Kavayitri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Third Year Bachelor of Engineering

in

(Civil)

(As per NEP 2020 Guidelines)

Faculty of Science and Technology



SYLLABUS STRUCTURE

For Affiliated Colleges

Semester – V &VI

W. E. F. 2026 – 27

Syllabus Structure for Third Year Engineering (Semester – V, Level – 5.5) (CIVIL) (w. e. f. 2026 – 27)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs. / Week	Tutorial Hrs. / Week	Practical Hrs. / Week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE-501	Transportation Engineering	PCC	3			3	40	60			100	3
CE-502	Transportation Engineering Lab	PCC			2	2			25	25 (OR)	50	1
CE-503	Geotechnical Engineering	PCC	3			3	40	60			100	3
CE-504	Geotechnical Engineering Lab	PCC			2	2			25	25 (OR)	50	1
CE-505	Structural Analysis Lab	PCC	3		4	7			50	25 (OR)	75	5
CE-506	Program Elective Course – I	PEC	3			3	40	60			100	3
CE-507	Program Elective Course – I Lab	PEC			2	2			25		25	1
CE-508	Theory of Structure	MDM	2			2	40	60	25		125	2
OE-509	Open Elective – III	OE	2			2			25		25	2
			16		**10**	**26**	**160**	**240**	**175**	**75**	**650**	**21**

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

CA: College Assessment UA: University Assessment

Program Elective Course – I		
Course Code		**Name of the Subject / Course**
CE-506	A	Building Construction Practices
CE-506	B	Hydrology
CE-506	C	Traffic Engineering

Syllabus Structure for Third Year Engineering (Semester– VI, Level–5.5) (w .e. f. 2026–27)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs. /Week	Tutorial Hrs. /Week	Practical Hrs. /Week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE-601	Structural Design and Drawing	PCC	3			3	40	60			100	3
CE-602	Structural Design and Drawing Lab	PCC			2	2			25	25 (OR)	50	1
CE-603	Environmental Engineering	PCC	3			3	40	60			100	3
CE-604	Environmental Engineering Lab	PCC			2	2			25	25 (OR)	50	1
CE-605	Program Elective Course – II Lab	PEC	3		4	7			50	25 (OR)	75	5
CE-606	Program Elective Course – III	PEC	3			3	40	60			100	3
CE-607	Program Elective Course – III Lab	PEC			2	2			25		25	1
CE-608	Design of Steel Structure	MDM	2			2	40	60	25		125	2
CE-609	Concrete Material Lab	VSEC	1		2	3			25		25	2
			15		**12**	**27**	**160**	**240**	**175**	**75**	**650**	**21**

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

CA: College Assessment UA: University Assessment

Program Elective Course – II Lab			Program Elective Course – III		
Course Code		Name of the Subject / Course	Course Code		Name of the Subject / Course
CE – 605	A	Advanced Surveying Lab	CE – 606	A	Foundation Engineering
CE – 605	B	Computer Aided Structural Drawing	CE – 606	B	Hydraulic Engineering
CE – 605	C	Remote Sensing and GIS	CE – 606	C	Earthquake Engineering

EXIT COURSE FOR U. G. B. VOCATIONAL in Civil (DURATION 8 WEEKS)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / Week	Tutorial Hrs / Week	Practical Hrs / Week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE-610	Internship / Apprenticeship	OJT							125			4
CE-611	Mini Project	Project							25			4
									150			**8**

Kavayitri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Third Year Bachelor of Engineering

in

(Civil)

(As per NEP 2020 Guidelines)

Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
(4th Cycle)

COURSE OUTLINE

For Affiliated Colleges

Semester – V

W. E. F. 2026 – 27

TRANSPORTATION ENGINEERING (PCC)					
COURSE OUTLINE					
Course Title:	**TRANSPORTATION ENGINEERING**	**Short Title:**	**TRE**	**Course Code: Theory**	**CE- 501**

Course Description:

Transportation facilities ensure the prosperity, security and integrity of a nation. The present course describes the importance of transportation network, their types, and role of civil engineer in their development. The syllabus is principally focused on highways, waterway, bridges& airways. . This course enables a student to plan design and execute a roadway project. It introduces complete geometric design and structural design of road pavements using relevant IS codes. It also introduces a student with comprehensive knowledge of the planning, design, construction, and maintenance of docks and harbour structures. This course introduces the principles of planning, analysis, design, construction, and maintenance of bridges. It covers various types of bridges based on structural form, material, and span, along with selection of suitable bridge sites considering hydraulic, geological, and traffic factors. This course deals with the planning, design, construction, and maintenance of airport infrastructure.

	Hours/Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. To introduce the fundamentals of highway planning, development, and classification of roads in India (NH, SH, MDR, ODR, VR as per IRC).
2. To impart knowledge of geometric design principles including cross-sectional elements, sight distance, super elevation, gradients, and horizontal and vertical curves.
3. To introduce the basic concepts of port and harbour engineering and their importance in national and international trade.
4. To introduce the fundamentals of air transportation systems and the role of airports in national and international connectivity.
5. To introduce the fundamental concepts of bridge engineering, including classification

and components of bridges.

Course Outcomes:

After successful completion of this course the student will be able to:

1. Design geometric elements of highways as per standards (IRC guidelines).
2. Understand the importance and classification of ports and harbors.
3. Classify and describe different types of bridges and their structural components.
4. Evaluate suitable bridge sites considering hydraulic, geological, and traffic conditions.
5. Explain the fundamentals of air transportation and airport planning.

