UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Civil & Infrastructure Engineering

Second Year with Effect from AY: 2021-22

Third Year with Effect from AY: 2022-23

Final Year with Effect from AY: 2023-24

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Civil and Infrastructure Engineering**
2	Eligibility for Admission	**After Passing Second Year Engineering as per theOrdinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances /Regulations(if any)	**Ordinance 0.6242**
5	No. of Years/Semesters	**8 semesters**
6	Level	**U.G.**
7	Pattern	**Semester**
8	Status	**New**
9	To be implemented from Academic Year	**With effect from Academic Year: 2021-2022**

Date:

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

In the last decade there has been rapid urbanization all over the country. It is due to constant human endeavor to strive for a more comfortable living. This is making existing infrastructure fall short to fulfil the demands of society. Accomplished infrastructure is required for the society in all its domains. Civil infrastructure consists of roads, bridges, buildings, dams, levees, water & wastewater treatment facilities, solid waste management, power generation-transmission and communications facilities.

There is a need to train engineers who have a holistic view of infrastructure and multidisciplinary knowledge background. A sound understanding of emerging and transformative technologies and functioning of the infrastructure systems is essential. Existing civil engineering program is not fully addressing this increasingly recognized need. This educational gap prompted new engineering program with more emphasis on planning, design and execution of infrastructure along with knowledge of civil engineering at undergraduate level. Accordingly AICTE proposed 'Civil and Infrastructure Engineering - a new programme at undergraduate level. Mumbai University intends to be on the forefront with a program in 'Civil and infrastructure Engineering which involves the design, construction and management ofinfrastructure.

The Faculty of science and technology resolved that to minimize the burden of contact hours, total credits of the entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore, in the presentcurriculum, skill-based laboratories and mini projects are made mandatory across all disciplines of engineering in the second and third year of programs, which will definitely facilitate self- learning of students. The overall credits and approach of curriculum proposed, is in line with AICTE model curriculum.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for Internal assessment, revision, guest lectures, coverage of content beyond syllabus etc.

The curriculum will be implemented for Second Year of Civil and Infrastructure Engineering from the academic year 2021-22. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2022-23, 2023-24, respectively.

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Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum design is mainly focused on knowledge component, skill based activities and project based activities. Self-learning opportunities are provided to learners. In the design process of syllabus of ‘C‘ scheme wherever possible, additional resource links of platforms such as NPTEL/Swayam are appropriately provided. In an earlier design of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current design based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ Heads/ Faculty members of all the institutes are required to motivate andencourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology, University ofMumbai

Dr. Anuradha Muzumdar
Dean
Faculty of Science and Technology, University ofMumbai

Preface

The engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality of education and employability of students. To meet this challenge, the issue of quality needs to be addressed and taken forward in a systematic manner. ***Accreditation*** is the principal means of quality assurance in higher education. It reflects that, in achieving recognition, the institution or program of study is committed and open to external review to meet specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program Outcomes (POs) are essentially a range of skills and knowledge that a student will haveat the time of graduation from the program. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education (OBE) in the process of curriculum development from Rev-2012 onwards and continued to enhance the curriculum further based on OBE in Rev-2016 and Rev-2019 ‗C' scheme.

As Chairman and Members of Board of Studies in Civil Engineering, University of Mumbai, we are happy to state here that, the Program Educational Objectives (PEOs) for Undergraduate Program were finalized by faculty members from different affiliated Institutes of the University, who are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The PEOs finalized for the undergraduate program in ***Civil and Infrastructure*** Engineering are listed below;

1. To prepare the Learner with a sound foundation in mathematical, scientific and engineering fundamentals.
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems.
3. To prepare the Learner for a successful career in Indian and Multinational Organizations and for excelling in Post-graduate studies.
4. To motivate learners for life-longing learning.
5. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.

In addition to the above listed PEOs, every institute is encouraged to add a few (2-3) more PEOs suiting their institute vision and mission

Apart from the PEOs, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of OBE. We strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Board of Studies in Civil Engineering, University of Mumbai

Dr. S. K. Ukarande	: Chairman	Dr. V. Jothiprakash	: Member
Dr. D.D. Sarode	: Member	Dr. K. K. Sangle	: Member
Dr. S. B. Charhate	: Member	Dr. D. G. Regulawar	: Member
Dr. Milind Waikar	: Member	Dr. A. R. Kambekar	: Member
Dr. R.B. Magar	: Member	Dr. Seema Jagtap	: Member

Semester-V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CIC501	Transportation Infrastructure – I	3	-	-	3	-	-	3
CIC502	Foundation Engineering	3	-	-	3	-	-	3
CIC503	Design of Steel Structures	4	-	-	4	-	-	4
CIDO501X	Department Optional Course – I	3	-	-	3	-	-	3
CIDO502X	Department Optional Course –II	3	-	-	3	-	-	3
CIL501	Transportation Infrastructure – I (Lab)	-	2	-	-	1	-	1
CIL502	Foundation Engineering (Lab)	-	2	-	-	1	-	1
CIL503	Design of Steel structures (Lab)		2			1		1
CIL504	Skill based lab Course-III	-	3	-	-	1.5	-	1.5
CIM501	Mini Project–2A	-	3	-	-	1.5	-	1.5
Total		**16**	**12**		**16**	**6**		**22**

Examination Scheme

Course Code	Course Name	Theory					Term Work	Prac./ Oral	Total
		Internal Assessment			End Sem Exam	Exam Dura-tion (Hrs.)			
		Test I	Test II	Avg.					
CIC501	Transportation Infrastructure – I	20	20	20	80	3	-	-	100
CIC502	Foundation Engineering	20	20	20	80	3	-	-	100
CIC503	Design of Steel structures	20	20	20	80	3	-	-	100
CIDO501X	Department Optional Course – I	20	20	20	80	3	-	-	100
CIDO502X	Department Optional Course –II	20	20	20	80	3	-	-	100
CIL501	Transportation Infrastructure – I (Lab)						25	25	50
CIL502	Foundation Engineering (Lab)						25	25	50
CIL503	Design of Steel structures (Lab)	-	-	-	-	-	25	25	50
CIL504	Skill based lab Course-III	-	-	-	-	-	50	-	50
CIM501	Mini Project–2A	-	-	-	-	-	25	25	50
Total				**100**	**400**	**-**	**150**	**100**	**750**

Department Level Optional Course – I

Sr. No.	Course Code CEDO501X	Department Level Optional Course – I
1	CIDO 5011	Architectural Planning & Design of Building
2	CIDO 5012	Transportation Planning & Economics
3	CIDO 5013	Advanced Concrete Technology
4	CIDO 5014	Rock Mechanics

Department Level Optional Course – II

Sr. No.	Course Code CEDO502X	Department Level Optional Course – II
1	CIDO 5021	Open Channel Flow
2	CIDO 5022	Geographic Information System
3	CIDO 5023	Building & Civil Infrastructural Services
4	CIDO 5024	Air & Noise Pollution

Undergraduate Program Structure for Third Year Civil and Infrastructure Engineering
University of Mumbai
(With Effect from A.Y. 2022-2023)
Semester - V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CIC 501	Transportation Infrastructure – I	3	-	-	3	-	-	3
CIC 502	Foundation Engineering	3	-	-	3	-	-	3
CIC 503	Design of Steel Structures	4	-	-	4	-	-	4
CIDO 501X	Department Level Optional Course – I	3	-	-	3	-	-	3
CIDO 502X	Department Level Optional Course –II	3	-	-	3	-	-	3
CIL 501	Transportation Infrastructure – I (Lab)	-	2	-	-	1	-	1
CIL 502	Foundation Engineering (Lab)	-	2	-	-	1	-	1
CIL 503	Design of Steel structures (Lab)		2			1		1
CIL 504	Skill based lab Course-III	-	3	-	-	1.5	-	1.5
CIM 501	Mini Project–2A	-	3	-	-	1.5	-	1.5
Total		**16**	**12**		**16**	**6**		**22**

Examination Scheme

Course Code	Course Name	Theory					Term Work	Prac. /Oral	Total
		Internal Assessment			End Sem Exam	Exam Dura-tion (Hrs.)			
		Test I	Test II	Avg.					
CIC 501	Transportation Infrastructure – I	20	20	20	80	3	-	-	100
CIC 502	Foundation Engineering	20	20	20	80	3	-	-	100
CIC 503	Design of Steel structures	20	20	20	80	3	-	-	100
CIDO501X	Department Level Optional Course – I	20	20	20	80	3	-	-	100
CIDO502X	Department Level Optional Course –II	20	20	20	80	3	-	-	100
CIL 501	Transportation Infrastructure – I (Lab)	-	-	-	-	-	25	25	50
CIL 502	Foundation Engineering (Lab)	-	-	-	-	-	25	25	50
CIL 503	Design of Steel structures (Lab)	-	-	-	-	-	25	25	50
CIL 504	Skill based lab Course-III	-	-	-	-	-	50	-	50

CIM 501	Mini Project–2A	-	-	-	-	-	25	25	50
Total				**100**	**400**	**-**	**150**	**100**	**750**

Undergraduate Program Structure for Third Year Civil and Infrastructure Engineering
University of Mumbai
(With Effect from A.Y. 2022-2023)
Semester - V

Department Level Optional Course – I

Sr. No.	Course Code CEDO501X	Department Level Optional Course – I
1	CIDO 5011	Architectural Planning & Design of Building
2	CIDO 5012	Transportation Planning & Economics
3	CIDO 5013	Advanced Concrete Technology
4	CIDO 5014	Rock Mechanics

Department Level Optional Course – II

Sr. No.	Course Code CEDO502X	Department Level Optional Course – II
1	CIDO 5021	Open Channel Flow
2	CIDO 5022	Geographic Information System
3	CIDO 5023	Building & Civil Infrastructural Services
4	CIDO 5024	Air & Noise Pollution

Semester-V

Course Code	Course Name	Credits
CIC 501	Transportation Infrastructure-I	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

Transportation contributes to the economical, industrial, social and cultural development of any country. The adequacy of transportation system of a country indicates its economic and social development. Three basic modes oftransportation include land, water and air. The land mode further gives rise tohighways and railways. The highways owing to its flexibility in catering door-to-door service forms one of the important modes. This course deals with the investigation, planning, design, construction and maintenance of highways for urban and rural areas. This course also deals with the planning, operation and control of the traffic.

Objectives

1. To give insight of the development in the field of highway engineering and to familiarize the students with different surveys required to be carried out for the implementation of the highway project.
2. To understand the phase of engineering that deals with the planning and geometrics design of streets, highways, abutting land and with traffic operations.
3. To study various traffic studies and to understand elements of traffic engineering for efficient planning and control.
4. To understand the concept of subgrade materials and soil stabilization in the construction of highway and allied structures.
5. To enable the students to understand the classification and behaviour ofdifferent types of pavements and factors to be considered in the design of pavements.

