of the PrOs marked '' are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Enlist green building practices with regard to National and International Green Building Rating systems	1	12
2	Identifying Green building concepts and Green building rating systems through secondary/primary case study of existing buildings in India.	2	12
3	Prepare conceptual drawings of a given residential site: Develop Green building design of a selected a building unit and prepare all Drawings and sketch to a suitable scale.	3	12
4	Prepare all final presentation drawings: Prepare all Plans, Sections, Elevations and Details highlighting Green Building parameters	4	12
5	Evaluate the designed project with reference to Green Building fundamentals	4	8
	Total		**56**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course)that occur in the above listed **Practical Exercises Of** this course required which are embedded in the COs and ultimately the competency.*

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Measuring tape, laser measure tape, drawing sheets, tracing papers	1-5
2	Drawing board (A1 size @ 23"X32") with other instruments like parallel, set squares (45˚ and 30˚-60˚), adjustable set square, triangular scale, tracing papers, and drawing sheets.	1-5
3	Interactive board with LCD overhead projector.	1-5
4	Desktop PCs with latest configuration	1-5
5	Latest Digital Single-Lens Reflex (DSLR) Camera	1-5

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned Cos and PrOs. More could be added to fulfill the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Participates in class discussions.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit — 1 Green Building Concept and Principles	1a. Discuss the concept of Green building and sustainable development. 1b. Enlist the Objectives, Principles and Benefits of Green building design. 1.c. Discuss various National & International Green Building Rating System:	1.1 Introduction –Concept of Green building and sustainable development 1.2 Objectives, Principles and Benefits of Green building design. ● design for healthy, comfortable & environmentally friendly homes ● Effective use of site resources ● Water conservation ● Energy efficiency ● Handling of house-hold waste-5 – R concept (Refuse, Reduce, Reuse & Repurpose, Recycle) 1.3 National & International Green Building Rating System: GRIHA, IGBC & USGBC
Unit— 2 Case study of Existing Green	2a. Understand the existing green building concept, design and its requirements. 2b. Use GRIHA/IGBC/USGBC	2.1 Study of selected examples of Green Building based on – materials, Factors affecting indoor environment quality,

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
building	checklist to assess existing green buildings.	water & energy saving and waste management.
Unit—3 Development of Concept	3a. Develop conceptual design considering various green design parameters for further design development of the given residential site ***(Preferably Sem 2nd Advanced architectural design studio project or any other similar project)***. 3b. Design development with green building considerations. 3c. Discuss about embodied energy for different material and its application, operational energy in building and life cycle energy in construction industry.	3.1 Various concept development parameters ● Building orientation on Sustainable Site ● Material & Resources : ● Sustainable building Material & Resources. ● Land and building relationship. ● Functional aspects ● Water conservation ● Energy efficiency ● Indoor Environmental Quality ● Handling of house-hold waste
Unit—4 Final Presentation with details	4a. Develop design considering various green design parameters. 4b. Development of elevations and sections with respect to activities and usage of different green materials. 4.c. Self-evaluation of proposed design	4.1 Floor plan with complete Site layout should include building units, roads and landscaped areas drawn clearly with appropriate annotations. 4.2 Green building design's details with annotations to understand the layout in its totality. 4.3 Detailed drawings showing all the components and elements of Green building e.g. Water conservation, passive solar design, alternative energy sources, energy conservation, and reuse of materials etc. as per the design 4.4 Exercise of self-evaluation of proposed design with reference to any of rating system i.e. IGBC etc. and study the outcome

Note*: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	**Green Building Concept and Principles**	8	**Not Applicable**			
II	**Case study of Existing Green building**	12				
III	**Development of Concept**	16				
IV	**Final Presentation with details**	20				
Total		**56**				

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist learners for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightlyfrom the above table.*

10. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities like: course/topic-based seminars, internet based assignments, teacher guided self-learning activities, and course/library/internet/lab based Mini-Projects, etc. These could be individual or group based.
i) Visit existing green building and draw sketches of elements of green building
ii) Poster making on green building
iii) Visit exhibitions and seminars related to Green building and sustainable development
iv) Encourage and promote activity such as interacting with the architects / firms practicing green building concepts & principles.
v) Relevant internet-based case studies.