COURSE CONTENT

TRANSPORTATION ENGINEERING		**Semester:**	**V**	**Course Code**	**CE – 501**
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 Hours/Week**	**End Semester Exam (ESE) UA:**			**60 Marks**
		Duration of ESE:			**03 Hours**
		Internal Sessional Exam (ISE) CA:			**40 Marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Highway Planning and Development: Highway planning in India, development, rural and urban roads, road, departments in India, road classification, road authorities i.e. IRC, CRRI, NHAI, etc., Financing of road projects, road safety audit, Current road projects in India.

Field Surveys: Reconnaissance, aerial surveys, location surveys, location of bridges.

Highway alignment: Basic requirements of an ideal alignment and factors controlling it, special requirements for hill roads.

Highway Geometric Design: Topography and physical features, cross section elements like carriageway width, formation width, right of way, etc., friction, Light reflecting characteristics, roughness, camber, sight distances, horizontal alignment, design speed, super-elevation, transition curve, gradients.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Road Materials: Aggregates and their types, physical and engineering properties, Fillers, bitumen, characteristics, emulsions and cutbacks, basic tests on all materials, soil investigation, test on soil; CBR, plate load test.

Construction of Roads: Stabilized earth, gravel roads, W.B.M. Roads, high cost Roads

bituminous roads, cement concrete roads.

Highway Drainage: Surface and sub-surface drainage arrangements,

Highway Pavements: Design of Flexible (G.I.method and CBR method using IRC recommendations) and rigid pavements (Wester-gaurd wheel load analysis), Maintenance & Strengthening of pavements **Traffic Engineering:** Road user characteristics, vehicular characteristics, traffic flow characteristics , parking studies, definition, purpose, types, Accident studies , purpose, types, causes.

Traffic control devices: pavement marking, signs, signals, Traffic management.

Roadside Developments: Arboriculture, street lighting.

Advanced Urban Transport Technology: Classification, mass and rapid transit system, introduction to intelligent transportation System (ITS), electronic toll Collection

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Bridges: Site investigation, waterway calculations, scours depth, afflux, and economic span.

Classification & suitability: Classification of superstructures with respect to structural behaviour and material used types of substructures, flooring joints, movable bridges, and temporary bridges.

Construction methods & Maintenance: Methods of erection of various types of bridges, testing and strengthening of bridges.

Bridge Bearings & Foundation: Suitability for each type of bridges

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction: Classification of harbours, selection of site for harbour. Definitions/methods of Breakwater, Quay walls, Bulkhead, Wharves, Jetty, Dolphins, Dock fenders, piers, slips, moles, berths , pier heads, Jetties, mooring accessories function

Natural Phenomena: Inland water transport in India, tide winds and waves erosion, littoral drift, coast protection,

Other Facilities: Dry Dock, Wet docks purpose, Lift docks, repair docks, graving docks, floating docks, marine railway, signals, buoys, beacons, light house, ware house and Transit sheds.

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Basic definition & terms: Runway, Taxiway, Apron, Hanger, Airport obstruction, Airport Classification (ICAO), selection of site for airport.

Wind Rose Diagram, characteristics of aircraft, corrections to basic length of runway, Runway Geometrics, Taxiway Geometrics

Terminal Building requirements, Airport Drainage, Heliports, Main characteristics of Helicopters, nature of helicopters transport, site selection for helicopters

Text Books:

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017.
2. Kadiyalai, L.R., Traffic Engineering and Transport Planning, Khanna Publishers.
3. ParthaChakraborty, Principles Of Transportation Engineering, PHI Learning.
4. L. R. Kadiyali, N B. Lal, Principles & practice of Highway Engineering, Khanna Publication, 2005.

Reference Books:

1. Rangwala, Highway Engineering, Charotar.
2. Khanna&Arora,Airport planning & design, Nemchand Bros, Roorkee, Delhi.,3rd edition 2005.
3. Rangwala, Airport Engineering, 13th edition, 2013.
4. G. VenkatappaRao, Airport Engineering,1st edition,1992.
5. Rao G. V., Airport Engineering, Tata McGraw Hill.
6. Bindra S. P., Docks & Harbour Engineering, DhanpatRai& Sons, 1992.
7. R. Shrinivasan, Harbour dock & tunnel Engineering, New Delhi, 26th Edition, 2013.
8. Rangwala, Docks and Harbour, 3rdEditon, 2004.
9. K. L. Bhanot& S. B. Sehgal, Highway Engineering & Airport, 3rd Edition 1996.
10. S. P. Bindra, Bridge E]ngineering, Khanna Publication.S. Ponnuswamy, Bridge Harbour.

NPTEL Links:

1. https://nptel.ac.in/courses/105105107?utm Introduction to Transportation Engineering by

Dr. K.S. Reddy, Dr. Bhargab Maitra,IIT Kharagpur.

2. https://nptel.ac.in/courses/105101008 - Traffic Engineering and Management by Dr.Tom Mathew IIT Bombay.
3. https://nptel.ac.in/courses/105104098? Advanced Transportation Engineering by Prof. A. Das, Prof. Partha Chakraborty.

