GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Building Services
(Course Code: 4345004)

Diploma programme in which this course is offered	Semester in which offered
Architectural Assistantship	4th Semester

1. RATIONALE

This course focuses on a learner's acquisition of knowledge, skills and practices of essential building services for proper functioning and utility of building as a 'whole' unit/entity. Building services play a critical role in the overall functioning and performance of a building, affecting factors such as energy efficiency, comfort, safety, and sustainability. Building services are a cross-disciplinary field, involving aspects of electrical, mechanical, and plumbing engineering, and it is important to have a basic understanding of these systems. Knowledge about domestic water supply & sanitation system (external & internal) and house drainage & disposal facilities, rain water harvesting, ventilation and air conditioning, acoustics and creation of movement provisions and fire safety measures is imparted. Understanding of building services is essential for architects in the design and construction process, as well as for maintenance of buildings in the future. Hence, the study of building services is a critical component of the education of architecture students, providing them with the knowledge and skills necessary to design and manage the technical systems of buildings effectively.

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Apply knowledge of essential building services in architectural designs for their effective & efficient functioning**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Draw layout plan of water supply system, drainage system and rain water harvesting for a given building.
b) Prepare a plan indicating the location of ventilation/air conditioning system, lift, escalators, ramps and fire safety provision for a given building.
c) Select appropriate type of acoustic material as per the requirement for a given building.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical/Studio Marks		Total Marks
L	T	P/S	C	CA	ESE	CA	ESE	
3	0	2	4	70	30	25	25	150

*(*): For this practical/studio only course, 50 marks under the practical CA should be done by assessment of process of designing a public building with all design 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; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL/STUDIO EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. T*hey 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	Draw scheme for water supply for a given building	I	6
2	Draw detailed scheme for house drainage, sanitary fixtures and rain water harvesting for a given building	II	6
3	Prepare detailed layout of ventilation and air-conditioning for a given building	III	4
4	Design acoustics and identify fire safety provisions for a given building.	IV, V	6
5	Plan movement facilities: Lifts, escalators, ramps etc. for a given public building	V	6
	Total Hrs.		**28**

Note

*i. More **Practical/Studio 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. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss about type of data (which and why) before group start their site visits.

*iii. 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/Studio 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 %
1	Proper planning and layout of drawing sheet – overall composition (for optimum use of drawing sheet)	10
2	Completing given practice problems	20
3	Accuracy of drawing	20

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
4	Neatness of drawing	10
5	Timely submission of completed drawing sheet	20
6	Answering viva voce questions	20
Total		**100**

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 practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO.No.
1	Drawing Board with other drawing Instruments	1-5
2	Interactive board with LCD overhead projector	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 fulfil the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Social and Functional Competence of design
d) Participates in class discussions and present the design effectively, Generate new ideals.
e) Practice environmentally friendly methods and design processes.

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

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such 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 different levels)	Topics and Sub-topics
Unit –I **Domestic water supply**	**1a.** Enlist various sources of water and uses of water. **1b.** Calculate demand of water for domestic purpose. **1c.** Explain the factors affecting rate of demand of water. **1d.** Explain various methods of water distribution and layout of distribution pipes with sketch.	1.1 Sources of water 1.1.1 Uses of water 1.1.2 Demand of water for domestic purpose only 1.1.3 Factors affecting rate of demand of water 1.2 Methods of water distribution 1.2.1 Systems of supply of water 1.2.2 Methods of layout of distribution pipes

