GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Building Services
(Course-4360605)

Diploma programme in which this course is offered	Semester in which offered
Civil Engineering	6th Semester

1. RATIONALE

The building services encompass a wide range of systems, including electrical, mechanical and civil engineering services. They are essential for various types of buildings, such as residential, industrial, high-rise, hotels, motels, and monumental structures; and they ensure the efficient and effective operation of buildings for their intended purposes

No building can be effectively utilized without these services. Additionally, the current need for ecofriendly and sustainable designs, including green building principles and grey-water management. Therefore, it is expected for civil engineering students to know about the basic principles, installation procedures, and the operation and maintenance of these building services. It is here clarified that some services like plumbing and sanitary services have already been taken care of in a separate course, so they are not included in this particular curriculum.

2. COMPETENCY

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

1. **Plan various types of services required for different types of buildings.**
2. **Supervise the execution of installation of services such as lift, fire protection, elevators, escalators, acoustic and sound insulations, lightings, air conditioning and allied services for creating human comfort in the buildings.**

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) Manage building services provisions in big construction sites.
b) Synchronize the installation of building services as per the sequence of construction activities.
c) Select the suitable electrical as well mechanical services for particular requirements of buildings.
d) Ensure Fire Protection, Acoustics and Sound insulation along with green building applications to the new constructions.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total
L	T	P	C	CA	ESE	CA	ESE	Marks
3	-	2	4	30*	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment 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, **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	Prepare Lighting plan for a commercial complex	1	2*
2	Prepare electrical layout plan for given building.	2	2*
3	Prepare Lift standards as per norms.	3	2*
4	Identify proper locations for Lift/ Escalator/ Elevator in a given commercial complex.	3	2*
5	Suggest noise control methods for a given commercial complex.	4	2*
6	Prepare a case study for the fire fighting services for commercial building in the nearby area.	4	4*
7	Compute space requirement for Rooftop rain water harvesting system and Prepare rain water harvesting layout plan for a building.	5	2*
8	Prepare a report on implementing the reuse of grey water of an existing hotel building in a nearby area.	5	4*
9	Visit a residential building & commercial building under construction and prepare layout for electrical, water supply, sanitary and related allied services of civil engineering and prepare site visit detailed report	1, 2, 3, 4, & 5	4*
10	Topic of seminar shall be given to a group of students not more than three. The students are required to submit report including power point presentation and present/ defended the seminar in the presence of students and teachers.	1, 2, 3, 4, & 5	4*

Total		**28**

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.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
For PrOs 1, 2		
1	Neatness, Cleanness in Sketch book/ Drawing Sheet	10
2	Uniformity in Drawing and line work	10
3	Creating given drawing	40
4	Dimensioning the given drawing and writing text	20
5	Answer the question	10
6	Submission of drawing in time	10
	Total	**100**

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
For PrOs 9		
1	Discipline	10
2	Involvement during site visit	20
3	Data collection at site	20
4	Organization of report	20
5	Answer the question	10
6	Timely submission of report	20
	Total	**100**

S. No.	Sample Performance Indicators for the PrOs	Weightage in %

For PrOs 3, 4, 5, 6, 7, 8		
1	Data collection	20
2	Calculation, Write up, Grammar etc.	20
3	Organization of report	20
4	Answer the question	20
5	Timely submission of report	20
	Total	**100**

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
	For PrOs 10	
1	Initiative	20
2	Data Collection	20
3	Content of Presentation (Use of multi media)	20
4	Presentation (Body Language- Gesture, Posture etc.)	20
5	Answer the question	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipments 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.