<table>
<tr><th colspan="6">TRANSPORTATION ENGINEERING LAB (PCC)</th></tr>
<tr><th colspan="6">LAB COURSE CONTENT</th></tr>
<tr><td colspan="2">TRANSPORTATION ENGINEERING LAB</td><td>Semester:</td><td>V</td><td>Course Code</td><td>CE – 502</td></tr>
<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td rowspan="2">Practical:</td><td rowspan="2">2 Hours/Week</td><td colspan="3">Internal Continuous Assessment (ICA) CA:</td><td>25 Marks</td></tr>
<tr><td colspan="3">End Semester Exam (ESE) UA:</td><td>25 Marks (OR)</td></tr>
<tr><td colspan="2">End Semester Exam (ESE) Pattern</td><td colspan="4">Oral (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL: (Any Six practical should be performed)
1. Penetration test
2. Ductility of Bitumen
3. Softening point of Bitumen
4. Flash & fire point
5. Specific gravity of Bitumen
6. Viscosity of Bitumen
7. Bitumen extraction test(on premix sample)
8. California Bearing Ratio (CBR) Test
9. Los Angeles Abrasion Test
10 .A report on at least one site visit.
(Visit to construction site of major road projects, hot mix plant etc.)</td></tr>
<tr><td colspan="6">Guidelines for ICA:</td></tr>
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<tr><td colspan="6">Guidelines for ESE:</td></tr>
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GEOTECHNICAL ENGINEERING (PCC)					
COURSE OUTLINE					
Course Title:	**GEOTECHNICAL ENGINEERING**	**Short Title:**	**GTE**	**Course Code: Theory**	**CE- 503**

Course Description:

Geotechnical Engineering is a core civil engineering course covering the behaviour of earth materials (soil and rock) under loading, focusing on soil mechanics, classification, and engineering properties.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Nil

Course Objectives:

The primary objective of soil mechanics is to understand, predict, and analyse the physical, mechanical, and hydraulic behaviour of soil under various loading and environmental conditions. It applies engineering principles to ensure safe, stable, and cost-effective designs for foundations, slopes, retaining structures, and earthwork, preventing failures like collapses or landslides.

Course Outcomes:

After successful completion of this course the student will be able to understand:

1. Soil, Soil mechanics, Classification of soil.
2. Index (Elementary) engineering properties of soil.
3. Soil Hydraulics.
4. Consolidation and compaction of soil.
5. Shear Strength of soil and Earth Pressure.

COURSE CONTENT

GEOTECHNICAL ENGINEERING		**Semester:**	**V**	**Course Code**	**CE – 503**
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 Hours/Week**	**End Semester Exam (ESE) UA:**			**60 Marks**
		Duration of ESE:			**03 Hours**
		Internal Sessional Exam (ISE) CA:			**40 Marks**
Unit–I:		**No. of Lectures: 09 Hours**		**Marks: 12**	

Introduction: Soil and Soil Engineering, History of Development of Soil Mechanics

(Geotechnical Engineering), Scope of Geotechnical Engineering.

Preliminary Definitions and Relationship: Soil as a three phase system, Water content, Density and Unit weights, Specific gravity, Voids ration, Porosity and Degree of saturation, Density Index and relative compaction, Functional Relationship, Examples (Numerical).

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Determination of Index Properties: General, Water content, Specific Gravity, Particle size distribution curve, Sieve analysis, Particle size distribution curve. Examples (Numerical).

Consistency of Soil: Determination of Liquid limit, Plastic limit, Shrinkage limit, and their relationship, determination of in-situ density, Activity of Clay, Sensitivity of Clays, Thixotropic of Clays. Examples (Numerical).

Classifications of Soil: General, Particle size classification, Textural classification, Highway Research board classification, Unified soil classification system, Indian Standard Classification system. (No Numerical)

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Soil water: Effective and Neutral Stresses Modes of Occurrence of water in soil, Adsorbed water, Capillary water, Capillary tension, Capillary potential and soil suction, Capillary phenomenon in soil, Shrinkage and swelling of soil, slaking of clay, bulking of sand, Stress condition in soil (Effective and Neutral pressure). (No Numerical)

Permeability: Introduction, Darcy's Law, Discharge velocity and seepage velocity, Validity of Darcy's law, Factors affecting permeability, Constant head permeability test, falling head permeability test, Jodhpur permeameter, permeability of stratified soil deposits. Examples (Numerical).

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Consolidation: One Dimensional Consolidation: Introduction, consolidation process (Spring Analogy) consolidation of laterally confined soil, consolidation of undisturbed specimen, Terzaghi's theory of one dimensional consolidation, Laboratory consolidation test, determination of coefficient of consolidation, secondary consolidation, Three dimensional consolidation introduction. (No numerical).

Compaction: Introduction, Standard Compaction test, (Light compaction test), Modified Proctor Test (Heavy Compaction test) Field compaction methods, Factors affecting compaction, Effect

of compaction on soil properties. Examples (Numerical)

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Shear Strength: Introduction, Theoretical consideration, Mohr's stress circle, Mohr-Columb failure theory, the effective stress principle, measurement of shear strength, direct shear test, triaxial compression test, Unconfined compression test, Vane shear test, shear strength of cohesive soil. Examples (Numerical)

Earth Pressure: Introduction, Plastic equilibrium of in soil Active and Passive states, Earth pressure at rest, Active earth pressure Rankine's theory, Active earth pressure of cohesive soil, Passive earth pressure Rankine's theory, Columb's wedge theory, Earth pressure computation for practical cases. Examples (Numerical)

Text Books:

1. Soil Mechanics and Foundation Engineering: Geotechnical Engineering Series, V. N. S. Murthy, CRC Press
2. Geotechnical Engineering: Principles and Practices of soil mechanics and foundation engineering, V. N. S. Murthy, CRC Press
3. Soil Mechanics and Foundation Engineering (Geotechnical Engineering), P N Modi, Standard Book House.
4. Fundamentals of Soil Mechanics, Dr A. V. Narasimha Rao, University Science Press.

