Program Name : **Civil Engineering Program Group**

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

Semester : **Sixth**

Course Title : **Building Services (Elective-II)**

Course Code : **22604**

1. RATIONALE

Buildings serve several societal needs – primarily as shelter from weather, security, living space, privacy, to store belongings, and to comfortably live and work. Building services are the systems installed in buildings to make them comfortable, functional, efficient and safe. They can include fire safety, HVAC (heating, ventilation and air conditioning), lighting, plumbing, ICT (information and communications technology), and so on. Building Services Engineers are the people who make this happen. The knowledge of building services is necessary to maintain the functional requirements of the building by a civil technologists. As buildings are becoming more complex and more modern, it is essential to include the same in the Civil Engineering curriculum. This course is designed to enhance the employability with the skills required for building service industries.

2. COMPETENCY

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

- **Execute the building services for creating human comfort in the buildings.**

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 the building services for the requisite functional requirements.
b) Estimate the space requirements for vertical communication services.
c) Propose the fire safety requirements for multi-storeyed buildings.
d) Devise the water supply and sanitation system for buildings.
e) Evaluate the potential of rain water harvesting and solar water heater system for the buildings.
f) Execute the relevant system of lighting, ventilation and acoustics for buildings.

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 attainment of COs and the remaining 20 marks for tests and assignments given by the teacher.