6. To study the pavement failure and strengthening of existing pavement.

Detailed Syllabus

Module	Course Modules / Contents		Periods
1	**Transportation Infrastructure Highway Planning**		04
	1.1	Brief history of road developments in India; present status of roads development programme in India including different programs being executed by various agencies, principles of transport infrastructure design, roads and others	
	1.2	Preparation of transportation network, infrastructure maps, Highway alignment, basic requirement of ideal alignment, factors governing highway alignment. Different types of surveys (highway location survey, map study, reconnaissance, topographic surveys), highway alignment in hilly area, drawing report preparation	
2	**Design of Road Infrastructure System**		10
	2.1	Road cross sectional elements; road hierarchy and design considerations of urban and rural roads; Geometric design: design speed, sight distance, perception time, break reaction time, analysis of safe sight distance, analysis of overtaking sight distance, intersection sight distance	
	2.2	Road alignment, horizontal curves, vertical curves; gradients; design principles of intersections.	
3	**Traffic Engineering**		05
	3.1	Different Traffic Studies: Speed studies (spot speed and speed and delay studies), traffic volume, parking studies, significance/applications of these studies; different methods of conducting traffic studies, methods of the presentation of data.	
	3.2	Introduction to relationship between speed, density and volume; Capacity: Different types and factors affecting the capacity, concept of Passenger Car Units (PCU) and Level of Service (LoS).	
	3.3	Introduction to different types of traffic control devices: traffic signs, signals (no design), road marking	
	3.4	Different types of intersections: At grade and grade separated; grade separated interchanges; rotary intersections	

4	**Highway Materials**		**03**
	4.1	Subgrade materials: desirable properties, various tests to be conducted to evaluate the suitability of the soil as the highway material.	
	4.2	Soil stabilization; subcase material: desirable properties, different teststo be conducted on aggregate, requirement of aggregate for different types of pavements. Bituminous materials: types of bituminous material, test on bituminous material, desirable properties.	
5	**Highway Pavement Design**		**12**
	5.1	Types of pavements: Flexible, rigid, semi-rigid and composite; comparison between them vis-à-vis based on the structural behavior and other parameters; Factors affecting design of pavements including traffic factors (design wheel load, equivalent single wheel load, equivalent wheel load factor/VDF)	
	5.2	Flexible pavement: Various approaches of designing the pavement andmethods falling under each category (theoretical, semi-theoretical or semi-empirical, empirical, mechanistic empirical and methods based onroad performance); Overview of the method prescribed by IRC along with the modifications incorporated therein time to time (IRC: 37- 1970, 1984, 2001, 2012 and 2018)	
	5.3	Rigid Pavements: Introduction to the different types rigid pavements (plain jointed, plain jointed reinforce, continuous reinforced, fiber reinforced, roller compacted concrete); Analysis of the stresses to be developed in the pavement (wheel load, warping and frictional); critical combination of the loading; Overview of the various approaches (analytical, empirical and mechanistic empirical) of designing the pavements and methods falling under the respective category; overview of the methods prescribed by IRC along with modifications incorporated therein time to time (IRC: 58-1974, 58-1988; 58-2002, 58-2015,58-2020); Design of plain jointed rigid pavements (IRC: 58- 2002 and IRC: 58- 2015 with more emphasis on IRC: 58- 2020) including design of joints.	
6	**Rehabilitation and Maintenance**		**05**
	6.1	Pavement failure: Classification of distresses in pavements (functional and structural); different types of distresses in flexible and rigid pavements along with the causes and remedial measures; various types of maintenance of pavements; functional and nondestructive evaluation of pavement, various equipment used in evaluation of pavements along with their principles (profilometer, bump integrator,	

		Benkelman beam, lacroix deflectograph, falling weight deflectometer) and utility in the evaluation.	
	6.2	Strengthening of existing pavement: Objective of strengthening, different types of overlays, design of flexible overlays on flexible pavement using effective thickness approach, and deflection approach resorting to Benkelman Beam method (IRC: 81-1981) and Mechanistic Empirical approach using deflection (IRC: 81-1997)	
		TOTAL	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1. Identify different surveys required to be carried out for the implementation of the highway project.
2. Categorize different types of traffic studies along with design of streets, highways, abutting land and with traffic operations.
3. Estimate elements of traffic engineering for efficient planning and control.
4. Study subgrade materials and soil stabilization in the construction of highway and allied structures.
5. Assessing different types of pavements and factors to be considered in the design of pavements.
6. Understand pavement failure and strengthening of existing pavement

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour. Average of marks will be considered for IAE.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Recommended Books:

1. Highway Engineering: Khanna, S.K., Justo,C. E.G. and Veeraraghavan A; Nem Chand and Bros., Roorkee (Revised10thEdition)
2. Principles and Practice of Highway Engineering: Kadiyali, L.R.; Khanna Publishers, Delhi
3. A Text Book of Highway and Traffic Engineering: Saxena, Subhash Chandra; CBS Publishers and Distributors (2014)
4. A Text Book of Highway Engineering: Sriniwasa kumar, R.; University Press, Hyderabad (First Published in 2011; Reprinted in2013)
5. Transportation Engineering (Vol.-I)-Highway Engineering: Venkatramaiah, C.; University Press, Hyderabad (2016).
6. Principles of Transportation and Highway Engineering, Rao, G.V.; Tata McGrawHill Publishing House Pvt. Ltd., New Delhi.
7. Principles, Practice and Design of Highway Engineering (Including Airport Engineering): Sharma, S.K.; S. Chand and Company Pvt. Ltd., New Delhi.
8. Principles of Transportation Engineering: Chakraborty, Parthaand Das, Animesh; Prentice Hall India Learning Pvt. Ltd., New Delhi (Eighth Printing: January2013).

Reference Books:

1. Transportation Engineering and Planning: Papacostas, C.S. and Prevedouros, P.D.; Prentice Hall India Learning Pvt. Ltd., New Delhi.
2. Transportation Engineering: Khisty, C.J. and Lall, Kent,B.; Prentice Hall India Learning Pvt. Ltd., New Delhi.
3. Traffic Engineering and Transport Planning: Kadiyali, L.R., Khanna Publishers, Delhi
4. Pavement Design: Srinivasakumar, R; University press, Hyderabad (First Published 2013; Reprinted in 2015).
5. Highway Material and Pavement Testing: Khanna, S.K., Justo, C.E.G. and Veeraragavan, A.; Nem Chand and Bros., Roorkee, India.

Semester-V

Course Code	Course Name	Credits
CIC 502	Foundation Engineering	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

The present syllabus is designed to provide an understanding of different types of substructures systems, i.e., shallow foundations, pile foundations, retaining walls, sheet pile walls and deep excavation systems. The foundation systems are integral part of structures to transfer the superstructure loads safely over or into the soil avoiding bearing capacity and, or settlement failure. The wall systems are required to retain soils and, or water bodies. The present syllabus also introduces an overview of the necessity and choice of ground improvement techniques for foundation use as well as it includes the prerequisite concept of shear strength, vertical stress distribution and consolidation.

Objectives

1. To understand types of foundations, applications and minimum design requirements.
2. To understand the concept of shear strength, vertical stress distribution and consolidation.
3. To understand the bearing capacity theories, field tests and settlement of shallow foundation.
4. To understand load transfer mechanism and types of piles, load carrying capacity and settlement of single and group of piles
5. To understand earth pressure theories and graphical methods for active and passive earth pressure conditions.
6. To understand stability analysis of gravity and cantilever retaining walls, and have an overview of sheet pile walls and deep excavation systems.

Detailed Syllabus

Module	Course Modules / Contents		Periods
1	**Overview of Foundation Engineering**		05
	1.1	Foundation types, definitions and typical usage; minimum requirements for designing a foundation: in terms of settlement and soil strength, site specific additional considerations.	
	1.2	Improving site soils for foundation use (an overview): types and selection of ground improvement techniques (refer IS 13094), compaction, precompression to improve site soils, drainage using sand blankets and drains, stone columns, foundation grouting and chemical stabilization, use of geotextiles to improve soil	
	1.3	Factors to consider in foundation design (an overview): footing depth and spacing, types of loads acting on foundation, design soil pressures, displaced soil effects, erosion problems for structures adjacent to flowing water, corrosion protection, water table fluctuation, environmental considerations; foundations in sand and silt deposits, loess and other collapsible soils, clays and clayey silts, sanitary landfill sites.	
2	**Overview on Shear Strength, Vertical Stress Distribution and Consolidation**		08
	2.1	Total stress, pore water pressure, effective stress; Factors affecting effective stress: water table, surcharge pressure, capillary, seepage; shear strength of soil: definition, Mohr-Coulomb failure theories and modification, shear strength parameters; Mohr-Coulomb failure envelope, relationship between major and minor principal stresses at failure; concept of critical void ratio and liquefaction.	
	2.2	Boussinesq's theories and concept: vertical stress distribution under a point load (no derivation), strip load, circular area and rectangular area; Newmark's influence chart; isobar diagram, influence diagram, contact pressure distribution under flexible and rigid footings	
	2.3	Concept of over consolidated and normally consolidated clay and preconsolidation pressure; Terzaghi's one dimensional consolidation theory (derivation not required); distribution of excess pore water pressure with depth & time; field consolidation curve.	
3	**Shallow Foundation**		08
	3.1	Introduction to shallow foundation; modes of failure; ultimate and net ultimate bearing capacity, factor of safety, allowable	

		bearing capacity of soil.	
	3.2	Bearing capacity equations as per Vesic and IS code; influence of ground water table on bearing capacity; eccentric loading on footing.	
	3.3	Determination of bearing capacity based on penetration tests (SPT, SCPT, DCPT), plate load test and pressure meter test.	
	3.4	Allowable bearing pressure for permissible total settlement: Terzaghi-Peck, Meyerhof, Peck-Hanson-Thornburn analyses (equations and applications).	
	3.5	Immediate settlement computations, consolidation settlement; size effects on settlement and bearing capacity; structural tolerance to settlement and differential settlements	
4	**Pile Foundation**		**08**
	4.1	Pile foundation classification based on: materials, functions, methods of installation, displacement of soil; load transfer mechanism of pile foundation	
	4.2	Individual pile capacity under axial vertical compression load: static formulae, dynamic formula; validity of dynamic formulae	
	4.3	Pile capacity from pile load test, standard penetration test (SPT) and cone penetration test (SCPT, DCPT)	
	4.4	Group efficiency of pile; pile group in sand and clay, group capacity of piles; settlement of pile group. Refer IS 2911 parts 1 to 4 and IRC 78.	
	4.5	Negative skin friction: reasons and steps to eliminate it, effect on pile capacity; under-reamed piles (an overview).	
5	**Earth Pressure Theories**		**06**
	5.1	Lateral earth pressure problems; active, passive and at rest earth pressure conditions	
	5.2	Rankine's earth pressure theory: active and passive states in cohesionless soil and extension for cohesive soil; Coulomb's wedge theory (concept): active and passive states in cohesionless soil (derivation not required); General comments on both methods; soil properties for lateral earth pressure computations	
	5.3	Rehbann's and Culmann's graphical method (no proof)	
6	**Types of Retaining Walls and Applications**		**04**
	6.1	Stability analysis of cantilever and gravity retaining walls, applications.	
	6.2	Cantilevered and anchored sheet pile walls (an overview): concept, pressure diagrams (derivation of equations is not required), soil properties for sheet-pile walls, applications	
	6.3	Deep excavation (an overview): concept, braced cut systems	

		and applications, apparent earth pressure diagrams	
		TOTAL	**39**

Contribution to Outcome

On completion of this course, the students will be able to:

1. Understand the requirements of different types of foundations, necessity and types of site soil improvement techniques.
2. Understand the concept of shear strength, vertical stress distribution and consolidation.
3. Estimate the bearing capacity and settlement of shallow foundation.
4. Evaluate the load carrying capacity and settlement of single and group of piles
5. Compute active and passive earth pressure forces on retaining walls.
6. Perform stability analysis of gravity and cantilever retaining walls, and understand the types and applications of sheet pile walls and deep excavation systems

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour. Average of marks will be considered for IAE.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Recommended Books:

1. Bowles, J. E., 1996, "Foundation analysis and design", The McGraw-Hill Companies, Inc.
2. Nayak, N. V. (2018), "Foundation Design Manual", Dhanpatrai Publication, New Delhi.
3. K. R. Arora: "Soil Mechanics and Foundation Engineering". Standard Publishers and Distributors, New Delhi.
4. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain: "Soil Mechanics and Foundations", Laxmi Publications (P) LTD., New Delhi.
5. V. N. S. Murthy: "Soil Mechanics and Foundation Engineering", CBS Publishers & Distributors
6. Tomlinson, M. J. (1986), "Foundation design and construction", 7thedition, Prentice Hall, New Jersey, United States.

7. Som, N. N. and Das, S. C. (2003), "Theory and Practice of Foundation Design".Prentice Hall of India private limited, New Delhi.