Reference Books:

1. Soil Mechanics and Foundations, Dr B. C. Punmia, Laxmi Publications, Pvt. Ltd.
2. Foundation Engineering, Dr B J Kasmalkar, Pune VidyarthiGruhPrakashan.
3. Soil Mechanics and Foundation Engineering, S. K. Gerg, Khanna Publisher.
4. Soil Mechanics in Engineering Practice, Karl Terzaghi, Ralph B. Peck, and GholamrezaMesri, Third Edition (1996), Wiley/Chapman & Hall.

NPTEL Links:

1. https://nptel.ac.in/courses/105105185 - Geotechnical Engineering II Foundation Engineering, Prof. Dilip Kumar Baidya, IIT Kharagpur
2. https://onlinecourses.nptel.ac.in/noc22_ce03/preview Geotechnical Engineering - 1, Prof. D. N. Singh, IIT Bombay.
3. https://nptel.ac.in/courses/105105168 Soil Mechanics/Geotechnical Engineering I, IIT Kharagpur, Prof. Dilip Kumar Baidya, IIT Kharagpur.

4. https://nptel.ac.in/courses/105101160 Geotechnical Engineering Laboratory, Prof. J.N. Mandal, IIT Bombay
5. https://onlinecourses.nptel.ac.in/noc21_ce39/preview Foundation Engineering, Prof. Kousik Deb, IIT Kharagpur.
6. https://onlinecourses.nptel.ac.in/noc26_ce41/preview Advanced Foundation Engineering, Prof. Kousik Deb, IIT Kharagpur

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<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
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<tr><td colspan="6">LIST OF PRACTICAL (Any Six practical should be performed.)
1. Water content by Oven Drying method OR Pycnometer Method.
2. Specific Gravity by Voluminometer OR Pycnometer Method.
3. Field density by Core cutter method OR Sand Replacement Method.
4. Particle size distribution by sieving (Grain size analysis).
5. Liquid Limit, Plastic Limit and Shrinkage Limit and Plasticity Chart.
6. Permeability of soil by Constant Head OR Variable Head Method.
7. Compaction by Proctor OR Modified Proctor Test.
8. Unconfined Compression Test.
9. Direct Shear Test.
10. Triaxial Shear Test.
11. California Bearing Ratio (CBR) Test.</td></tr>
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</table>

Engineering, Prof. Dilip Kumar Baidya, IIT Kharagpur

2. https://onlinecourses.nptel.ac.in/noc22_ce03/preview Geotechnical Engineering - 1, Prof. D. N. Singh, IIT Bombay.
3. https://nptel.ac.in/courses/105105168 Soil Mechanics/Geotechnical Engineering I, IIT Kharagpur, Prof. Dilip Kumar Baidya, IIT Kharagpur.
4. https://nptel.ac.in/courses/105101160 Geotechnical Engineering Laboratory, Prof. J.N. Mandal, IIT Bombay
5. https://onlinecourses.nptel.ac.in/noc21_ce39/preview Foundation Engineering, Prof. Kousik Deb, IIT Kharagpur.
6. https://onlinecourses.nptel.ac.in/noc26_ce41/preview Advanced Foundation Engineering, Prof. Kousik Deb, IIT Kharagpur

STRUCTURAL ANALYSIS LAB (PCC)					
LAB COURSE OUTLINE					
Course Title:	**STRUCTURAL ANALYSIS LAB**	**Short Title :**	**SA-LAB**	**Course Code: Theory**	**CE-505**

Course Description:

Structural Analysis is a core subject in Civil Engineering that deals with the determination of internal forces, moments, reactions, and deflections in structural members subjected to different types of loads. The course introduces the fundamental principles governing the behaviour of structural systems such as beams, trusses, frames. It covers the analysis of both statically determinate and indeterminate structures using matrix methods.

The subject includes methods for evaluating structural response such as slope deflection method. Students also learn the concept and applications of influence line diagrams for structures subjected to moving loads.

	Hours/Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Theory	03	15	45	5
Practical	04	15	60	

Prerequisite course(s):

Nil

Course Objectives:

1. To understand the basic concepts and principles of structural analysis.
2. To analyse statically determinate structures such as beams, trusses, and arches.
3. To analyse beams and frames by using displacement methods.
4. To analyse statically indeterminate structures using classical methods.
5. To apply slope deflection and moment distribution methods for analysis of beams and frames.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Identify different types of structural systems and analyse determinate and indeterminate structures.
2. Analyse the structures beams**,** trusses**,** arches, cables, frames by consistent deformation method.