***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 center of this map.

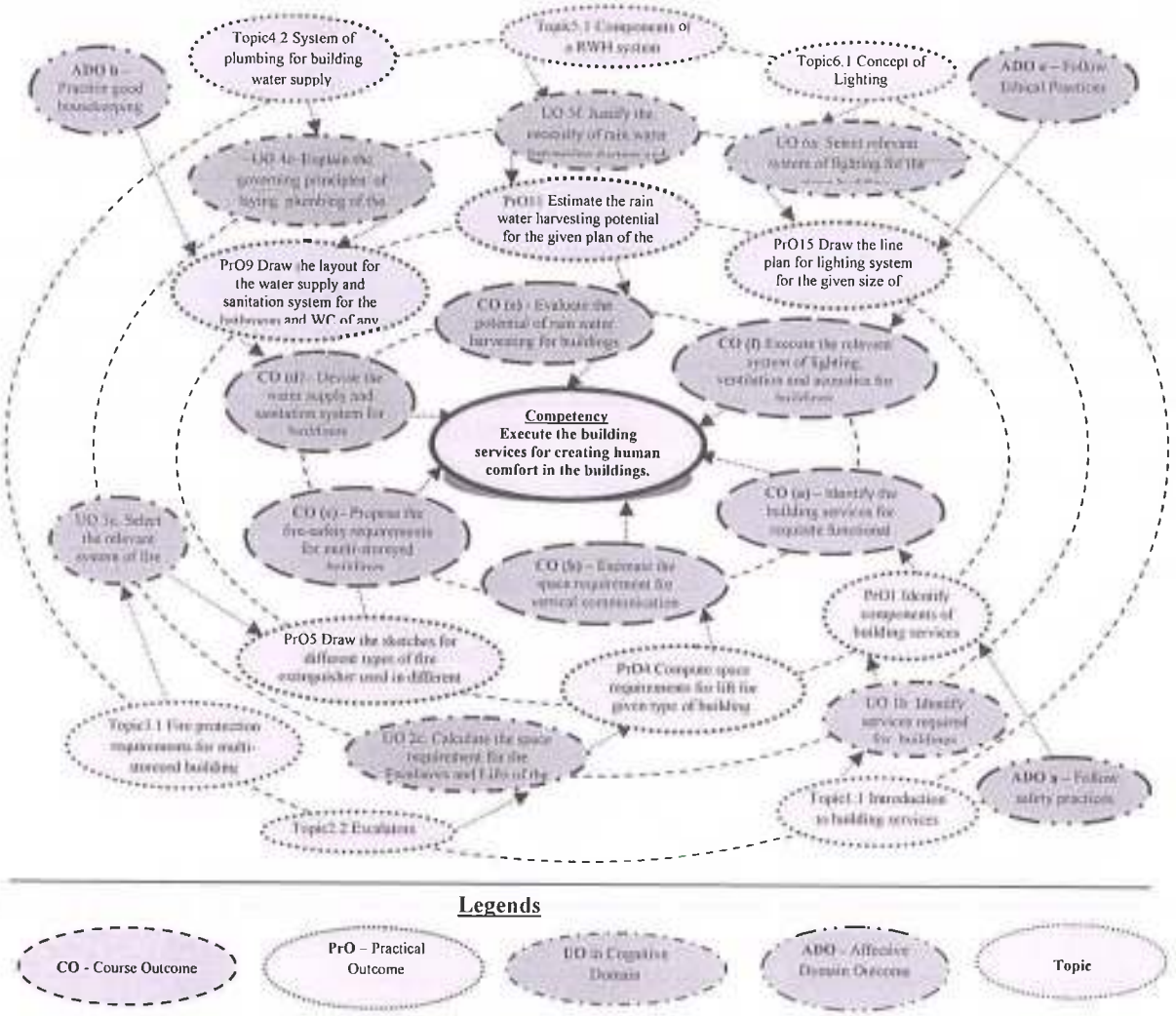

Figure 1 - Course Map

6. SUGGESTED PRACTICALS / EXERCISES

The practical/exercises/tutorials in this section are psychomotor domain PrOs (i.e. sub-components of the COs) are to be developed and assessed in the student to lead to the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Identify components of building services available in your institute building and prepare a report.	I	02
2	Compute the space requirements for the rain water harvesting system for the given type of building.	I	02
3	Compute the space requirements for the escalator for the given type of building as per guidelines of national building code.	II	02*
4	Compute the space requirements for the lift for the given type	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	of building as per guidelines of national building code.		
5	Submit your observations along with your comments on the specifications and working of the fire extinguisher by viewing the relevant video/simulation/photographs.	III	02*
6	View the relevant video/simulation/photographs and then draw a line plan showing the provisions of fire safety system in any multi storied residential building/anyone public building in your locality.	III	02
7	Submit your observations along with your comments on the layout for the water supply and sanitation system for the bathroom and WC of any multi-storey building including design parameters by viewing the relevant video/simulation/photographs.	IV	02*
8	Submit your observations along with your comments on the layout for the water supply and sanitation system for the bathroom and WC of any local public building including design parameters by viewing the relevant video/simulation/photographs.	IV	02*
9	Submit your observations along with your comments (labeled sketch, specifications) on the working of valves, pipes of different sizes and fittings (five each) by viewing the relevant video/simulation/photographs.	IV	02*
10	Estimate the rain water harvesting potential for the given plan of the residential building (single storey load bearing structure) and given data.	V	02*
11	Plan the proposed rain water harvesting system for data produced in practical no.10 with necessary sketch, diagram, specifications.	V	02
12	Estimate the rain water harvesting potential for the given plan of the residential building (multi storey framed structure) and given data.	V	02*
13	Submit your observations along with your comments on the specifications and data required for installation and maintenance of the solar water heating system for a dwelling unit with provided data by viewing the relevant video/simulation/photographs.	V	02*
14	Submit your observations along with your comments on the components and working of solar water heating system for the given type of dwelling unit with provided data by viewing the relevant video/simulation/photographs.	V	02
15	Submit your observations along with your comments on the laying of lighting system to be provided for the given size of room of a dwelling unit by viewing the relevant video/simulation/photographs.	VI	02
16	Estimate the quantities of the electrical points, switches and wiring system required for the given type of dwelling unit and Prepare a budget for it with summarization of all relevant information in the form of a report.	VI	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
17	Submit your observations along with your comments on natural and artificial ventilation for the public building by viewing the relevant video/simulation/photographs.	VI	02
18	Submit your observations along with your comments on natural and artificial ventilation for the residential building by viewing the relevant video/simulation/photographs.	VI	02
	Total		**36**

Note:

i. *A suggestive list of PrOs is given in above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical UOs/tutorials need to be performed, out of which, the practical 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. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of practical set up	10
2	Setting and operation	10
3	Safety measures	20
4	Observations and Recording	20
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	10
7	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) Work as a leader/a team member.
d) 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.
- 'Organization Level' in 2nd year.
- 'Characterization 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 administrators.

S. No.	Equipment Name with Broad Specifications	PrO S. No.
1	Model of a civil engineering structure depicting various components.	1,2
2	Chart showing detailing of lift, escalator and ramp.	3,4
3	Model of various material used in water supply and sanitary drainage system such as fixtures, fittings, pipe section, joints and valves.	7, 8 and 9
4	Model of a civil engineering structure depicting various components of Rain Water Harvesting system.	10
5	Model of a civil engineering structure depicting various components of Solar Water Heating system.	12