Reference Books:

1. Das, B. M., 1998, "Principles of geotechnical engineering", PWS series in civil engineering.
2. Korner, R.M., "Designing with Geosynthetics" Xlibris; 6th edition.
3. IS: 1892-1979, "Code of Practice for Subsurface Investigations for Foundations".
4. IS: 13094-1992, "Selection of ground improvement techniques for foundation in week soils- Guidelines".
5. IRC 78: 2014, "Standard Specifications and Code of Practice for Road Bridges, Section VII, Foundations and Substructure, (Revised Edition)".
6. IS: 1904-1986, "Design and Construction of Foundations in Soils, General Requirements".
7. IS: 6403-1981, "Code of Practice for Determination of Bearing Capacity of Shallow Foundations".
8. IS: 8009-Part 1-1976, "Shallow Foundation Subjected to Symmetrical Static Vertical Loads".
9. IS: 2911-Part I-Sect. 1-1979, "Design and Construction of Pile Foundations-Driven Cast in- situ concrete Piles".
10. IS: 2911-Part I-Sect. 3-1979, "Design and construction of Pile Foundation-Driven Precast Piles".
11. IS: 2911-Part 3-1980, "Code of Practice for Design and Construction of Pile Foundation- Under reamed Piles".
12. IS: 8009-Part 2-1980, "Code of Practice for calculations of settlement of Foundation-Deep Foundation subjected to Symmetrical Static Vertical Loading".
13. IS: 2911-Part 4-1974, "Load Test on Piles".
14. IS: 4968-Part 3-1976, "Static cone Penetration Test".
15. IS: 5121-1969, "Safety code for Piling and other Deep Foundations".
16. IS: 3764-1970, "Safety Codes for Excavation work"

Semester-V

Course Code	Course Name	Credits
CIC 503	Design of Steel Structure	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
04	--	--	04	--	--	04

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

Steel structures are preferred due to their higher strength, speed of construction and aesthetic view. Civil Engineers must have knowledge of designing and detailing of steel structures to make structures safe and serviceable during its life span. I.S. code specifying the use of Limit State design philosophy for design of steel structures and its various components. This course is designed to provide basic knowledge of design and detailing of steel structures

Objectives

1. To understand the behavior of steel structure and their components under the action of various loads.
2. To study the effective use of IS codes, design tables and aids in analyzing and designing the steel structures by limit state method.
3. To design connections of steel members.
4. To study the aspects required for designing tension member, compression members and column bases.
5. To study the aspects required for designing of flexural members.
6. To aid students in designing steel trusses

Detailed Syllabus

Module	Course Modules / Contents		Periods
1	**Introduction**		04
	1.1	Types of steel structures, properties of structural steel, indian standard specifications and sections, advantages and limitations of WSM, permissible stresses in WSM, Introduction to Limit state design, partial safety factors for load and resistance, design load combinations, section classification such as plastic, compact, semi-compact and slender.	
2	**Design of Bolted and Welded Connections**		09
	2.1	Design of bolted and welded connections for axial force, beam to beam and beam to column connections. Framed, stiffened and unstiffened seat connections, bracket connections.	
3	**Design of Tension Members**		07
	3.1	Introduction, types of tension members, net area calculation. Design strength due to yielding, rupture and block shear. Design of tension members with welded and bolted end connection using single angle section & double angle section.	
4	**Design of Compression Members and Column Bases**		12
	4.1	Introduction, types of compression members, classification of cross sections, types of buckling, effective length of column and slenderness ratio, buckling curves, design of compression members as struts using single angle sections & double angle section.	
	4.2	Design of axially loaded column using rolled steel sections, design of built up column, laced and battened Columns.	
	4.3	Design of slab bases & gusseted base	
5	**Design of Flexural Members**		12
	5.1	Design strength in bending, effective length, Lateral torsion buckling behavior of unrestrained beams, design of single rolled section with or without flange plates, design strength of laterally supported beams, low and high shear, design strength of laterally unsupported beams, web buckling, web crippling, shear lag effect and deflection.	
	5.2	Design of welded plate girder: proportioning of web and flanges, flange plate curtailment	
6	**Design of Truss Using Round Tubular Structural Members**		08
	6.1	Design of determinate truss. Calculation of dead load, live load and wind load acting on truss. Load combinations and calculation of internal forces. Properties of steel tubes, design	

		of tension member and compression member, design of welded connections, design of flexural members, analysis and design of tubular trusses including purlins and supports.	
		TOTAL	**52**

Contribution to Outcome

On completion of this course, the students will be able to:

1. Use the knowledge of limit state design philosophy as applied to steel structures. IS 800 code clauses.
2. Design bolted and welded connections.
3. Design members subjected to axial tension.
4. Design compression members, built-up columns and column bases.
5. Design members subjected to bending moment, shear force etc.
6. Estimate design loads as per IS 875 for roof truss and design the steel roof truss.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour. Average of marks will be considered for IAE.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total Five questions. (32+4x16)
2. Question 1 will be compulsory carrying 32 marks and should be based on steel design project.
3. Remaining questions will be carrying 4x16 marks, mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. Only three questions carrying 16 marks need to be solved.
4. Total four questions need to be solved. (32+16+16+16)
5. In end semester examination, students will write answers in answer booklet and draw sketches on half imperial drawing sheet.

Recommended Books:

1. Design of Steel Structure by N. Subramanian, Oxford University Press, New Delhi.
2. Limit state design of steel structures by S. K. Duggal, McGraw Hill Education (India) Pvt. Limited, New Delhi.
3. Design of steel structure by Limit State Method as per IS: 800- 2007 by Bhavikatti S. S., I.K. International Publishing House, New Delhi
4. Design of Steel Structures by K. S. Sai Ram, Pearson Education, New Delhi.
5. Limit state design of steel structures as per IS 800/2007. by S. Kanthimathinathan. I.K. International Publishing House, New Delhi.

6. Relevant Indian Specifications, Bureau of Indian Standards, New Delhi
7. Limit state design of steel structure by Dr. V.L. Shah and Gore, Structures publication pvt. Pune.

Reference Books:

1. Design of Steel Structure by Allen Williams
2. Practical Design of Steel Structure by Karuna Moy Ghosh, Whittles Publishing
3. Structural design and drawing by D.Krishnamurthy, CBS Publishers, New Delhi.
4. Teaching Resources Material for steel structures by INSDAG Kolkata.

Semester-V

Course Code	Course Name	Credits
CIDO 5011	Department Level Optional Course – I Architectural Planning & Design of Buildings	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

Drawing is the language of Civil Engineers to communicate. Drawing is one of the most essential documents as far as civil engineering is concerned. It provides guidance and instructions to architects, engineers and workmen at field, on how to construct structures according to the figures and dimensions shown in the drawing. Approved drawings are also essential for the estimation of cost and materials; as well as a very important contract document.

Objectives

1. To remember and recall the intricate details of building design and drawing.
2. To gain an understanding of the basic concepts of building design and drawing.
3. To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices, rules, regulation and byelaws, Building codes
4. To identify, analyze, research literate and solve complex building design and drawing problems.
5. To have new solutions for complex building design and drawing problems.
6. To effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

Detailed Syllabus

Module	Course Modules / Contents		Periods
1	**Principles and Codes of Practices for Planning and Designing of Buildings (Residential and Public Buildings)**		**16**
	1.1	Study of IS 962: 1989 – Code of practice for Architectural and Building Drawings - How to develop Line plan into actual plan, elevation, section etc. including all the construction details of various components in a building on drawing sheets.	
	1.2	Principles of planning for residential buildings	
	1.3	Study of Principles of planning for public buildings: Building for education: schools, colleges, institutions etc., buildings for health: hospitals, primary health centers etc.	
	1.4	Study & drawing of site plan, foundation plan, roof plan of building on drawing sheets; study of building bye-laws, zoning regulations and permissions required from commencement to completion of the building according to National Building Code (NBC) of India and local Development Control (DC) rules	
	1.5	Study of sun path diagram, wind rose diagram and sun shading devices	
	1.6	Calculation of setback distances, carpet area, built-up area and floor space index (FSI)	
	1.7	Classification of buildings (Draw Plan, elevation, section, site plan, foundation plan, roof plan for residential & public building): Residential–Individual Bungalows & Apartments/Flats. Public – Education (Schools, Colleges etc.) & Health (Primary Health Center, Hospital) related buildings	
2	**Components and Services of a Building**		**06**
	2.1	Staircase (dog -legged) planning, designing & drawing in details	
	2.2	Foundations drawing: stepped footing, isolated sloped footing and combined footing	
	2.3	Openings: doors and windows	
	2.4	Types of pitched roof and their suitability (plan and section) drawing	
	2.5	Building services: Water supply, sanitary and electrical layouts	
3	**Perspective Drawings**		**04**
	3.1	One-point perspective drawing	
	3.2	Two-point perspective drawing	
4	**Town Planning, Architectural Planning & Built Environment**		**04**

	4.1	Objectives and planning of town planning	
	4.2	Master plan, Re-Development of buildings, Slum rehabilitation.	
	4.3	Architectural Planning: Introduction and principles	
	4.4	Built Environment: Introduction and principles	
5	**Green Buildings**		**02**
	5.1	Introduction, uses, objectives of Green Buildings and overview	
	5.2	Study of Certification methods such as LEED, TERI, GRIHA, IGBC	
6	**Computer Aided Drawing (CAD)**		**07**
	6.1	Details and learning methods of CAD in Civil Engineering structures.	
	6.2	Study and demonstration of any one of the professional CAD software's	
		TOTAL	**39**

Note: Minimum one industrial visit based on above module may be conducted.

Contribution to Outcome

On completion of this course, the students will be able to:

1. Remember and recall the intricate details of building design and drawing.
2. Understand the basic concepts of building design and drawing.
3. Learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
4. Identify, analyze, research literate and solve complex building design and drawing problems.
5. Analyze new solutions for complex building design and drawing problems.
6. Effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour. Average of marks will be considered for IAE.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum

3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Recommended Books:

1. Planning and Designing Buildings by Y. S. Sane (Modern Publication House, Pune)
2. Building Drawing and Detailing by B.T.S. Prabhu, K.V. Paul and C. V. Vijayan (SPADES Publication, Calicut)
3. Building Planning by Gurucharan Singh (Standard Publishers & Distributors, New Delhi

Reference Books/Codes:

1. IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
2. National Building Code of India – 2005 (NBC 2005)
3. Development Control Regulations for Mumbai Metropolitan Region for 2016-2036 (https://mmrda.maharashtra.gov.in)
4. Development Control Regulations for Navi Mumbai Municipal Corporation- 1994 (https://www.nmmc.gov.in/development-control-regulations)
5. Development Plan and Control Regulation KDMC, https://mmrda.maharashtra.gov.in
6. National Building Code of India, 2005
7. IS 779-1978 Specification for Water Meter
8. IS 909-1975 Specification for Fire Hydrant
9. IS 1172-1983 Code of Basic Requirement for Water Supply, Drainage & Sanitation
10. IS 1742-1983 Code of Practice for Building Drainage

Semester-V

Course Code	Course Name	Credits
CIDO 5012	Department Level Optional Course – I Transportation Planning and Economics	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Total
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

The ultimate aim of transport planning is to generate alternatives for improving Transportation system to meet future demand and selecting the best alternative after proper evaluation. The course concentrates on transportation system planning, public transportation planning, parking planning, and economic analysis of transportation projects. Basic purpose of transportation planning is focusing on what's the most efficient movement for people and goods around the world. Improving access to an area not only reduces congestion, but the accessibility attracts new residents and businesses ultimately helping economic development.

Objectives

1. To understand various urban development policies in India and to learn different planning surveys.
2. To analyze and plan future traffic flow using four stage modelling.
3. To understand the implementation of land use transport model in urban area.
4. To carry out economic analyses for different transportation infrastructure projects.
5. To understand and plan Urban Public Transportation system.
6. To plan and design parking system for residential, commercial and other projects.