3. Analyse the structures beams and frames by using classical methods.
4. Develop influence line diagrams and apply them for static and dynamic load analysis
5. To analyse beams and frames by using matrix method of structural analysis

COURSE CONTENT

Structural Analysis Lab		**Semester:**	V	**Course Code**	CE – 505
Teaching Scheme:		**Examination scheme**			
Theory	**3 Hours/Week**	**Internal Continuous Assessment (ICA) CA:**		50 Marks	
Practical	**4 hours/week**	**End Semester Exam (ESE) UA:**		25 Marks Oral	
End Semester Exam		**Oral (OR)**			

Basic Concepts

a) Statically determinate and statically indeterminate structures
b) Degree of static indeterminacy
c) Method of superposition

Analysis of Structures

a) Analysis of beams
b) Analysis of trusses
c) Analysis of arches
d) Analysis of cables
e) Analysis of frames

Displacement Methods

a) Slope Deflection Method
b) Moment Distribution Method

Influence Line Diagrams

a) Influence lines for reactions
b) Influence lines for shear force and bending moment

c) Applications for moving loads

Matrix Methods of Structural Analysis

a) Flexibility method

b) Stiffness method

Assignments:

1. Analysis of Statically determinate and statically indeterminate structures (Beams and frames).
2. Analysis of structures by using Analysis of beams**,** trusses**,** arches, cables, frames.
3. Analysis of beams and frames by using displacement methods.
4. Determination of influence line diagram for beams.
5. Analysis of beams by using Influence line diagram.
6. Analysis of beams and frames by using matrix methods of structural analysis

Text Books:

1. Structural analysis Vol –I, II by S.S. Bhavikatti, Vikas Publishing House Pvt. Ltd.
2. Mechanics of structures Vol – II by S.B.Junnarkar and Dr. H.J. Shah, Charotar Publishing House.

Reference Books:

1. Analysis of structures (Volume - I & II) by V.N.Vazirani, M.M. Ratwani and Dr. S. K. Duggal, Khanna Publications.
2. Theory of structures by S. Rammamrutham, Dhanpatrai Publishing Company.
3. Basic structural analysis by C. S. Reddy
4. Punmia B. C. – Theory of Structure, Laxmi Publication.

Guide lines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each practical/assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design/drawing.
Guide lines for ESE:
ESE will be based on practical/assignments submitted by the students in the form of journal/drawing sheet. Evaluation will be based on oral, paper work and performance in the ESE.
NPTEL Links:
1. https://nptel.ac.in/courses/105101085Structural Analysis by Dr. R.S. Jangid, Dr. Siddhartha Ghosh IIT Bombay. 2. https://nptel.ac.in/courses/105105180 Matrix method of structural Analysis by Prof. Amit Shaw Prof Biswanath Banerjee, IIT Kharagpur

BUILDING CONSTRUCTION PRACTICE (PEC – I)					
COURSE OUTLINE					
Course Title:	**BUILDING CONSTRUCTION PRACTICE**	**Short Title:**	**BCP**	**Course Code: Theory**	**CE-506 A**

Course Description:

This is a basic course which makes a student familiar with the detailed features of various building components and appraises about construction practices. The course includes description of Types of building structures & various parts of building, Different types of masonry, scaffolding, shoring, under pinning and strutting, Description of building finishes and types, Concrete and R.C.C. construction, Types of foundations, Study of building materials such as stone, bricks & timber, Aluminium, glass, heat insulating and sound absorbent materials.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Nil

Course Objectives:

The objective of this course is to:

1. The student must become aware of common building components and their detailed construction.
2. The students should know about the types of buildings according to their material and load distribution system.
3. The Student should know about the construction and support structure in practices.
4. The Student should execution of various types of finishing works should also be known.
5. The student should know to develop an understanding of material handling techniques.

Course Outcomes:

After successful completion of this course the student will be able to:

1. Identify the different type of building and foundation in actual practice.
2. Identify the various types of door and window.
3. Known the various type of building component with their different material.
4. Select proper material for building construction.

5. Various materials used in building construction.

COURSE CONTENT					
BUILDING CONSTRUCTION PRACTICE		**Semester:**	**V**	**Course Code**	**CE – 506 A**
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 Hours/week**	**End Semester Exam (ESE) UA:**			**60 Marks**
		Duration of ESE:			**03 Hours**
		Internal Sessional Exam (ISE) CA:			**40 Marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks:** 12

Types of Buildings: - Types of building, load bearing, framed structure, steel structure, timber structure, composite structure. Various parts of building, sub structure and super structure. Plinth, sill, floor, and roof level, plinth height, plinth protection, cornice, coping and their function.

Foundation: Purpose and classification, advantages and disadvantages of each and circumstances under which each is used, Factor considered for selection of foundation.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Doors and Windows: Type of each and circumference under which each is used, minimum area of window opening for different climatic conditions, various material used for doors and window

Circulation: Horizontal and vertical, stair and staircase planning and design, types of staircase as per shape and material used, requirement of good stair.

Floor: Types of floors, Material used for flooring, advantage and disadvantages of pre - cast concrete floor.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Stone Masonry: types of stone masonry, precautions to be taken in stone masonry construction, types of Partition (brick partition, timber partition, glass partition etc.)

Brick Masonry: types of brick masonry, types of bond in brick masonry, precautions to be taken in brick masonry construction, composite masonry,

Formwork: Function, requirement and precaution of form work, material used for form work.