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop the same 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 Overview of Building Services	1a. Classify the building based on the basis of the given type of occupancy with reference to the provisions of National Building Code. 1b. List the relevant type of services required for the given building with justification. 1c. Explain the different components of the given building services provided in the given building. 1d. Explain the salient characteristics of BMS required for the given type of building. 1e. Describe the relevant parameters to convert the given type of building into a smart building. 1f. Justify the necessity of providing the relevant building services in the given type of building.	1.1 Introduction to building services, Classification of buildings as per national building code, Necessity of building services, Functional requirements of building. Different types of building services i.e. HVAC (Heat, Ventilation and Air Conditioning), escalators and lifts, fire safety, protection and control, plumbing services, rain water harvesting, solar water heating system, lightening, acoustics, sound insulation and electric installation etc. 1.2 Role and responsibility of Building Service Engineer, Introduction to BMS (Building Management Services), Role of BMS, concept of smart building.
Unit – II Modes of vertical communication	2a. Suggest the civil engineering requirements for the Escalators to be installed in the given type of civil structure with justification. 2b. Explain the safety measures required for installing the Escalators and Lifts in the given type of civil structure. 2c. Explain the method of	2.1 Objectives and modes of Vertical Communication in building. Lifts: Different types of lifts and its uses Component parts of Lift- Lift Well, Travel, Pit, Hoist Way, Machine, Buffer, Door Locks, Suspended Rope, Lift Car, Landing Door, Call Indicators, Call Push etc., Design provisions for basic size calculation of space enclosure to

	computing the space requirement for the Escalators and Lifts of the given type of civil structure. 2d. Suggest the specifications for the elevator required in the given building with justification. 2e. Draft the specifications required for construction of ramp required for physically handicapped and elderly persons for the given type of the building structure.	accommodate lift services, Safety measures. 2.2 Escalators: Different Types of Escalators and its Uses. Components of escalators, Design provisions for basic size calculation of space enclosure to accommodate escalator services, Safety measures. 2.3 Ramp: Necessity, design consideration, gradient calculation, layout and Special features required for physically handicapped and elderly.
Unit- III Fire Safety	3a. Justify the provision of the fire safety system for the given type of buildings. 3b. Explain the working principle of the given type of fire protection systems provided in the given type of building. 3c. Select the relevant system of fire safety for the given structure with justification. 3d. Explain the national building code requirements of providing Fire protection system for the given type of multi-storeyed building. 3e. Specify the provisions of NBC for the installation of fire extinguishing equipments in the given type of building.	3.1 Fire protection requirements for multi-storeyed building. Causes of fire in building. Fire detecting and various extinguishing system. Working principles of various fire protection systems. 3.2 Safety against fire in residential and public buildings (multi-storeyed building), National Building Code provision for fire safety, Fire resisting materials and their properties, Fire resistant construction, procedures for carrying out fire safety inspections of existing buildings. Provisions for evacuation.
Unit– IV Water supply and sanitation services	4a. Explain the significance of AHJ approval in laying the plumbing system in the given type of building. 4b. Select the fixtures required for laying the plumbing system for the given type of building. 4c. Explain the governing principles of laying the plumbing services (water supply/drainage/vent) in the given type of building. 4d. Select the relevant type of valves, pipe material and fittings required for laying the water supply and drainage system for the given site condition with justification. 4e. Suggest the relevant plumbing	4.1 Importance of plumbing, AHJ (Authority Having Jurisdiction) approval, Plumbing Terminology and fixtures: Terms used in plumbing, Different types of plumbing fixtures, shapes/ sizes, capacities, situation and where used, Traps, Interceptors. 4.2 System of plumbing for building water supply: sources of water, storage of water, hot and cold water supply system. 4.3 System of plumbing for building drainage: types of drainage system such as two pipe system, one pipe system, types of Vents and purpose of venting, Concept of gray water and reclaimed water. 4.4 Different pipe materials, and jointing methods, fittings, hanger, supports