Detailed Syllabus

Module	Course Modules / Contents		Periods
1	**Urban Transportation Planning**		04
	1.1	Problems & factors in Transportation Planning, Development of transportation systems in India, growth of transport -trends in traffic - imbalances in transport system.	
	1.2	Urban growth mechanism – urban morphology - urbanization& travel demand - urban development planning policy – NUTP - Urban transport projects - urban transport problems in India	
	1.3	Urban travel patterns - study area delineation- zoning - planning surveys - urban activity system, trip based and activity-based approach - four stage travel demand modelling.	
2	**Four Stage Modelling**		10
	2.1	Trip generation analysis: trip classification, multiple regression analysis, category analysis	
	2.2	Trip distribution analysis: introduction, methods of trip distribution, uniform and average factor method, Fratar method, Furness method, the gravity model, opportunities model.	
	2.3	Modal split analysis: introduction, modal split analysis modal split models.	
	2.4	Traffic Assignment: purpose of traffic assignment, Assignment techniques: all or nothing assignment, multiple route assignment, capacity restraint assignment, diversion curves.	
3	**Land Use Transport Modelling**		05
	3.1	Urban system components - urban spatial structure – accessibility - location theory	
	3.2	Land use models - Land use transport models, Lowry & Garin – Lowry models	
4	**Transportation Economics**		10
	4.1	Economic evaluation of highway schemes, need for economic evaluation, cost and benefits of transportation projects	
	4.2	Basic principles of economic evaluation, net present value method, benefit/cost ratio method, internal rate of return method, vehicle operating costs.	
5	**Urban Public Transport Planning**		05
	5.1	Growth history – urban growth & public transport needs - modes of public transport and comparison - public transport travel characteristics	

	5.2	Technology of bus, rail, rapid transit systems, and basic operating elements. transit characteristics -fleet size and capacity estimation.	
6	**Parking Planning and Design**		**05**
	6.1	Types of parking's, methods of surveys, parking inventories, parking design	
	6.2	Planning of parking for residential and commercial buildings including shopping complex, malls and multiplex.	
		TOTAL	**39**

Note: Minimum one industrial visit based on above module may be conducted.

Contribution to Outcome

On completion of this course, the students will be able to:

1. Understand various Urban transport related terms and policies along with methods to carry out planning surveys.
2. Carry out trip generation, trip distribution, modal split and traffic assignment for planning of urban transport system.
3. Apply land use transport models at Urban area.
4. Carry out economic analysis of different Transport related Infrastructure projects by analyzing costs and benefits related to projects using NPV, IRR and B/C ratio method.
5. Estimate capacity of different public transportation modes in Urban area and to plan and schedule the same based on fleet size.
6. Plan and design Parking facility at Urban area.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour. Average of marks will be considered for IAE.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Recommended Books:

1. Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers, NewDelhi, 2002.
2. IRC: SP: 30-1993., Manual on Economic Evaluation of Highway Projects in India.
3. Sarkar P K., Maitri V.,Economics in Highway and Transportation Planning, Standard Publisher, New Delhi, 2010.
4. K.S. Ramegauda, Urban and Regional Planning, Mysore University Publication.
5. Ceder, A.,Public Transit Planning and Operation: Theory, Modeling and Practice, B-HElsevier Ltd., MA, 2007.
6. IRC: SP:12-2015, Guidelines for Parking Facilities in Urban Roads

Reference Books/Codes:

1. Khisty C J., Lall B.Kent, Transportation Engineering – An Introduction, Prentice-Hall,NJ, 2005.
2. Ortuzar, J. D., Willumsen, L.G., Modeling Transport, John Wiley & Sons, 1994.
3. Papacostas C.S. and Prevedouros, P.D., Transportation Engineering & Planning, PHI, New Delhi,2002.
4. Hutchinson B.G., Principles of Urban Transportation System Planning, Mc- Graw Hill, 1974.

Semester-V

Course Code	Course Name	Credits
CIDO 5013	Department Level Optional Course – I Advanced Concrete Technology	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

Basic concept of concrete technology is essential for civil engineering students to execute the civil engineering projects as per the standard laid down time to time. Advancements in concrete technology is the backbone of infrastructure of civil engineering field. This course provides necessary knowledge about various concreting operations and testing operations during and after construction. This course is intended for gaining knowledge about the properties of materials, especially concrete and to maintain quality in construction projects. This course will also provide knowledge to the students about the criteria to be remembered during the selection of materials, its mix proportioning, mixing, placing, compacting, curing and finishing.

Objectives

1. To understand the various properties and tests of materials used in concrete.
2. To study the different procedures for testing hardened concrete, its compositions and quality of in place concrete.
3. To understand the concept of durability and cracking in concrete. To also understand the significance and parameters of concreting under extreme environment and conditions.
4. To understand the concept and optimization of the mix design of concrete by various codes.

5. To study various constituents, properties, significance of special concrete.
6. To study the quality of concrete and check the acceptance criteria.

Detailed Syllabus

Module	Course Modules / Contents		Periods
1	**Constituents and Properties of Concrete**		08
	1.1	Introduction of cement and water: Chemical composition of OPC, hydration, chemistry of cement, cement testing, water requirement for hydration, water quality for concrete and water quality test.	
	1.2	Aggregates: Types of aggregate (natural, synthetic, recycled), required characteristics of aggregates for concrete, introduction to gradation of aggregates, standard grading curve and gap grading.	
	1.3	Chemical admixture: Introduction to accelerators, retarders, plasticizers, super plasticizers, viscosity modifying admixtures, water proofers	
	1.4	Mineral admixture: Introduction, composition of mineral admixture, fly ash and its type, silica fume, ground granulated blast furnace slag and others. Effects of mineral admixture on fresh and hardened concrete properties	
	1.5	Properties of fresh concrete: Introduction to properties of fresh concrete, w/c ratio, w/b ratio, gel space ratio, maturity concept, aggregate cement bond strength	
2	**Testing of Concrete**		05
	2.1	Introduction to properties and testing of hardened concrete - compression, tension, and flexure. Methods of testing (destructive, semi destructive, non-destructive). Factors influencing strength and relationship between compressive and tensile strength.	
	2.2	Advanced non-destructive evaluation: Ground penetration radar, probe test penetration, pull out/off, break off method, stress wave propagation method, magnetic methods, infrared thermography, and core test.	
3	**Durability of Concrete**		09
	3.1	Introduction to durability and permeability: Transport mechanism of fluids and gases in concrete, role of w/c and admixture on durability. Types and causes of cracks pre and post hardening.	
	3.2	Corrosion and carbonation: Introduction to corrosion of reinforcement in concrete, factors influencing corrosion,	

		damages preventive measures of corrosion, tests for existing structures and remedial measures of corrosion. Introduction and measurement of depth of carbonation.	
	3.3	Concrete structures in special environment: Frost action, fire or high temperature, chemical attack and aggressive environment (sulphate attack, chloride attack, acid attack in sewers, sea water attack), alkali aggregate reaction (alkali silica and carbonate reaction).	
	3.4	Concreting under extreme weather: Hot and cold weather concreting, underwater concreting	
4	**Concrete Mixture Design**		**07**
	4.1	Design of concrete mixes by IS 10262 (latest edition) method – with and without fly ash, super plasticizer, effect of pumping of concrete on mixture design	
	4.2	Design of concrete mixes by American Concrete Institute (ACI) method – Air and non-air entrained concrete	
	4.3	Design of concrete mixes by Department of Environment (DoE) method	
	4.4	Design of high strength concrete mixes using ACI 211.4R - 93 Method.	
5	**Special Concretes**		**07**
	5.1	Light weight concrete: Types and properties of light weight aggregates, factors influencing the strength and density of light weight aggregate concrete, properties of light weight aggregate concrete. Introduction to other light weight concrete – Cellular and foamed concrete.	
	5.2	High performance concrete: Methods for achieving high performance concrete, requirements for high performance characteristics, material selection, advantages and applications.	
	5.3	Self-compacting concrete (SCC): Materials for SCC, comparison of traditional and SCC constituents, requirements for SCC, initial mix compositions, production and placing of SCC, fresh concrete tests for SCC.	
	5.4	Fiber Reinforced Concrete (FRC): Study of different fibers (metallic fiber, polymeric fibers, carbon fibers, glass fibers, naturally occurring fibers) in concrete with respect to volume fraction, orientation and aspect ratio, Comparison of Steel Fiber reinforced concrete with conventional concrete.	
	5.5	Introduction to other special concrete – Vacuum concrete, waste material-based concrete, shotcreting, roller compacted, mass concrete.	
6	**Quality Control (QC)**		**03**

	6.1	Introduction: Statistical QC, quality factors, control charts.	
	6.2	Acceptance criteria according to Indian standards: Strength of concrete (site and laboratory).	
		TOTAL	**39**

Note: Minimum one industrial visit based on above module may be conducted.

Contribution to Outcome

On completion of this course, the students will be able to:

1. Study the various concrete materials and demonstrate the fresh properties of concrete.
2. Perform different testing methods of concrete.
3. Describe the durability of concrete and apply the knowledge of durability in extreme weather concreting.
4. Design the concrete mix for field application by different methods.
5. Explain the various properties of special concrete.
6. Discuss the quality of concrete and explain the acceptance criteria.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour. Average of marks will be considered for IAE.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Recommended Books:

1. Concrete Technology: A. R. Shanthakumar, Oxford University Press, New Delhi, 2007.
2. Concrete Technology Theory and Practice: Shetty M.S., S. Chand.
3. Properties of concrete: Neville, Isaac Pitman, London.
4. Concrete Technology: Gambhir M.L., Tata McGraw Hill, New Delhi.
5. Concrete Technology: Neville A.M. & Brooks. J. J., ELBS-Longman, Pearson Education Ltd.
6. Relevant I.S. codes: Bureau of Indian standard and ACI code.
7. Design of concrete mixes by N Krishna Raju (Latest Edition), CBS Publishers and

Distributers Pvt. Ltd.

Reference Books/Codes:

1. Fibre Reinforced Cementitious Composites: Arnon Bentur and Sidney Mindess, Modern Concrete Technology Series, Tylor and Francis.
2. Concrete- Microstructures, Properties and Materials: P. Kumar Mehta and Paulo J. M. Monteiro, Indian Edition, Indian Concrete Institute, Chennai, 1999
3. Special Publication of ACI on Polymer concrete and FRC.
4. Concrete Technology: D.F. Orchardi, Wiley, 1962.

Semester-V

Course Code	Course Name	Credits
CIDO 5014	Department Level Optional Course – I Rock Mechanics	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

The Civil Engineering structures are built on or through rocks. The design of structures depends on the rock mass properties and the interaction between the rock and the structure. This demands the study of deformation resulting from the strain of rocks in response to various stresses working on them. The mechanisms and character of the deformation of rocks can be investigated through laboratory experiments. The course will give an idea of in- situ testing of the rock and observation of geological conditions that can affect the way a rock behaves when subjected to loads and stresses.

Objectives

1. To provide basic knowledge of rock mechanics to understand design aspects of various structures on or through rocks.
2. To study the various classification schemes of rock masses and their application.
3. To study the physical properties of rocks and various lab test conducted on them to determine the strength.
4. To determine properties and behaviour of various types of rock under different loading conditions.
5. To study bearing capacity, stress distribution and factor of safety within the rock.
6. To study the stability of rock slopes and design aspects of openings in/on the rocks.