Lintel: Types of lintel, detailing of R.C.C. lintel, Material used for lintel.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Various Material Used in Construction

Stone: stone quarrying, uses of stones and qualities of good building stone, Tools used for stone masonry, tests on stone.

Bricks: Composition of good brick earth, classification of burnt brick, manufacturing of bricks, qualities of good bricks, test on bricks.

Timber: Properties and uses, testing, conservation and sawing, defects in timbers. **Miscellaneous Materials:** Aluminium, glass, heat insulating materials, sound absorbent materials, Paints

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Equipment – excavating equipment, Earth compacting equipment, Hoisting equipment etc.

Steel trusses: Type, Function, connecting materials, Precaution.

Scaffolding: Type, Function, Precaution.

Shoring: Type, Function, Precaution.

Text Books:

1. Building Construction by Rangwala- Published by Charotar Publishing House , 2011
2. Building Construction by Sushil Kumar- Published by Standard Publishers Distributors, 2010

Reference Books:

1. Building Construction by S.P. Bindra, S.P. Arora, Published by Dhanpat Rai Publications,2010
2. Building Construction by Ashok K. Jain, B. C. Punmia, Arun Kr. Jain, Published by Laxmi Publications, 2009
3. Building Construction by Rangwala, Publisher Charotar Publishing House, ISBN-13 9789380358482, ISBN-10 9380358482
4. Barrid, “Building Construction” Tata McGraw Hill, New Delhi
5. Civil Engineering Material by Dr. S.V. Deodhar.
6. Engineering Materials by Rangwala, Publisher Charotar Publishing House, Publication Year 2011

NPTEL Links:

1. https://nptel.ac.in/courses/105102088 Building material and Construction, IIT Delhi by Dr. B Bhattacharjee.
2. https://onlinecourses.nptel.ac.in/noc25_ar26/ preview Building material composite, Prof. Samana Gupta, IIT Kharagpur

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<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td>Practical:</td><td>2 hours/week</td><td colspan="3">Internal Continuous Assessment (ICA) CA:</td><td>25 Marks</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL- Any Six practical should be performed. Students are used the half sheet for practical purpose.
1. Draw the sketches of various bonds with details.
2. Draw the various Doors and windows with plan, elevation and section.
3. Draw the various type of masonry structure.
4. Draw the Plan, Section, and Elevation of stair case any Two.
5. Draw the various types of trusses.
6. Draw the various types of Foundation.
7. Draw the detail C/S of building wall showing all component part.
8. Draw the various types of Excavating and Hoisting Equipment.
9. Draw the sketches of various Scaffolding.
10. Draw the Sketches of various Shoring
Site Visit:
Site visit for building construction.</td></tr>
<tr><td colspan="6">Guide lines for ICA:</td></tr>
<tr><td colspan="6">Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design/drawing.</td></tr>
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HYDROLOGY (PEC – I)					
COURSE OUTLINE					
Course Title:	**HYDROLOGY**	**Short Title:**	**HE**	**Course Code:**	**CE – 506-B**

Course Description:

Water is the most precious civil engineering entity. Availability of water is an index of nation's prosperity. The responsibility of a civil engineer is to avail water for drinking, domestic, industrial and irrigation applications, which is the largest consumer of water. This requires identification of water resources, their harnessing techniques, water management and water conservation techniques. Sum total of this forms the syllabus of the present subject. It includes hydrology to assess the flow potentials and to plan the water retaining structures. It also includes the design of after retaining common structures. Topics like water logging, crop water requirements also supplement the subject.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	3	15	45	03
Practical	2	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. To understand the hydrologic cycle and its components
2. To study precipitation, evaporation, infiltration, and runoff processes
3. To analyse rainfall–runoff relationships for watershed management
4. To apply hydrological principles in design of hydraulic structures

Course Outcomes:

Upon successful completion of the course, the students will be able to:

1. Identify and use hydrological instruments such as rain gauges, evaporimeters, and infiltrometers.
2. Process rainfall data and prepare hyetographs, mass curves, and rainfall distribution maps.
3. Determine infiltration, evaporation, and runoff characteristics experimentally
4. Plot and interpret hydrographs and groundwater data.

5. Analyse watershed characteristics using maps and field data.

COURSE CONTENT

HYDROLOGY		**Semester:**	V
Teaching Scheme:		**Examination scheme**	
Lectures:	3 Hours/Week	**End Semester Exam (ESE) UA:**	60 Marks
		Duration of ESE:	03 Hours
		Internal Sessional Exam (ISE) CA:	40 Marks

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Hydrology: terms and terminology, hydrological cycle, its applications. Precipitation: forms, measurement, presentation of rain gauge data, mass inflow curves, hyeptograph, average precipitation, optimization of rain gauge numbers. Concept of evaporation, transpiration, infiltration, factors affecting them, their measurements.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Stream gauging, discharge and stage measurements. Run off: yield, factors affecting runoff, estimation of runoff using mathematical expressions. Hydrographs: definition, concept, factors affecting its shape, base flow separation. Flood hydro graph, unit hydrograph – definition, derivations, applications, S hydrograph.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Ground water hydrology: occurrence and distribution of ground water, yield of acquifers, movement of ground water, Darcy's law, permeability, safe yield of basins, well loss, and specific capacity of well, well irrigation and its applications. Water logging and drainage: causes, preventive measures, curative measures.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Reservoir Planning, storage and diversion works, multi –purpose reservoir projects, investigations for locating a reservoir, mass curve and its use for estimation of required storage, economic aspects, B/C ratio. Reservoir sedimentation: process of erosion, introduction to suspended and bed loads, critical tractive force, trap efficiency, life of reservoir, factors affecting silting, and control measures. Irrigation: necessity, benefits, ill effects, methods.