S. No.	Equipment Name with Broad Specifications	PrO.No.
1		

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 fulfil the development of this competency.

a) Work as a leader/a team member.
b) Follow safe practice on site/ lab.
c) Maintain tools and equipment.
d) Follow ethical practices.
e) Practice environmental friendly methods and processes. (Environment related)

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) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Unit– I Introduction	**1a.** Describe basics of building services. **1b.** Apply various types of services as per needs of building. **1c.** Apply Lighting and Ventilation provisions	1.1 Definitions 1.2 Objective and uses of services 1.3 Applications of services for different types of building 1.4 Classification of building services 1.5 Types of services and selection of services 1.6 Natural and artificial lighting: principles and factors 1.7 Arrangement of luminaries, Distribution of illumination, Utilization factors 1.8 Necessity of Ventilation Types – Natural and Mechanical Factors to be considered in the design of Ventilation
Unit– II Electrical Services	**2a.** Prepare electrical services requirement and Layout of a given building	2.1 electrical services in the building: Technical terms and symbols for electrical installations and Accessories of

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics

and Layout	**2b.** Conceptualise Smart Home **2c.** Provide Rooftop Solar Power plants	wiring 2.2 Systems of wiring like wooden casing, cleat wiring, CTS wiring, conduit wiring 2.3 Types of insulation 2.4 Electrical layout for residence, small work shop, show room, school building, etc. 2.5 Smart Home: Uses, Smart Electrical Appliances, Smart Security systems 2.6 Rooftop Solar PV Power plant: overview of Solar PV Technology, overview of Rooftop Solar Sector in India, type of Rooftop Solar PV Power Plants and operating principles.
Unit – III Mechanical Services in Buildings	**3a.** Identify the services like lift, elevators, conveyors and escalators, etc. **3b.** Plan various types of mechanical services as per requirements of building **3c.** Select the right type of air conditioning and the position of air conditioning	3.1 Introduction of mechanical services 3.2 Lift 3.2.1 Definition, Types of Lifts, Design Considerations, Location, Sizes, Component parts- Lift Well, Travel, Pit, Hoist Way, Machine, Buffer, Door Locks, Suspended Rope, Lift Car, Landing Door, Call Indicators, Call Push 3.3 Elevators & Escalators 3.3.1 Different types of elevators and Escalators, Freight elevators, Passenger elevators, Hospital elevators, 3.3.2 Uses of different types of elevators Escalators. 3.4 Dumbwaiters 3.4.1 Different types of Dumbwaiters 3.4.2 Uses of different types of Dumbwaiter. 3.5 Air Conditioning 3.5.1 Definition, Purpose, Principles, Temperature Control, Air Velocity Control, Humidity Control, Air Distribution system, Cleaners, Filters, Spray washers, Electric precipitators,
Unit	**Unit Outcomes (UOs)**	**Topics and Sub-topics**

	(4 to 6 UOs at Application and above level)	
		3.5.2 Types of Air Conditioners
Unit – IV Fire Protection, Acoustic and Sound Insulations	**4a.** Identify the services of Fire **4b.** Apply various types of fire services as per requirements of building **4c.** Select the suitable type of Fire protection. **4d.** Provide Acoustic and sound insulation as per needs	4.1 Introduction 4.2 Causes of fire and Effect s of fire 4.3 General Requirements of Fire Resisting building as per IS and NBC 2005 4.4 Characteristics of Fire resisting materials 4.5 Maximum Travel Distance 4.6 Fire Fighting Installations for Horizontal Exit, Roof Exit/ Fire Lifts, External Stairs 4.7 Requirement of good Acoustic 4.8 Various sound absolvent 4.9 Factors to be followed for noise control in residential building
Unit – V Miscellaneous Services & Green Buildings Provision	**5a.** Plan for Rain Water Harvesting in the new buildings **5b.** Apply Green Building technology aspects	**5.1.** Rain water Harvesting for buildings 5.1.1 Rooftop rainwater harvesting **5.2.** Grey water reuse 6.2.1 Significance of Grey water reuse 6.2.2 Components of Grey water system & its management. **5.3.** Concept of GREEN buildings. **5.4.** Components of GREEN building.