Detailed Syllabus

Module	Course Modules / Contents		Periods
1	**Structural Geology and Data Interpretation**		05
	1.1	Introduction to Rock Mechanics and Importance	
	1.2	Geological classification of rocks	
	1.3	Description of discontinuities and their effect on rocks	
	1.4	Stereographic analysis of structural Geology	
2	**Engineering Classification of Rocks and Rock Masses**		06
	2.1	Classification of intact rocks. Rock mass classifications: Rock Quality Designation (RQD), Rock Structural Rating (RSR), Rock Mass Quality (Q system).	
	2.2	Strength and modulus from classifications, classification based on strength and modulus	
	2.3	Geo-mechanics (RMR)} and geo-engineering classification	
	2.4	Deere and Miller's engineering classification	
3	**Laboratory Testing of Rocks: Field and Laboratory Tests on Rocks**		07
	3.1	Determination of physical properties of rocks	
	3.2	Uniaxial Compressive Strength Test.	
	3.3	Tensile Strength Test	
	3.4	Direct Shear Test and Triaxial Test	
	3.5	Slake Durability Test	
	3.6	Schmidt Rebound Hardness, Swelling Pressure and Free-Swell, Void Index, Hydraulic fracture, Flat Jack Test	
4	**Strength, Modulus and Stress-Strain Responses of Rocks**		07
	4.1	Factors influencing rock responses, strength criteria for isotropic intact rocks, modulus of isotropic intact rocks.	
	4.2	Uni-axial Compressive Strength of intact anisotropic rocks, Strength due to induced anisotropy in rocks, compressive strength and modulus from SPT.	
	4.3	Stress- strain models (constitutive models, elastic stress-strain model, elastic-plastic stress-strain model, Visco-elastic Model.	
5	**Bearing Capacity of Rocks**		06
	5.1	Estimation of bearing capacity (foundation on intact rock, heavily fractured rock), UBC with Hoek-Brown criterion, foundation on slope	
	5.2	Stress distribution in rocks, factor of safety, strengthening measures (concrete shear keys, bored concrete piles, tensioned cable anchors, concrete block at toe)	
	5.3	Settlement in rocks (from joint factor, for horizontal joints,	

		from field tests)	
6	**Stability of Rock Slopes & Opening in Rocks**		**08**
	6.1	Modes of failure, rotational failure, plane failure, wedge method of analysis, buckling failure, toppling failure, application of stereographic projection, remedial measures.	
	6.2	Rock Bolting and Grouting: Methods to improve rock mass responses, grouting in rocks, objectives, contact grouting, consolidation grouting, process of grouting, grout requirement, types of grout, stage grouting, grout curtain. Rock bolting rock anchors.	
	6.3	Tunneling: Ground conditions in tunneling, Computing structural discontinuities in rock masses, requirement of lining in tunnels, pressure tunnels and tunnels for other purposes, application of stereographic projection	
		TOTAL	**39**

Note: Minimum one industrial visit based on above module may be conducted.

Contribution to Outcome

On completion of this course, the students will be able to:

1. Explain basic concepts of Rock -Mechanics and apply it to design aspects of various Civil Engineering structures on or through the rocks.
2. Classify the rock masses and evaluate them for various Civil Engineering works.
3. Explain the laboratory testing of rocks and determine the physical properties and strength of intact rocks and rock masses.
4. Explain the stress-strain responses of the rocks and influencing factors.
5. Determine the bearing capacity and factor of safety of rocks.
6. Determine the stability of slopes and underground excavations.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour. Average of marks will be considered for IAE.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum

3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Recommended Books:

1. Introduction to Rock Mechanics: Goodman, RE (1989), Canada, Jhon Wiley & Sons.
2. Rock Slope Engineering, Hoek, E and Bray, JW (1977), The Institution of Mining and Metallurgy, London.
3. Rock Mechanics and Design of Structures on Rock: Obert, Leon and W. I. Duvall.
4. Engineering Rock Mass Classification, Singh, B and Goel RK (20011), Oxford, UK, Elsevier Inc.

Reference Books/Codes:

1. Rock Mechanics in Engineering Practice: K. G. Stagg and O. C. Zienkiewicz, John Willey and Sons, New York.
2. Rock Mechanics – Vol. I and II: Jumukis, Trans Tech Publication, USA.
3. Fundamentals of Rock Mechanics: Jaeger, JG, Cook, NGW and Zimmerman, RW (2007) 4 th Ed., Singapore, Blackwell Publishing Rock Mechanics and Design of Structures on Rock: Obert, Leon and W. I. Duvall

Semester-V

Course Code	Course Name	Credits
CIDO 5021	Department Level Optional Course – II Open Channel Flow	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

Civil engineers deal with the analysis and design of irrigation systems which include dams, weirs, barrages, canals, drains and other supporting systems, for which good knowledge of open channel flow is very much essential. Hence this course is designed to study different types of flow like uniform flow, non-uniform flow, spatially varied flow, and unsteady flow occurring in open channels. Competencies developed by this course would therefore be useful for students to handle and solve the practical problems/ issues in the field of Water resource management, Water shed management etc. It is expected that the students will be better equipped to address various engineering problems related to hydrology and hydraulics.

Objectives

1. To understand the nature of flow, explain the basic concepts of uniform flow and to design the best hydraulic sections in open channel.
2. To apply the Energy concepts of fluid in open channel and demonstrate various flow measurement devices in open channels.
3. To study dynamic equation to compute the flow profiles for gradually varied flow and classify water profiles in prismatic channels with different slope conditions.
4. To illustrate the causes of rapidly varied flow, predict the formation of hydraulic jump and its applications.
5. To determine different types of spatially varied flow with varying discharges and

characteristics of water surface profiles.

6. To study and analyze the temporal flow variations in open channel and the formation of surges.

Detailed Syllabus

Module	Course Modules / Contents		Periods
1	**Uniform Flow**		07
	1.1	Flow through open channel, Types of channels, open and covered channels, classification of flow in channel, geometrical properties, velocity distribution in a channel section	
	1.2	Uniform flow in open channels, discharge through open channel, Manning's and Chezy's equation, determination of roughness coefficients	
	1.3	Determination of conveyance of a channel, hydraulic mean depth, normal depth and normal velocity, computation of uniform flow	
	1.4	Most economical sections of prismatic channels, condition for maximum velocity in a circular channel, condition for maximum discharge in a circular channel	
2	**Energy-Depth Relationships**		07
	2.1	Specific energy, specific energy curve, depth- discharge diagram, critical depth, critical slope, critical flow, alternate depths	
	2.2	Condition for maximum discharge for a given value of specific energy	
	2.3	Momentum in open channel flow- specific force, specific force diagram, dimensionless specific force diagram	
	2.4	Critical flow and its computation, application of specific energy and discharge diagrams to channel transitions	
	2.5	Metering Flumes-Venturi flume, standing wave flume, parshall flume, determination of mean velocity of flow, measurement of discharge in rivers	
3	**Non-Uniform Flow: Gradually Varied Flow**		07
	3.1	Dynamic equation of Gradually Varied Flow (GVF) in rectangular and wide rectangular channels	
	3.2	Types of slopes- channel bottom slopes and water surface slopes, classification of channel bottom slopes and surface profiles	
	3.3	Characteristics of surface profiles, backwater curve and drawdown curve	
	3.4	Computation of GVF-Direct step and Standard step method,	

		numerical methods, graphical integration method	
4	**Non-Uniform Flow: Rapidly Varied Flow**		**07**
	4.1	Rapidly varied flow (RVF), hydraulic jump, momentum equation for the jump	
	4.2	Hydraulic jump in a rectangular channel, froude number before and after jump, classification of jumps, characteristics of jump in a rectangular channel	
	4.3	Jumps in non-rectangular channel, applications of jump, location of jump, surges in open channel	
	4.4	Use of RVF for flow measurement purpose - sharp crested weir, broad crested weir, ogee spillway, sluice gate	
5	**Spatially Varied Flow**		**06**
	5.1	Importance of Spatially Varied Flow (SVF), causes, continuity, momentum and energy equation	
	5.2	Water surface profiles, applications, differential equation for SVF with increasing and decreasing discharge	
	5.3	Relevant case studies	
6	**Unsteady Flow**		**05**
	6.1	Basic concepts of gradually varied unsteady flow, rapidly varied unsteady flow	
	6.2	Positive and negative surges	
	6.3	Relevant case studies	
		TOTAL	**39**

Note: Minimum one industrial visit based on above module may be conducted.

Contribution to Outcome

On completion of this course, the students will be able to:

1. Describe the basic nature of flow in open channels, analyze the behaviour of flow & apply basic theories to design the optimum channel sections.
2. Demonstrate the energy concepts in open channel and its practical applications.
3. Apply dynamic equation for Gradually varied flow (GVF) and evaluate water profiles at different conditions in prismatic channels.
4. Differentiate between Gradually varied flow (GVF) and Rapidly Varied Flow (RVF), analyze hydraulic jump in open channel and its importance.
5. Explain the spatially varied flow and classify water profiles.
6. Discuss the temporal variations of flow in GVF and RVF in open channel.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents

covered in Test I). Duration of each test shall be one hour. Average of marks will be considered for IAE.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Recommended Books:

1. Flow in Open channels: K. Subramanya, Tata Mc Graw -Hill Publishing Co. Ltd., New Delhi
2. Flow through Open channels: Rajesh Srivastava, Oxford University Press
3. Flow through Open channels: K. G. Ranga Raju, Tata Mc Graw -Hill Publishing Co. Ltd., New Delhi
4. Fluid Mechanics and Hydraulics: Dr S.K. Ukarande, Ane's Books Pvt. Ltd., (Revised Version 2012)
5. Hydraulics & Fluid Mechanics: Modi P.N. & Seth S.M, Standard book house, New Delhi
6. Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
7. Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.
8. Fluid Mechanics I & II: Dr. Atulya Patil, C Jamanadas Publication.

Reference Books/Codes:

1. Open channel Hydraulics: Chow, V.T., McGraw Hill International, New York
2. Open Channel Flow: Henderson F.M., McGraw Hill International
3. Open Channel Flow: M. Hanif Chaudhry, Prentice Hall of India.
4. Open channel Hydraulics: French, R.H., McGraw Hill International

Semester-V

Course Code	Course Name	Credits
CIDO 5022	Department Level Optional Course – II Geographical Information Systems	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

Geographic Information Systems provides power of mapping to civil engineers. GIS lets us visualize, question, analyze and interpret geographical data to understand relationships, patterns and trends in the data. In this subject, the students get acquainted with the detailed study of GIS. Data models of spatial and non-spatial information are also explained. An overview on digitizing, editing and structuring of map data is also provided for error detection, correction and appropriate topology creation. Various types of topological models namely Digital Elevation Models (DEM), Digital Terrain model (DTM), Digital surface model (DSM) and their uses are also incorporated. Solutions to various civil engineering problems can be provided for using Integration of GIS-GPS and remote sensing techniques.

Objectives

1. To develop clear understanding of mapping using Geographical Information System and its advantages over conventional mapping system.
2. To study various GIS data structures and learn the process of preparation of a GIS database.
3. To understand the applications of the various geo-processing tools available in a Geographical information system for carrying out spatial analysis.
4. To develop understanding of Global Navigation Satellite System (GNSS) study the various applications of Global Positioning System (GPS) in Civil and Infrastructure

Engineering.

5. To study the various applications of GIS in town planning and disaster management.
6. To study the various applications of GIS in urban transportation planning.

Detailed Syllabus

Module	Course Modules / Contents		Periods
1	**Introduction**		06
	1.1	Definition of GIS, history and evolution, components of GIS, market for GIS, geodesy, earth surfaces, datums, projection systems – purposes and types, coordinate systems – purposes and types. Cartography – concepts for geographical mapping, map elements, conventional mapping and digital mapping,	
	1.2	Data types – Spatial, vector and raster, sources of spatial data, remote sensing data, google earth data, topographic sheets, analog and digital, GPS, aerial photogrammetry, local surveying data, geometry, reports, spreadsheets. Non-Spatial, ttribute data – statistics, labels, characteristics.	
	1.3	GIS workflow data acquisition, data preprocessing, data management, data manipulation and data analysis and product generation	
2	**Introduction to Geo-informatics Technology**		06
	2.1	Aerial Photogrammetry – aerial photography, flight planning and mapping, stereoscope & stereoscopic pair, photo interpretation, photogrammetry	
	2.2	Remote Sensing – remote sensing system, satellite types, EMR spectrum, spectral signatures, resolution-spatial, temporal, radiometric, spectral.	
	2.3	GPS – GPS segments, working principle of GPS, GPS satellites & types, static GPS, kinematic GPS, differential GPS and GPS applications.	
3	**GIS Database Management**		09
	3.1	Spatial Data Modelling – Raster and vector data models, types of raster data models – grid and IMGRID models, types of vector data models – Spaghetti model and Topological model	
	3.2	Data acquisition- sources of data – various existing satellite and GIS databases national and global – BHUVAN and USGS earth explorer	
	3.3	Data input methods – vector and raster data, manual digitizing, Geo-referencing, keyboard entries, errors in digitizing. Data editing – Sources of error, types of errors and their correction. Geometric transformations –map to map and image to image.	