Unit–V:	**No. of Lectures: 09 Hours**	**Marks:** 12

Soil – water – plant relationship, classification of soil water, saturation capacity, field capacity, quality of irrigation water. Crop water requirements, limiting soil moisture conditions, depth of irrigation water and frequency, principal Indian crops and their seasons, base period, duty of

water and delta, factors affecting, duty and delta. Methods of improving duty. Intensity of irrigation, paleo irrigation, kor depth, kor period, outlet factor, capacity factor, time factor, crop ratio, overlap allowance, calculation of canal capacity, application of water.

Text Books:

1. Irrigation engineering and hydraulic structures by S K Garg, Khanna Publications.
2. Irrigation and water power engineering by B C Punmia, Laxmi Publications.
3. A Text book of hydrology and Water resources, by R K Sharma, Dhanpatrai Publications.

Reference Books:

1. Irrigation, water resources and water power engineering by P N Modi, Standard Book House Publication.
2. Theory and design of irrigation structures, Vol I and II, Varshney R S, Gupta S C and Gupta R L, New Chand and Brothers Publication, Roork

NPTEL Links:

1. https://nptel.ac.in/courses/105101002 Advanced Hydrology by Dr. Subhankar Karmakar Centre for Environmental Science and Engineering (CESE)IIT Bombay
2. https://nptel.ac.in/courses/105104103 Water Resources Engineering, by Prof. Rajesh Srivastava, Dr. Pranab K Mohapatra,IIT Kanpur.
3. https://www.nptel.ac.in/courses/105105110 Water Resources Engineering, by Dr. Dhrubajyoti Sen, IIT Kanpur.

HYDROLOGY LAB (PEC – I Lab)					
LAB COURSE CONTENT					
HYDROLOGY LAB		**Semester:**	**V**	**Course Code**	**CE -507 B**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 Hours/Week**	**Internal Continuous Assessment (ICA) CA:**			**25 Marks**

LIST OF ASSIGNMENT (Any **Six** assignment should be performed.)

1. Study of different types of rain gauges.
2. Determination of average rainfall using Thiessen polygon method.
3. Preparation of hyetograph and mass curve.
4. Determination of infiltration rate using double ring infiltrometer.
5. Measurement of evaporation using pan evaporimeter.
6. Hydrograph plotting and base flow separation.
7. Determination of runoff using empirical methods.
8. Study of groundwater table fluctuation using observation data.
9. Estimation of well yield using pumping test data.
10. Watershed area calculation using contour maps.

Guide lines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.

TRAFFIC ENGINEERING (PEC – I)					
COURSE OUTLINE					
Course Title:	**TRAFFIC ENGINEERING**	**Short Title:**	**TE**	**Course Code:**	**CE – 506 C**

Course Description:

This course focuses on the principles and practices of traffic flow, control, and management for safe and efficient transportation systems. It introduces students to traffic characteristics, road user behaviour, and traffic studies such as volume, speed, density, and parking analysis the course covers traffic control devices including traffic signs, signals, road markings, and channelization. Emphasis is given to traffic flow theory, intersection design, capacity analysis, and level of service (LOS) evaluation. Students also learn accident analysis, road safety measures, and traffic management techniques in urban and highway environments. Modern concepts such as intelligent transportation systems (ITS), traffic simulation, and sustainable traffic planning are also introduced.by the end of the course, students will be able to conduct traffic studies, analyse traffic flow characteristics, design traffic control measures, and recommend safety improvements for transportation networks.

	Hours/Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Theory	3	15	45	03
Practical	2	15	30	01

Prerequisite course(s): Nil

Course Objectives:

The objective of this course is to:

1. To introduce the fundamental characteristics of traffic flow, road users, and vehicles influencing transportation systems.
2. To develop understanding of traffic studies such as traffic volume, speed, density, headway, parking, and accident analysis.
3. To familiarize students with traffic control devices including traffic signs, signals, road markings, and channelization techniques as per IRC standards.
4. To explain principles of intersection design, signal timing, and traffic management strategies in urban and highway environments.
5. To introduce modern traffic engineering concepts such as road safety measures, Intelligent Transportation Systems (ITS), and sustainable traffic planning.

Course Outcomes:

After successful completion of this course the student will be able to:

1. Explain the fundamental characteristics of traffic flow, road users, and vehicles affecting transportation systems.
2. Evaluate highway and intersection capacity and determine Level of Service (LOS) using standard methods (IRC/HCM concepts).
3. Design and recommend appropriate traffic control devices including signs, signals, road markings, and channelization.
4. Apply principles of signal timing and intersection design for efficient traffic management.
5. Propose road safety measures and basic traffic management strategies incorporating modern concepts such as ITS.