	system for the given type of building with justification.	and valves used in plumbing and their suitability.
Unit–V Natural resources conservation services	5a. Propose the relevant components required for the design of rain water harvesting system in the given type of building structure. 5b. Explain the method of estimating the rain water harvesting potential for the given type of structure. 5c. Explain the procedure for designing the rain water harvesting system for the given type of structure. 5d. Select the relevant Solar water heater system required for the given site condition with justification. 5e. Draft the specifications for setting a solar water heating system in the given type of building. 5f. Justify the necessity of rain water harvesting system and solar water heating system in the given situation.	5.1 Components of a RWH system (Catchments, gutters, conduits, filters, Storage facility, Recharge structures etc.), Advantages of RWH, Application of RWH, RWH potential and factors affecting RWH potential, planning, designing, construction and maintenance of RWH for residential and institutional buildings, colonies, industries, public areas like parks, airports, forested areas. 5.2 Concept of SWH (Solar water heating), component parts of SWHS, various system of SWH (heat transfer, propulsion, passive direct system, active direct system, Do-it-yourself), SWHS design principles, specification, installation and maintenance, cost effect, energy production, life cycle energy assessment and applications of SWHS.
Unit– VI Lighting, Ventilation, and Acoustics.	6a. Select relevant system of lighting for the given building with justification. 6b. Suggest the lumen capacity required for the given size of the room. 6c. Describe the methods used for the ventilation purposes in the given type of building. 6d. Explain the significance of providing air conditioning system in the given type of building. 6e. Justify the need of acoustic treatment in the given type of building structure. 6f. Explain the relevant method of acoustic treatment for the given type of building structure.	6.1. Concept of lighting, types of lighting (natural and artificial), factors influencing the brightness of room, factors affecting selection of artificial lighting, installation of light (direct, half-direct, indirect, half-indirect and direct-indirect), types of light control (manual switch, remote switch, timer switch and photo-electric cell switch), types of lamps (incandescent, tungsten halogen and electric discharge), Lamp selection as per room sizes. Conversion from Lumen (unit of measurement indicating the visible light output of a light source) to Lux (the metric system of luminance). 6.2. Concept of ventilation, necessity and types of ventilation, Overview of Air Conditioning system for building. 6.3. Building Acoustic, Objectives, acoustic Control in a building, acoustic material (porous absorber and cavity resonator)

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' 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	Overview of Building Services	02	02	02	-	04
II	Modes of Vertical Communication	10	04	04	06	14
III	Fire Safety	08	02	04	06	12
IV	Water Supply and Sanitation System	10	04	04	06	14
V	Natural Resources Conservation Services	10	04	04	06	14
VI	Lighting, Ventilation, and Acoustics	08	04	04	04	12
Total		**48**	**20**	**22**	**28**	**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 LOs. 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) Prepare journals based on practical performed in laboratory.
b) Give seminar on relevant topic.
c) Undertake micro-projects.
d) Visit any three buildings near by your institute and classify them in accordance with the provisions made in National Building Code in report form.
e) Identify the components of building services by inspecting the nearby buildings to prepare a detailed report w.r.t. adequacy, deficiency and exceeding the requirement.
f) Collect the technical brochures of the different components of building services from the local market/internet to present in report form.
g) Visit any building certified by Building Management Services to record the important features that has converted it into green building and submit a report.
h) Estimate the RWH and SWH potential for your house and institute building.

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) Arrange visit to nearby construction sites for understanding various construction activities.
g) Use of video/animation films to explain various processes of building construction.
h) Use different instructional strategies in classroom teaching.
i) Demonstration of different small activities related to building services.
j) Display of various technical brochures of modern building services.

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 sketchbook consisting of components of modern building services (for Sketches which are not included in Practical sketch book).
b) Collect the relevant information of recent technologies in elevators and prepare a report on it.
c) Prepare a report on BMS including a case study.
d) Collect the relevant information of different techniques for RWH or SWHS and submit a report on it.
e) Prepare a summary report with reference to lighting, ventilation and acoustic system of a building.
f) Prepare a report on modern Fire Safety, Detection and Protection systems.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	The A to Z of Practical Building Construction and its Management	Mantri, Sandeep	Satya Prakashan, New Delhi ISBN-13: 978-8176849692
2	Plumbing Design and Practice	Deolalikar, S. G.	McGraw-Hill, New Delhi, 2004 ISBN: 9780074620694

3	Fire Services in India: History, Detection, Protection, Management	Bag, S. P.	Mittal Publications, New Delhi, 1995, ISBN 8170995981
4	Principles of Fire Safety Engineering: Understanding Fire and Fire Protection	Akhil Kumar Das	PHI Learning Pvt. Ltd, New Delhi. 2014, ISB:9788120350380

BIS/ International Codes of Practice:

S. No.	Title of Book	Author	Publication
1	National Building Code Part1, 4, 8, 9	BIS	Bureau of Indian Standard, New Delhi
2	IS 12183(Part 1):1987 Code of practice for plumbing in multistoried buildings	BIS	
3	2008 Uniform plumbing code – India (UPC-I)	BIS	

14. SOFTWARE/LEARNING WEBSITES

a) http://bis.org.in
b) https://www.capterra.com
c) http://bmsbuildingservice.com
d) http://www.plumbingservices.com