	3.4	Database Management systems, its functions, hierarchical database models, object-based data models, entity relationship attribute model. attribute data entry, manipulation of fields, and attribute data table query, joining fields to attribute table	
4	**Spatial Analysis**		**09**
	4.1	Vector and raster Geo-processing tools – clip, intersect, merge, dissolve, union and buffer	
	4.2	Spatial Analysis – proximity analysis, overlay analysis, buffer analysis, and network analysis. topology, types of topology, terrain mapping and analysis – DEM, DTM, DSM, TIN.	
	4.3	Spatial interpolation and GIS queries	
	4.4	Map composition, layout preparation of qualitative and quantitative maps, levels of maps, map elements and map scales	
5	**Application of GIS in Infrastructure Management – Town Planning and Disaster Management**		**06**
	5.1	Town planning applications – cadastral maps, land use land cover studies, urban spatial data mapping – plot boundaries, water supply lines, sewer lines, urban data updating, development and master plan maps. Underground Infrastructure Management – mapping utility networks, water distribution, sewerage line and water distribution networks. GIS for real estate valuation	
	5.2	Disaster Management – Mapping of disaster vulnerable zones according to type of disaster, flood area mapping, and loss of wetland studies.	
6	**Application of GIS in Urban Transportation Planning**		**03**
	6.1	Travel demand estimation-application of GIS, Traffic Analysis Zone (TAZ), network representation of a transportation system, shortest path determination, GIS based transportation planning	
		TOTAL	**39**

Note: Minimum one industrial visit based on above module may be conducted.

Contribution to Outcome

On completion of this course, the students will be able to:

1. Understand the theory and principles of GIS, Components of GIS.
2. Understand various geo-informatics technologies and their applications.

3. Differentiate between the categories of GIS data models and understand the process of preparing a GIS database.
4. Understand the geo-processing tools available in GIS to carry out spatial analysis and topological modelling.
5. Apply the various GIS techniques required for town planning and disaster management.
6. Integrate the various GIS techniques required for urban transportation planning.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour. Average of marks will be considered for IAE.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Recommended Books:

1. Remote sensing and geographical information systems: M. Anji Reddy, BS Publications
2. Introduction to Geographic Information Systems: Kang-Tsung Chang, Tata McGrawHill.
3. Remote Sensing and GIS, Basudeb Bhatta, Publisher: Oxford University Press, India, Latest Edition
4. GIS, Spatial Analysis, and Modeling: Maguire, D., M. Batty, and M. Goodchild.2005. ESRI Press.
5. Introduction to Geomatics –QGIS user guide – Mr. C.V. Nishinkanth, Mrs. Annu Nishinkanth, Dr. S. S. Vasudevan, Dr. P. Ramkumar

Reference Books/Codes:

1. Burrough, P.A., and McDonnell, R.A., Principles of Geographical Information Systems, 2nd Edition, Oxford University Press, 1998.
2. Demers, M. N., Fundamentals of Geographic Information Systems, John Wiley & Sons, 3rd Edition, 2002.
3. Longley,P.A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W., Geographic Information Systems and Science, 2nd Edition, John Wiley and Sons, 2005.
4. Kang-tsung Chang,"Introduction to Geographic Information Systems", McGraw-Hill Book Company,2006
5. Ormsby, T., E. Napoleon, R. Burke, C. Groessl, and L. Bowden 2010, Getting to Know

Semester-V

Course Code	Course Name	Credits
CIDO 5023	Department Level Optional Course – II Building and Civil Infrastructure Services	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

Mechanical, Electrical and Plumbing (MEP), natural resources and conservation services are integral part of any building and civil infrastructure activity. No building and civil infrastructure can be occupied without having these services and facilities in it. They make the building and civil infrastructure comfortable, functional, efficient and safe. Building service 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 technologist. This course is designed to enhance the employability with the skills required for building service industries.

Objectives

1. To impart basic understanding and knowledge on various service requirements of building and civil infrastructure.
2. To remember the various types of mechanical services provided in building and civil infrastructure.
3. To understand the electrical systems, power requirements and power distribution in building and civil infrastructure.
4. To illustrate plumbing system for water supply and drainage in building and civil infrastructure.
5. To apply the knowledge of rain water harvesting and solar water heating systems in building and civil infrastructure.

6. To implement the knowledge about the IT infrastructure in building and civil infrastructure.

Detailed Syllabus

Module	Course Modules / Contents		Periods
1	**Introduction to Building and Civil Infrastructure Services**		02
	1.1	Objective of building services, classification of building services, selection of services and application to different types of building. Necessity of building services.	
	1.2	Role and responsibility of building service engineer	
2	**Mechanical Services**		09
	2.1	Fire Fighting Systems: Installation requirements, components of firefighting systems. Basics of types of systems like fire extinguishers, fire hose reels, fire hydrant systems & automatic sprinkler systems.	
	2.2	HVAC (Heating, Ventilation and Air Conditioning): Basics, types of HVAC, capacity planning of HVAC, types of ducts, duct profiling	
	2.3	Vertical Communication: Various types of lifts, escalation system. financial aspects of lift and escalators. space design, capacity, material assembly, safety aspects, safety precautionary, standards for lift and escalator	
	2.4	Ventilation system in building: Mechanical ventilation systems in building.	
3	**Electrical Services**		09
	3.1	Electrical System: General overview of electricity demand & supply. Different types of electrical wiring system. AC & DC power supply, power modulator, and open loop and closed loop system, UPS and emergency lighting.	
	3.2	Power requirement calculation for typical civil infrastructure: Residential building, industrial building, commercial and social infrastructures	
	3.3	Power distribution systems for township: Township power distribution system, substations, underground power distribution, overhead power distribution and electrical maintenance.	
	3.4	Power distribution systems for industrial plant: Internal power distribution system, protection system and safety.	
4	**Plumbing Services**		09
	4.1	Importance of 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 grey water and reclaimed water.	
	4.4	Different pipe materials, and jointing methods, fittings, hanger supports and valves used in plumbing and their suitability	
5	**Natural Resources and Conservation Services**		**05**
	5.1	Components of a Rain Water Harvesting (RWH) system (catchments, gutters, conduits, filters, storage facility, 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 public buildings, colonies, industries, public areas like parks, airports, forested areas	
	5.2	Concept of Solar Water Heating (SWH), component parts of SWHS, various system of SWH (heat transfer, propulsion, passive direct system, active direct system), SWHS design principles, specification, installation and maintenance, energy production, life cycle energy assessment and applications of SWHS..	
6	**IT infrastructure**		**05**
	6.1	Introduction to IT infrastructure, network devices and hardware (hub, routers, switches, modems), network switching, network cables & cable types, basics of wireless communication, tracking systems - RFID and GPS, securing information systems, introduction to home automation system.	
		TOTAL	**39**

Note: Minimum one industrial visit based on above module may be conducted.

Contribution to Outcome

On completion of this course, the students will be able to:

1. Understand various service requirements of building and civil infrastructure.
2. Acquire the knowledge of various types of mechanical services provided in building and civil infrastructure.
3. Understand the electrical systems, power requirements and power distribution in building and civil infrastructure.
4. Gain the knowledge about plumbing system for water supply and drainage in building and civil infrastructure.
5. Get acquainted with rain water harvesting and solar water heating systems in building and

civil infrastructure.

6. Get familiar with the IT infrastructure in building and civil infrastructure.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour. Average of marks will be considered for IAE.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Recommended Books:

1. National Building Code Part 1, 4, 8, 9, BIS, New Delhi.
2. V. K. Jain, Fire Safety in Building: New Age International Publication, Delhi
3. Akhil Kumar Das, Principles of fire safety engineering: understanding fire and fire protection, PHI Learning Pvt. Ltd.
4. A. Ameen, Refrigeration and Air Conditioning, Prentice Hall of India Private Limited, New Delhi.
5. N.C. Gupta, Comprehensive HVAC Design: A Handbook on Practical Approach to Air Conditioning, Heating and Ventilation System.
6. Prasad Dandapani, Understanding Elevator Technology, Notion Press.
7. A.K. Mittal, Electrical and Mechanical Services in High rise buildings design and estimation manual 2001,
8. Water supply and Sanitary Installations: A. C. Panchdhari, New Age International Publication, Delhi

Reference Books/Codes:

1. Bashargow G, Rainwater Harvesting Technology, LAP Lambert Academic Publisher.
2. Ernest Tricomi, ABC's of Air Conditioning, Bobbs-Merrill Co.
3. Deolalikar S. G., Plumbing Design and Practice, McGraw Hill.
4. D. P. Kothari and I.J. Nagrath, Modern Power System Analysis, Tata McGraw-Hill, Third Edition.
5. M. A. Pai, Computer Techniques in Power System Analysis, Tata McGraw-Hill, Second Edition.
6. Michael Boxwell, Solar Electricity Handbook, Greenstream, Publishing
7. Y. MD. Riyazuddin and Srinivas Yedlapalli, Compter Network Hardware and Software, LAP Lambert Academic Publisher.

Semester-V

Course Code	Course Name	Credits
CIDO 5024	Department Level Optional Course – II Air and Noise Pollution and Control	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

Air pollution is caused by solid and liquid particles and certain gases that are suspended in the air. These particles and gases can come from car and truck exhaust, factories, dust, pollen, mold spores, volcanoes and wildfires, possibly causing diseases, death to humans, damage to living organisms. Noise pollution impacts millions of people on a daily basis. The most common health problem it causes is Noise Induced Hearing Loss (NIHL). Exposure to loud noise can also cause high blood pressure, heart disease, sleep disturbances, and stress. This subject is intended to make students aware about the noise and air pollution, various sources which contribute in degradation of air quality, assessing the air quality through air quality index, and various air and noise pollution control methods and equipment used by industries.

Objectives

1. To understand basic concepts of air pollution.
2. To study air pollution effects.
3. To identify sampling types and methods for ambient air and stack monitoring.
4. To study macro and micro meteorology for understanding the dispersion of pollutants.
5. To understand the current issues on air pollution globally.
6. To study noise pollution control methods, mechanisms and devices, laws.

Detailed Syllabus

Module	Course Modules / Contents		Periods
1	**Introduction to Air Pollution**		05
	1.1	Definition, air pollutants and its classification and sources of generation, emission inventory, indoor air pollution, measurement of air pollution, air pollution in India and other countries, air quality index, numerical on conversion of units of pollutants.	
2	**Environmental Effects of Air Pollution**		06
	2.1	Effects of air pollutants on human beings, plants, animals, properties and visibility, exposure to air pollution, numerical problems based on COH, CoHb	
3	**Measurement and Control Technology of Air Pollutants**		10
	3.1	Measurement of Air Pollutants: Methods to measure ambient air pollution and stack emissions, high volume sampler, wind rose diagram.	
	3.2	Control Technology: Control devices principles, operations and types, simple hoods and ducts. Settling chambers, cyclones, electrostatic precipitators (ESP), Filters, scrubbers, absorption towers and incinerators. Collection efficiencies for laminar and turbulent flows for settling chambers, particle cut size for cyclone, ESP Concept of frictional and overall efficiencies. Design criteria for filters, scrubbers, absorption towers and incinerators.	
4	**Meteorological Process and Air Quality Monitoring**		10
	4.1	Large scale wind circulation geotropic wind, gradient wind, cyclone, anticyclone, planetary boundary layer. Lapse rate, stability conditions, wind velocity profile, maximum mixing depth, topographic effects. Plum patterns, plum dispersion, Gaussian model for predicting concentration, downwind from a single source, diffusion coefficients, Turner's stability categories and graphs for dispersion estimates. Maximum ground level concentration, inversion effects, distance touching ground modification of Gaussian model to predict particulate dispersion, plume rise, modified Holland equation for small source.	
5	**Legal Aspects and Current Issues on Air Pollution and Global**		04
	5.1	Legal Aspects, air pollution laws, Indian standards- emission and air quality standards greenhouse effect/ global warming, ozone pollution, acid rain	

6	**Noise Pollution**		**04**
	6.1	Definition and introduction, the effects of noise, characteristics of sound and its measurement, levels of noise and problems, noise rating system, noise level standards, sources of noise and their noise levels, noise abatement and control	
		TOTAL	**39**

Note: Minimum one industrial visit based on above module may be conducted.