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	1e. Explain various water supply system **1f.** Explain various water supply fittings, fixtures and pipes. **1g.** Draw layout of water supply system for a residence. **1h.** Plan for Rain water harvesting in the new buildings	1.3 Water supply fittings & fixtures Air valves, Bib cocks, Fire hydrants, Reflux valves, Relief valves, Sluice valves, Water meters 1.3.1 Pipes of different materials used for water supply 1.4 Simple layout of water supply system for a residence 1.5 Rain water harvesting for buildings
Unit– II Sanitation and house drainage	**2a.** Explain various purposes and principles of sanitation. **2b.** Define Bacteria, Invert, Refuse, Sewer, Sewerage **2c.** Explain various system of sewerage. **2d.** Explain principles of house drainage. **2e.** Define traps and classify them according to shape and function **2f.** Explain various system of plumbing and **2g.** Define Anti-siphonage pipe, Cowl, Fresh air inlet, Siphonage, Soil pipe, Vent pipe, Waste pipe. **2h.** Explain various sanitary fittings and **2i.** Draw Drainage plan of a building. **2j.** Explain maintenance of house drainage system **2k.** Explain septic tank, soak pit and manholes with sketch. **2l.** Describe objective of manhole **2m.** Explain location and classification of manhole	2.1 Purpose of sanitation 2.1.1 Principles of sanitation 2.1.2 Definitions: Bacteria, Invert,Refuse, Sewer, Sewerage 2.1.3 Systems of sewerage: • Separate system • Combined system • Partially separate system 2.2 Principles of house drainage- 2.2.1 Traps: definition, function andrequirement of a good trap 2.2.2 Classification of traps according toshape-P,Q and S Traps 2.2.3 Classification of traps according to function-Intercepting traps, Gully traps, Grease traps 2.2.4 Definitions of Anti-siphonage pipe,Cowl, Fresh air inlet, Siphonage, Soil pipe, Vent pipe, Waste pipe 2.2.5 System of Plumbing • Single stack system • One pipe system • One pipe system partiallyventilated • Two pipe system 2.2.6 Sanitary Fittings-Sinks, Bath tub,Water closets, Flushing cistern, Urinals, wash basin 2.3 Drainage plan of a building 2.4 Maintenance of house drainagesystem 2.5 Septic tank and soak pit-constructional features,

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		advantagesand disadvantages 2.6 Manholes: • Definitions • Objective • Location • Classification of manholes • Component parts
Unit – III **Ventilation and Air conditioning**	**3a.** Define ventilation and its necessity. Explain the functional requirements and essentials of good ventilation system. **3b.** Describe system of ventilation **3c.** Define air conditioning and purpose and classification of air conditioning. **3d.** Explain the principles of comfort air conditioning. **3e.** Describe the system of air conditioning with sketch.	3.1 Definition of ventilation and its necessity 3.1.1 Functional requirements of ventilation system. 3.1.2 System of ventilation- Natural/mechanical i.e., exhaust airsupply and combined. 3.1.3 Essentials of good ventilating system. 3.2 Definition of air conditioning 3.2.1 Purpose of air conditioning. 3.2.2 Classification of air conditioning. • Comfort A.C • Industrial comfort • Summer, Winter airconditioning. 3.2.3 Principles of comfort air conditioning. • Temp control • Air velocity control • Humidity control 3.2.4 System of air conditioning. 3.2.5 Central system 3.2.6 Self-contained system unit 3.2.7 Combined system
Unit – IV **Acoustics**	**4a.** List out and explain characteristics of audible sound **4b.** Explain various acoustical defects. **4c.** Define insufficient loudness and external noise. **4d.** Classify various sound absorbent materials and explain them. **4e.** Explain the required conditions of good acoustics.	4.1 General discussion 4.2 Characteristics of audible sound • Frequency of pitch • Intensity of loudness of sound • Measurement of sound • Principles of acoustics. • Behavior of sound and its effect. 4.3 Acoustical defects • Formation of echoes. • Reverberation • Reverberation time • Optimum time of reverberation

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	4f. Explain general principles in acoustical design.	• Dead spot • Sound foci 4.4 Insufficient loudness and external noise. 4.5 Sound absorbent material and their classification. 4.6 Requirement and conditions of good acoustics. 4.7 General principles in acoustical design • Site selection • Volume • Space • Treatment of interior • Surface • Reverberation • Sound absorption • Seats and seating arrangement
Unit – V Movement Facilities & Fire Safety Provisions	**5a.** Explain electrical lifts along with its component parts with sketch. **5b.** Describe what is an escalator, its types, space required and approaches. **5c.** Explain ramps for different **5d.** Apply various types of fire services as per requirements of building **5e.** Select suitable types of fire protection	5.1 Electrical lifts, lift wall, lift door and gates and their detail with sketch 5.2 Escalators – types, space required and approaches 5.3 Ramp details for different purposes as well as their spaces and locations 5.4 Causes and effects of fire 5.5 General requirements of fire resisting building as per IS and NBC 2005 5.6 Characteristics of fire resisting materials