***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	Introduction	6	2	4	4	10
II	Electrical Services and Layout	12	4	8	8	20
III	Mechanical Services in Buildings	10	4	8	8	20
IV	Fire Protection, Acoustic and Sound Insulations	8	2	4	4	10
V	Miscellaneous Services and Green Buildings Provision	6	2	4	4	10
Total		**42**	**14**	**28**	**28**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

***Note**: This specification table provides general guidelines to assist student 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 slightly from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested studentrelated ***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) Visit of construction sites to observe the current services practices and prepare a report.
b) In a group of 4-5 students prepare an internet/ library-based presentation for each of above topics considering recent practices prevailing across the world.

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) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means 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 is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.11***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environ and sustainability.

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

a) **Green Solutions:** Prepare a report suggesting replacement of/ augmenting atleast 10 nos. of items to convert it into a Green Building and justify it in terms of environmental impact.
b) **Green Solutions:** Prepare a report on implementing recycling of grey water for your Institute.
c) **Mechanical Services:** Collect the relevant information of recent technologies in elevators and prepare a report on it.
d) **Mechanical Services:** Suggest the type of mechanical services to be provided in a building as per its functional requirements and compute the space requirements for it as per guidelines of national building code.
e) **Miscellaneous Services:** Prepare a report on BMS including a case study.
f) **Miscellaneous Services:** Collect the relevant information of different techniques for RWH and submit a report on it.
g) **Miscellaneous Services:** Prepare a report on enhancing the Building services of an existing building in nearby area.
h) **Lighting and Ventilation:** Prepare a summary report with reference to lighting, ventilation and acoustic system of a building.
i) **Air Conditioning:** Plan and draw in detail ventilation and air-conditioning for a given building
j) **Safety**: Prepare a report on modern Fire Safety, Detection and Protection systems.
k) **Acoustic and Sound Insulations:** Prepare a report on executing the requirements of any sound proof room.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	The A to Z of Practical Building Construction and its Management	Sandeep Mantri	Satya Prakashan, New Delhi ISBN-139351922629-978 :
2	Plumbing Design and Practice	Deolalikar, S. G.	McGraw-Hill, New Delhi, 2004 ISBN: 9780074620694
3	Fire Services in India: History, Detection, Protection, Management, Environment, Training and Loss Prevention	Bag, S. P.	Mital Publications, New Delhi, 1995, ISBN-13: 978-8170995982
4	Principles of Fire Safety Engineering: Understanding Fire and Fire Protection	Akhil Kumar Das	Prentice Hall India Learning Private Limited, New Delhi, 2014, ISBN-13: 978-8120350380

5	National Building Code of India - 2005	Bureau of Indian Standards	BIS, New Delhi
6	Building Services	S. M. Patil	Seema Publication, Mumbai Revised edition
7	A text book on Building Services	R. Udaykumar	Eswar Press, Chennai
8	Green Building Fundamentals	G Harihara Iyer	Notion Press, Vanagaram ,
S. No.	**Title of Book**	**Author**	**Publication with place, year and ISBN**
			Chennai ISBN-13: 979-8886416091

14. SOFTWARE/LEARNING WEBSITES

a) https://www.bis.gov.in/
b) https://bmsbuildingservice.com/
c) https://plumbingservices.com/
d) http://www.asce.org/
e) https://www.astm.org/

15. PO-COMPETENCY-CO MAPPING

Semester V	**Building Services (Course Code: 4*****)**									
	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** Lifelong learning	**PSO 1**	**PSO 2**	**PSO 3** (If needed)
Competency	**3. Plan various types of services required for different types of buildings.** **4. Supervise installation and testing of services such as lift, fire protection, elevators, escalators, acoustic and sound insulations, lightings, air conditioning and allied services.** **5. Execute the building services for creating human comfort in the buildings.**									
Course Outcomes CO a) Manage building services provisions in big construction sites .	3	2	-	-	3	-	3	-	-	-
CO b) Synchronize the installation of building services as per the sequence of construction activities.	3	3	3	-	3	2	3	-	-	-

CO c) Select the suitable electrical as well mechanical services for particular requirements of buildings.	3	2	2	-	3	-	3	-	-	-
CO d) Ensure Fire Protection, Acoustics and Sound insulation along with green building applications to the new constructions.	3	2	2	-	3	-	3	-	-	-

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

17. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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