Contribution to Outcome

On completion of this course, the students will be able to:

1. Identify air pollution problems and interpret criteria for air quality data.
2. Recognize various environmental transformation processes of pollutants under extreme weather condition.
3. Understand the sampling process and various methods for ambient air and stack monitoring.
4. Knowledge to analyze quality of air in the form of air quality index and dispersion modeling.
5. Relate and analyze the air pollution levels globally.
6. Identify noise pollution control methods and interpret criteria for noise quality data.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests.** First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour. Average of marks will be considered for IAE.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Recommended Books:

1. Air Pollution: Rao. M. N. and Rao, H. V. N., Tata McGraw Hill Publication, New Delhi.
2. Environmental Pollution Control Engineering: Rao C.S., New Age International Publishers.
3. Noise Pollution: Agarwal S.K., APH Publishing Corporation.
4. Noise Pollution and Control Strategy: Singal S.P., Alpha Science International LTD.

5. Sewage disposal and Air pollution engineering: Garg, S.K., Khanna Pbl.

Reference Books/Codes:

1. Air Pollution: Part A- Analysis and Part B-Prevention and Control: Ledbetter, J. O., Make Dekker Inc., New York.
2. Air Pollution: Wark and Warner, Harper and Row, New York.
3. Air Pollution Vol.1: Tripathi, A. K., Ashish Publication House, New Delhi.
4. Air Pollution Handbook: Magill, P. L.et al., McGraw Hill publication.
5. Air and Noise Pollution Control: Volume 1: Wang,L.K. and Pereira, N.C., Humana
6. Textbook of Noise Pollution and its Control: Bhatia S. C., Atlantic Publishers and Distributors, New Delhi.
7. Industrial Air Pollution Handbook: Parker, A., Tata McGraw Hills Publication.
8. Air Pollution: Henry Capeskins, McGraw Hill publication.
9. Environmental Noise Pollution: Noise Mapping, Public Health, and Policy, Enda Murphy and Eoin King.
10. Air Pollution: Wark and Warner, Harper and Row, New York.
11. Government of India's Publication of laws related to air pollution, Maharashtra Pollution Control Board's (MPCB) Publication of standards. Indian Standards relevant to Air Pollution Monitoring, Definitions, Standards.
12. Air Pollution Control Theory: Martin Crawford, McGraw Hill Publication

Semester-V

Course Code	Course Name	Credits
CIL 501	Transportation Infrastructure – I (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
--	02	--	--	01	--	01

Theory					Term Work / Practical / Oral			
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Total
Test-I	Test-II	Average						
--	--	--	--	--	25	-	25	50

Objectives

1. To determine Impact, Abrasion and Crushing value of aggregate.
2. To carry out shape test on aggregates.
3. To determine Penetration grade and Viscosity grade of bitumen.
4. To find the Softening point and Ductility value of bitumen.
5. To carry out Marshall stability test on the bituminous mix.
6. To determine California Bearing Ratio on sub grade soil material

Contribution to Outcome

On completion of this course, the students will be able to:

1. Determine suitability of aggregate on basis of Impact value, Abrasion value and Crushing value.
2. Differentiate Elongated and Flaky aggregates on basis of Shape test.
3. Classify Bitumen on basis of Penetration and Viscosity grade.
4. Select Bitumen as per suitability on basis of Softening point and Ductility value.
5. Measure the load and flow rate of the bituminous mix.
6. Determine the strength of the subgrade soil and enable appropriate selection of suitable pavement thickness for the anticipated traffic density.

List of Experiments (Minimum nine)

Module	Detailed Contents	Lab Sessions/Hr
1.	Impact test on aggregates	**02**
2.	Abrasion test on aggregates	**02**
3.	Crushing test on aggregates	**02**
4.	Shape test on aggregates	**02**
5.	Soundness test	**02**
6.	Polished stone value test	**02**
7.	Stripping value or bitumen adhesion test (water sensitivity)	**02**
8.	Penetration test on bitumen	**02**
9.	Ductility test on bitumen	**02**
10.	Softening point test on bitumen	**02**
11.	Viscosity test on bitumen	**02**
12.	Flash point and fire point test on bitumen	**02**
13.	Marshall stability test on the bituminous mix	**02**
14.	CBR test on sub grade soil material (Laboratory or Field)	**02**
15.	Plate bearing test on sub grades oil	**02**

Assessment:

- **Term Work:** Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

  Laboratory Work : 10 Marks
  Site Visit : 05 Marks
  Assignments : 05 Marks
  Attendance : 05 Marks

  Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

- **End Semester Practical/Oral Examination:** Oral examination will be conducted on the basis of term work, site visit and laboratory work.

Recommended Books:

1. Highway Engineering: Khanna, S.K., Justo,C. E.G. and Veeraraghavan A; Nem Chand and Bros., Roorkee (Revised10thEdition)
2. Principles and Practice of Highway Engineering: Kadiyali, L.R.; Khanna Publishers, Delhi
3. A Text Book of Highway and Traffic Engineering: Saxena, Subhash Chandra; CBS Publishers and Distributors (2014)
4. A Text Book of Highway Engineering: Sriniwasa kumar, R.; University Press, Hyderabad (First Published in 2011; Reprinted in2013)

5. Transportation Engineering (Vol.-I)-Highway Engineering: Venkatramaiah,C.; University Press, Hyderabad(2016).
6. Principles of Transportation and Highway Engineering, Rao, G.V.; Tata McGraw Hill Publishing House Pvt. Ltd., New Delhi.
7. Principles, Practice and Design of Highway Engineering (Including Airport Engineering): Sharma, S.K.; S. Chand and Company Pvt. Ltd., New Delhi.
8. Principles of Transportation Engineering: Chakraborty, Parthaand Das, Animesh; Prentice Hall India Learning Pvt. Ltd., New Delhi (Eighth Printing: January2013).

Reference Books/Codes:

1. Transportation Engineering and Planning: Papacostas, C.S. and Prevedouros, P.D.; Prentice Hall India Learning Pvt. Ltd., New Delhi.
2. Transportation Engineering: Khisty, C.J. and Lall, Kent,B.; Prentice Hall India Learning Pvt. Ltd., New Delhi.
3. Traffic Engineering and Transport Planning: Kadiyali, L.R., Khanna Publishers, Delhi
4. Pavement Design: Srinivasakumar, R; University press, Hyderabad (First Published 2013; Reprinted in 2015).
5. Highway Material and Pavement Testing: Khanna, S.K., Justo, C.E.G. and Veeraragavan, A.; Nem Chand and Bros., Roorkee, India.

Semester-V

Course Code	Course Name	Credits
CIL 502	Foundation Engineering (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
--	02	--	--	01	--	01

Theory					Term Work / Practical / Oral			
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Total
Test-I	Test-II	Average						
--	--	--	--	--	25	-	25	50

Objectives

1. To perform one dimensional consolidation test on saturated clay in laboratory
2. To determine shear parameters from direct shear test, unconsolidated undrained tri-axial test, unconfined compression test and vane shear test
3. To determine C.B.R. value from California Bearing Ratio test
4. To determine swelling index and swelling pressure of clay
5. To determine tensile strength and, or pull-out capacity of a geotextile/geogrid
6. To determine load carrying capacity of soil from plate load test, field SPT 'N' value by Standard Penetration Test and, or, cone resistance value from SCPT test

Contribution to Outcome

On completion of this course, the students will be able to:

1. Analyze test results from consolidation test and estimate the consolidation parameters, i.e., co-efficient of compressibility, co-efficient of compression, coefficient of consolidation, etc.
2. Evaluate the shear strength parameters (cohesion, angle of internal friction) of soil in laboratory.
3. Determine design C.B.R. value of soils in laboratory
4. Evaluate swelling index of clay and assess swelling pressure exerted by the clay
5. Determine wide width tensile strength and pull-out capacity of a geotextile/geogrid
6. Determine load carrying capacity of soil, SPT 'n' value and SCPT cone resistance value

List of Experiments (Minimum eight)

Module	Detailed Contents	Lab Sessions/Hr
1.	Determination of coefficient of compression and coefficient of consolidation from one dimensional consolidation test on saturated clay	**02**
2.	Determination of shear parameters from direct shear test	**02**
3.	Determination of shear parameters form unconsolidated undrained tri- axial compression test	**02**
4.	Determination of cohesion from unconfined compression test on clay	**02**
5.	Determination of shear strength of soft clay from vane shear test	**02**
6.	Determination of C.B.R. value from California Bearing Ratio test	**02**
7.	Determination of swelling index and swelling pressure of clay	**02**
8.	Determination of tensile strength of a geosynthetic from wide width tensile strength test/ or, Determination of pullout capacity of a geotextile/geogrid from pull out test	**02**
9.	Small scale stress controlled/ or, strain-controlled plate load test in laboratory (Dummy test)	**02**
10.	Standard penetration test/ or, Static cone penetration test (Dummy test)	**02**

Assessment:

- **Term Work:** Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

  Laboratory Work : 10 Marks
  Site Visit : 05 Marks
  Assignments : 05 Marks
  Attendance : 05 Marks

  Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

- **End Semester Practical/Oral Examination:** Oral examination will be conducted on the basis of term work, site visit and laboratory work.

Recommended Books:

1. Bowles, J. E., 1996, "Foundation analysis and design", The McGraw-Hill Companies, Inc.
2. Nayak, N. V. (2018), "Foundation Design Manual", Dhanpatrai Publication, New Delhi.
3. K. R. Arora: "Soil Mechanics and Foundation Engineering". Standard Publishers and Distributors, New Delhi.
4. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain: "Soil Mechanics and Foundations", Laxmi Publications (P) LTD., New Delhi.

5. V. N. S. Murthy: “Soil Mechanics and Foundation Engineering”, CBS Publishers & Distributors
6. Tomlinson, M. J. (1986), “Foundation design and construction”, 7thedition, Prentice Hall, New Jersey, United States.
7. Som, N. N. and Das, S. C. (2003), “Theory and Practice of Foundation Design”.Prentice Hall of India private limited, New Delhi.

Reference Books/Codes:

1. Relevant Indian Standard Specifications Codes, ASTM Code Standards.
2. Departmental Laboratory Manual
3. Standard Geotechnical Engineering Hand-book
4. NPTEL Video Lectures on Practical
5. SCI/SCOPUS Indexed Refereed International Journals

Semester-V

Course Code	Course Name	Credits
CIL 503	Design of Steel Structure (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
--	02	--	--	01	--	01

Theory					Term Work / Practical / Oral			
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Total
Test-I	Test-II	Average						
--	--	--	--	--	25	-	25	50

Objectives

1. To estimate the design loads on steel structures as per IS 875
2. To analyze the member forces by any suitable method.
3. To design the members for axial, flexure and shear forces.
4. To prepare the detailed design report and fabrication drawings by manual or software.
5. To design floor system components such as beams and columns and column bases
6. To prepare detailed fabrication drawings for framed bolted and welded connections

Contribution to Outcome

On completion of this course, the students will be able to:

1. Calculate dead, live and wind loads on the structure.
2. Analyze the structure by analytical/graphical method.
3. Use steel table for selecting appropriate section.
4. Design the members for various load combinations.
5. Design the bolted and welded connection for column bases
6. Design the bolted and welded connection for steel frame

Note: The project shall be given to a group of students consisting of **not more than** 10 students.

List of Experiments (Minimum nine)

Schedule/ Week	Detailed Contents	Lab Sessions/Hr
Project 1	Design and drawing of steel roof truss for industrial shed should consist of the following items,	**02**
1.	Introduction, problem statement, calculation of panel point DL, LL, and WL on truss	**02**
2.	Analysis of truss by graphical method/ any software and calculation of design loads in members	**02**
3.	Design of purlins, principal rafter, main tie, design of remaining members of truss, etc.	**02**
4.	Design of bolted /welded connections and design of sliding and hinged supports including anchor bolts	**02**
5.	To generate/draw fabrication drawings on full imperial size drawing sheet and design report on A4 size pages.	**02**
6.	To generate fabrication drawings and design report including estimation of steel required	**02**
Project 2	Design and drawing of floor beam system for steel building G+1 should consist of the following items	**02**
7.	Introduction, problem statement and to draw grid floor plan	**02**
8.	Calculation of DL, LL on slab, beams etc. and to analyze frame for BM and SF	**02**
9.	Calculation of design loads on columns and footing	**02**
10.	Design of beams, columns and footings	**02**
11.	Design of beam end and beam-column connections	**02**
12.	To generate/draw fabrication drawings on full imperial size drawing sheet and design report on A4 size pages	**02**
13.	To generate fabrication drawings and design report including estimation of steel required	**02**

Assessment:

- **Term Work:** Shall consist of design report and fabrication drawings for the above projects and Site visit report related to this course, distribution of marks for Term Work shall be as follows:

  Project : 15 Marks
  Site Visit : 05 Marks
  Attendance : 05 Marks

  Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

- **End Semester Practical/Oral Examination:** Oral examination will be conducted on the basis of sketching examination, site visit, project work and entire syllabus.