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	Domestic water supply	08	02	08	04	14
II	Sanitation and house drainage	10	02	10	04	16
III	Ventilation and Air conditioning	09	02	06	06	14
IV	Acoustics	09	02	08	04	14
V	Movement Facilities & Fire Safety Provisions	06	00	07	05	12
Total		**42**	**08**	**39**	**23**	**70**

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 to 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 slightly vary from above table.*

10. SUGGESTED LEARNER ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested learner-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Learners should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (learner's) portfolio which may 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 learner(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 learners for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide learners on how to address issues on sketching, model making, etc.
g) Use relevant video/animation films to explain various concepts and processes related to basic Architectural design themes for Public Buildings.
h) Use different instructional strategies in classroom teaching.
i) Use the relevant architectural assignments in the given situation.
j) Guide learners on form, functions utility, method of construction, etc. to facilitate them to prepare actual measured drawings.
k) Use the technique of table top discussions along with design jury sessions to teach the relevant content to the learners.
l) Adopt various strategies to enhance each learner's individual creative ability especially with reference to concept and form

12. SUGGESTED DESIGN MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a learner 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 (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of learners 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 learner 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 duration of the microproject should be about **14-16 (fourteen to sixteen) learner engagement hours** during the course. The learners 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 Co. Similar micro-projects could be added by the concerned course teacher:

a. Study of on-going constructions works and documentation of the provisions of building services in the form of a report with photographs and sketches.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	The text book of Building Construction	S. P. Arora, S. P. Bindra	Dhanpat Rai Publications (P) Limited ISBN: 978-81-89928-80-3
2	Building Construction	Rangwala	Charotar Publishing House (P) Limited ISBN: 978-93-85039-04-1
3	Building Construction	Dr. B. C. Punmia, Er. Ashok K. Jain, Dr. Arun K. Jain	Laxmi Publication (P) Limited, Eleventh Edition (2016), ISBN: 978-81-318-0428-5
4	Building Construction and Materials	Gurcharan Singh	Standard Book House, ISBN-13: 9788189401214
5	Water supply and sanitary Engineering (including environmental engineering)	S.C. Rangwala	Charotar Publications, ISBN-10: 9385039202
6	Water supply and sanitary Engineering	Gurucharan Singh & Jagdish Singh	Standard Publishers, ISBN-10: 8180140296
7	A text book of Water supply and sanitary Engineering	G. J. Kulkarni	Oxford & IBH Pub. ISBN: 812041683X
8	Building Services and Equipment: Volume 1 to 3	Frederick E. Hall	Routledge, ISBN-13, 978-0582236523
9	National Building Code of India - 2005	National Building Code of India - 2005	BIS, New Delhi

14. SOFTWARE/LEARNING WEBSITES

a) https://archive.nptel.ac.in/courses/105/102/105102176/

b) www.epa.gov/iaq/schooldesign/hvac.html

c) PO-COMPETENCY-CO MAPPING

Semester IV	Building Services (Course Code: 4345004)								
	POs and PSOs								
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineer-ing Tools, Experimentation &Testing**	**PO 5 Engineer-ing practices for society, sustain-ability & environ-ment**	**PO 6 Project Management**	**PO 7 Life-long learning**	*** PSO 1 Planning & Design**	**#PSO 2 Execution**
Competency	• **Apply knowledge of essential building services in architectural designs for their effective & efficient functioning**								
Course Outcomes a) Draw layout plan of water supply system and drainage system for given residential building.	3	3	2	-	1	1	1	3	1
b) Prepare a plan indicating the location of ventilation/air conditioning system, lift, escalators, ramps and fire safety provision for a given residential building.	3	3	2	-	1	1	1	3	1
c) Select appropriate type of acoustic material as per the requirement for a given building.	3	3	1	-	2	1	2	3	2

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO/PSO.*

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

#PSO 2: Execution: Work competently as assistants in architectural firms so as to contribute and coordinate both office work and execution on site

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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