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/subtopics.
b) Guide student(s) in undertaking micro-projects.
c) Different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature are to be given to the learners for ***self-learning***, but to be assessed using different assessment methods.
e) Use different instructional strategies in classroom teaching.
f) Guide learners on form, functions utility, method of construction, etc. to facilitate them to prepare actual measured drawings.

g) Use the technique of table top discussions along with design jury sessions to teach the relevant content to the learners.

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 a dated work diary consisting of individual contributions 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 a micro-project by the end of the semester to develop the industry-oriented COs.

A suggested list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) **Document similar existing green building**
b) **Prepare a presentation on elements of Green building e.g. Site Selction, Water conservation, passive solar design, alternative energy sources, net zero buildings, etc.**

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Green Building Fundamentals	G Harihara Iyer	Notion Press,2022,ISBN: 979-8886416091
2	The Idea of Green Building	A.K. Jain	Khanna Publishers; First edition (1 January 2014),ISBN: 978-8174092564
3	Sustainable Building Design: Applications Using Climatic Data in India (Design Science and Innovation)	Chitrarekha Kabre	Springer; 1st ed. 2018 edition (23 October 2017),ISBN:978- 9811046179
4	A Green Vitruvius: Principles and Practices of Sustainable Architectural Design	J.Owen Lewis	Routledge; 2nd edition (17 June 2011) ISBN-13 : 978-1849711913
5	Green design: design for the Environment	Dorothy Mackenzie	Laurence King Publishing; 2nd edition (7 April 1997), ISBN-13 : 978-1856690966
6	Green Shift: Changing attitudes in architecture to the Natural World	John Farmer (Author), Kenneth Richardson (Editor)	Architectural Press; 2nd edition (10 September 1999), ISBN-13 : 978-0750643405
7	Non-Conventional Energy Resources	G. D. Rai	Khanna Publishers (1 January 1988), ISBN-13 : 978-8174090737

14. SOFTWARE/LEARNING WEBSITES

a) https://igbc.in/igbc/redirectHtml.htm?redVal=showGreenHomesnosign
b) https://www.usgbc.org/leed
c) https://www.greenbusinesscentre.com/
d) https://www.grihaindia.org/
e) https://www.usgbc.org/resources/green-building-design-and-construction-curriculum-toolkit-guide
f) https://urban-industrial.in/hrdpmp/igep-uid/content/e5170/e6258/e14631/e14635/TrainingManual_GreenBuilding.pdf
g) https://igbc.in/igbc/html_pdfs/abridged/IGBC%20Green%20New%20Buildings%20Rating%20System%20(Version%203.0).pdf
h) www.nptel.iitm.ac.in /
i) www.khanacademy/

15. PO-COMPETENCY-CO MAPPING

Semester II	**Green Buildings (Course Code: 4355007)**						
	POs and PSOs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation &Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Management**	**PO 7 Life-long learning**
Competency	**Will be able to apply prevailing green building concepts for architectural design**						
Course Outcomes CO a) Explore appropriate environmentally friendly building materials and technology.	1	-	-	-	1	-	2
CO b) Document the building using the principles of green building and the relevant materials.	1	1	-	-	1	-	-
CO c) Conceptualize green building design for a given site.	1	2	2	-	2	-	2
CO d) Develop the design using various concepts of green building.	1	2	2	-	2	-	-

Legend: '**3**' for high, '**2**' for medium, '**1**' for low or '**-**' for the relevant correlation of each competency, CO, with PO

***PSO 1: Planning & Design:** Prepare architectural designs and all types of drawings with appropriate material specifications and application techniques as per specific project requirements.

#PSO 2: Execution: Suggest appropriate building materials as per the requirement.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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1.	Shri Bhaskar J Iyer (HOD in Arch, Coordinator & Associate Dean)	Government Polytechnic for Girls, Ahmedabad	9879474833	bhaskariyer2004@gmail.com
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