Recommended Books:

1. Design of Steel Structure by N. Subramanian, Oxford University Press, New Delhi.

2. Limit state design of steel structures by S. K. Duggal, McGraw Hill Education (India) Pvt. Limited, New Delhi.
3. Design of steel structure by Limit State Method as per IS: 800- 2007 by Bhavikatti S. S., I.K. International Publishing House, New Delhi
4. Design of Steel Structures by K. S. Sai Ram, Pearson Education, New Delhi.
5. Limit state design of steel structures as per IS 800/2007. by S. Kanthimathinathan, I.K. International Publishing House, New Delhi.
6. Relevant Indian Specifications, Bureau of Indian Standards, New Delhi

Reference Books/Codes:

1. Design of Steel Structure by Allen Williams
2. Practical Design of Steel Structure by Karuna Moy Ghosh, Whittles Publishing
3. Structural design and drawing by D. Krishnamurthy, CBS Publishers, New Delhi.
4. Teaching Resources Material for steel structures by INSDAG Kolkata.

Semester-V

Course Code	Course Name	Credits
CIL 504	**Skill Based Lab Course-III** **Application of Geographical Information Systems in Civil and Infrastructure Engineering** **OR** **Total Station as a Modern Surveying Equipment**	1.5

Application of Geographical Information Systems in Civil and Infrastructure Engineering

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
--	03	--	--	1.5	--	1.5

Theory					Term Work / Practical / Oral			
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Total
Test-I	Test-II	Average						
--	--	--	--	--	50	--	--	50

Objectives

1. To provide a hands-on training to students on a Geographical Information System software
2. To enable learners to have access to freely available remote sensing data
3. To enable the learners to prepare a GIS database system for spatial and non-spatial data.
4. To enable the learners efficiently draft and label map components using the digital mapping concepts.
5. To learn remote sensing techniques of preparing a contour map and slope map using GIS
6. To understand the application of GIS with regard to Infrastructure planning and management.

Contribution to Outcome

On completion of this course, the students will be able to:

1. Understand and use the various functions of a Geographical Information system.
2. Understand the process of acquiring freely available remote sensing data.
3. Create a digital map by extracting the various spatial entities and prepare a GIS database having both spatial and non-spatial data.
4. Conduct spatial analysis like proximity analysis, overlay analysis, and buffer analysis on any GIS project.
5. Develop contour map using Digital Elevation model of a particular area.
6. Apply GIS software for conducting spatial analysis on various projects by integrating various GIS techniques required for Town planning, Urban Planning, and transportation planning.

List of Experiments (Minimum eight)

Module	Detailed Contents	Lab Sessions/Hr
1.	Introduction to a Geographical Information Software. Study of basic commands and tools within a Geographical Information System	**03**
2.	Remote sensing data acquisition from different sources and georeferencing of the data	**03**
3.	Georeferencing of physical map in GIS	**03**
4.	Digitizing of the geometrical features from the data source chosen for any Civil Engineering project and creating shape file for the same (Eg. Digitizing of roads, buildings, utility lines, landmarks)	**03**
5.	Creating shape files with spatial and non-spatial data and create queries on the data to analyze the data	**03**
6.	Spatial analysis – Carry out Proximity Analysis, Overlay Analysis, Buffer Analysis, and Network Analysis on any given project (carry out any two)	**03**
7.	Exploring digital elevation model from various sources. creating contour map and slope map from DEM	**03**
8.	Selection of the best route for a proposed transportation system using GIS using network analysis	**03**
9.	Creating a land use land cover map for a particular region using Supervised classification or unsupervised classification of multispectral remote sensing data	**03**
10.	Mapping of low laying area from flood prone areas analysis and determine of extent of floods and area of land that would be inundated using DEM	**03**
11.	Preparation of a map layout with patterns and legends representing various infrastructure facilities of a particular region. (Eg. Map layout representing road networks, water supply networks and sewage networks)	**03**

Assessment:

- **Term Work:** Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	30 Marks (Comprising of minimum 6 software generated sheets)
Presentation	:	10 Marks
Assignments	:	05 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

Recommended Books:

1. Dr. K.K. Maltiar & Dr. S.R. Maltiar, Cartography, remote sensing and GIS, Rajesh Publications (2019)
2. Basudev Bhatta, Remote sensing and GIS, Oxford Publications (2021)
3. Shivam Pandey and S. Tripathi, Basic concepts of remote sensing, GPS and GIS, Sankalp Publications (2020)
4. Paul Bolstad, GIS fundamentals, Xanedu Publications, Fifth edition (2016)

Reference Books/Codes:

1. Related User Manuals
2. Referred Journal papers on software applications

Semester-V

Course Code	Course Name	Credits
CIL 504	Skill Based Lab Course-III Application of Geographical Information Systems in Civil and Infrastructure Engineering **OR** Total Station as a Modern Surveying Equipment	1.5

Total Station as a Modern Surveying Equipment

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
--	03	--	--	1.5	--	1.5

Theory					Term Work / Practical / Oral			
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Total
Test-I	Test-II	Average						
--	--	--	--	--	50	--	--	50

Objectives

1. To provide a hands-on training for the use of total station as a modern surveying equipment.
2. To enable the learners to use total station for calculating distance and angular measurements.
3. To understand the use of total station in carrying out traverse survey.
4. To enable the learners to perform a contour survey using a total station.
5. To study the integration of total station with CAD software for better representation of survey data.
6. To understand the application of total station for performing setting out works.

Contribution to Outcome

On completion of this course, the students will be able to:

1. Understand the concepts and working principle of a total station.
2. Calculate distance measurement and height difference between two points and compute angular measurements of both horizontal and vertical angles using total station.

3. Conduct setting out works using total station.
4. Carry out a contour survey using a total station.
5. Conduct traversing using a total station
6. Integrate total station survey data with a CAD software for better representation of the survey data.

List of Experiments (Minimum eight)

Module	Detailed Contents	Lab Sessions/Hr
1.	Introduction to concepts, fundamental features and working principal of Total Station (TS)	**03**
2.	Temporary settings of a TS in field and perform height and distance measurement using principles of Tachometric surveying.	**03**
3.	Measurement of horizontal and vertical angles using TS	**03**
4.	Collect detailed features of a plot (comprising features such as 2-3 buildings, courtyards, security cabins, playgrounds, trees, gates, poles, roads, drainage lines, etc.) using TS	**06**
5.	Transfer data collected through TS on a convenient computer aided drafting (CAD) software	**03**
6.	Calculation of area of a plot using Total Station	**03**
7.	Setting out a foundation plan using Total Station	**03**
8.	Traversing using Total Station	**06**
9.	Contouring using Total Station	**06**
10.	Determination of Remote height using total station	**03**

Assessment:

- **Term Work:** Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	30 Marks (Comprising of min 4 software generated sheets and 4 written/printed practicals)
Presentation	:	10 Marks
Assignments	:	05 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

Recommended Books:

1. Walker, J., Awange, J.L. (2018). Total Station: Measurements and Computations. In: Surveying for Civil and Mine Engineers. Springer, Cham.
2. Advanced Surveying: Total Station, GIS and Remote Sensing by Satheesh Gopi, Gopi.

3. Optimum Establishment of Total Station by Milan Horemuž and Patric Jansson, Journal of Surveying Engineering Volume 143 Issue 2 - May 2017
5. Precision of angular measurement of total stations Trimble M3 by J. Braun, Advances and Trends in Geodesy, Cartography and Geo-informatics, CRC Press, 2018

Reference Books/Codes:

1. Total Station user manuals.
2. Textbook on Advanced Surveying by R. Agor, Khanna Publications.
3. Advanced Surveying: Total Station, GIS and Remote Sensing, Gopi S., Sathikumar R., Madhu N., Pearson Education India.
4. Referred Journal papers on software applications

Semester-V

Course Code	Course Name	Credits
CIM 501	Mini Project - 2A	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
--	03	--	--	1.5	--	1.5

Theory					Term Work / Practical / Oral			
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Total
Test-I	Test-II	Average						
--	--	--	--	--	25	--	25	50

Rationale

From primitive habitats of early years to modern buildings, the civil engineering industry's growth has been needing based and society centric. Civil engineers deal with many challenges on daily basis that most people do not have any idea. Mumbai University proposed Mini projects in the syllabus so that the budding civil engineers can connect with the world outside their books and have the idea of future course. The Mini project should actually provide solution to a typical problem after a brainstorming and in a stipulated period. The competitions ahead will give students the experience of the civil engineering industry's real-world problems and make students brainstorm ideas, learn, and explore the civil engineering industry.

Objectives

1. To recognize societal problems and convert them into a problem statement by understanding of facts and ideas in a group activity.
2. To deal with new problems and situations by applying acquired knowledge, facts, techniques and rules in a different way.
3. To examine and break information into parts, by analyzing motives or causes.
4. To learn evaluating information, validity of ideas and work based on a set of criteria.
5. To create solutions by compiling information together in a different way.
6. To design model by combining elements in a new pattern or proposing new solutions.

Contribution to Outcome

On completion of this course, the students will be able to:

1. Identify problems based on societal /research needs and formulate a solution strategy.
2. Apply fundamentals to develop solutions to solve societal problems in a group
3. Analyze the specific need, formulate the problem and deduce the interdisciplinary approaches, software-based solutions and computer applications.
4. Develop systematic flow chart, evaluate inter disciplinary practices, devices, available software, estimate and recommend possible solutions.
5. Draw the proper inferences from available results through theoretical/ experimental/ simulations and assemble physical systems.
6. Design a software/hardware based model.

Guidelines for Mini Project – 2A

- Expected outcome is software/hardware based, " Model."
- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students in consultation with faculty supervisor/ head of department/ internal committee of faculties select the title of the mini project based on operational infrastructure projects in India.
- Mini project topic can also be based on the internship completed by the students after semester 4 related to infrastructure projects or in consideration with the allotted guide.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/ supervisor can verify and record notes/ comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into a model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that Students come out with original solution.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/ modifications or a completely new project idea in even semester. This policy can be adopted on case-by-case basis.

Assessment:

- **Term Work:** The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
  In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions, distribution of term work marks for both semesters shall be as below:

Marks awarded by guide/supervisor based on log book	:	15 Marks
Marks awarded by review committee	:	05 Marks
Quality of Project report	:	05 Marks

- **One-year project:**
  Only if a project is very demanding it will be considered for 'One Year Project'. Subject to approval by the Head of the department.
  Outcome shall be a 'Hardware and a software based' solution
  There shall also a 'technical paper' to be presented in conference/published in journal (UGC approved) or student's competition.
  In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
  In second semester expected work shall be finalization of problem and proposed solution to the problem.
- **Half-year project:**
  In this case in one semester students group shall complete project in all aspects including Identification of need/problem Proposed final solution Procurement of components/systems

- **Guidelines for Assessment of Mini Project Practical/Oral Examination**
  Report should be prepared as per the guidelines issued by the University of Mumbai.
  Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years and approved by head of Institution.
  Students shall be motivated to publish a paper based on the work in conferences/students competitions.
  Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

- **Assessment criteria of Mini Project:**
  - Mini Project shall be assessed based on following criteria:
  - Quality of survey/ need identification
  - Clarity of Problem definition based on need.
  - Innovativeness in solutions
  - Feasibility of proposed problem solutions and selection of best solution
  - Cost effectiveness and Societal impact

- Contribution of an individual as member or leader
- Clarity in written and oral communication