COURSE CONTENT

TRAFFIC ENGINEERING		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 Hours/Week**	**End Semester Exam (ESE) UA:**	**60 Marks**
		Duration of ESE:	**03 Hours**
		Internal Sessional Exam (ISE) CA:	**40 Marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Traffic Engineering -Scope and importance of traffic engineering, Road user characteristics (physical, psychological factors), Vehicle characteristics and performance, Traffic characteristics: Volume, speed, density, headway, gap, Passenger Car Unit (PCU) concept ,Traffic flow relationships (Speed–Density–Flow**)**

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Traffic Studies -Traffic volume study (methods and analysis),Spot speed and speed & delay studies, Origin–Destination (O–D) study, Parking studies, Accident studies and analysis, Presentation and interpretation of traffic data

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Traffic Flow Theory and Capacity Analysis -Fundamental diagrams of traffic flow, Highway capacity and Level of Service (LOS),Capacity of urban roads and rural highways ,Intersection capacity analysis, Rotary intersection – design principles and capacity**.**

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Traffic Control Devices -Traffic signs (Regulatory, Warning, Informatory) – IRC specifications, Road markings and delineators ,Traffic signals – types, components, and signal phasing, Signal design: Webster's method (basic concept),Channelization and traffic islands

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Traffic Management and Road Safety -Traffic management techniques in urban areas ,One-way streets, grade-separated intersections, Road safety measures and accident prevention, Road Safety Audit (RSA),Introduction to Intelligent Transportation Systems (ITS),Sustainable traffic management practices, Traffic Simulation & it's advantages, Arboriculture, street lighting. Classification, mass and rapid transit system, electronic toll Collection.

Text Books:

1. L.R. Kadiyali – Traffic Engineering and Transportation Planning (Khanna Publishers)
2. Partha Chakroborty & Animesh Das – Principles of Transportation Engineering (PHI Learning)
3. S.K. Khanna, C.E.G. Justo & Veeraragavan – Highway Engineering (for basics support)

Reference Books:

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017

2. Kadiyalai, L.R., ' Traffic Engineering and Transport Planning', Khanna Publishers.

3 . Partha Chakraborty, ' Principles Of Transportation Engineering, PHI Learning,

4 . L. R. Kadiyali, N B. Lal, Principles & practice of Highway Engineering, Khanna Publication 2005.

5 . Rangwala, Highway Engineering, Charotar.

7.Introduction to Traffic Engineering by *R*. Srinivasa Kumar – Good for fundamentals,traffic

NPTEL Link:

1. **https://onlinecourses.nptel.ac.in/noc22_ce41/preview -** Traffic engineering ,by Prof. Bhargab Maitra ,IIT Kharagpur

TRAFFIC ENGINEERING LAB (PEC – I LAB)					
LAB COURSE CONTENT					
TRAFFIC ENGINEERING LAB		**Semester:**	**V**	**Course Code**	**CE -507 C**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 Hours/Week**	**Internal Continuous Assessment (ICA) CA:**			**25 Marks**

LIST OF ASSIGNMENT- (Any **Six** practical should be performed.)

1. Traffic Volume Study - Manual classified traffic count, Determination of ADT / AADT,PCU calculation
2. Peak Hour Factor (PHF) Determination
3. Traffic Flow Characteristics Study
4. Flow, density, and speed relationship
5. Speed Studies
6. Spot Speed Study- Determination of mean speed, median speed, 85th percentile speed
7. Speed and Delay Study -Moving car method
8. Parking Survey (On-street / Off-street) - Parking accumulation, Parking duration, Parking turn over, Parking index
9. Intersection Studies
10. Intersection Volume Count and Turning Movement Study
11. Design of Traffic Signal Timing - Webster's method (basic calculation)
12. Study of Rotary Intersection (Field Observation / Capacity Calculation)
13. Accident and Safety Studies - Accident Data Collection and Analysis, Black Spot Identification, Road Safety Audit (Field Visit / Case Study)

Guide lines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.

THEORY OF STRUCTURE (MDM)					
COURSE OUTLINE					
Course Title:	**Theory of Structure**	**Short Title:**	**TOS**	**Course Code: Theory**	**CE 508**

Course Description:

The primary objective of theory of structure is to understand, analyse, evaluate and to develop critical thinking about the fixed beam, continuous beam, moving load, slope and deflection of beams and trusses.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	02	15	30	02

Prerequisite course(s):

Nil

Course Objectives:

1. To understand the behaviour of statically determinate and indeterminate structures.
2. To analyse beams by using influence line diagrams
3. To learn classical methods for analysis of indeterminate structures.
4. To understand slope deflection and moment distribution methods for structural analysis.
5. To introduce matrix methods for structural analysis

Course Outcomes:

After successful completion of this course the student will be able to:

1. To know basic concepts and principles for analysis of indeterminate structures and to understand the principles of strain energy and deflection of structures.
2. To be able to analyze structures for static and moving loads by using ILD
3. To be able to analyze fixed and continuous beams
4. To be able to analyze beams and frames using slope deflection method.
5. To be able to analyze beams, non – sway frames with stiffness method

COURSE CONTENT					
Theory of Structure		**Semester:**	**V**	**Course Code**	**CE – 508**
Teaching Scheme:		**Examination scheme**			
Lectures:	**02 hours/week**	**End Semester Exam (ESE) UA:**			**60 Marks**
		Duration of ESE:			**03 Hours**

	Internal Sessional Exam (ISE) CA:	**40 Marks**
	Internal Continuous Assessment (ICA):	**25 marks**

Unit–I:	**No. of Lectures: 06 Hours**	**Marks: 12**

Strain Energy: Castigliano's first theorem and its application to find slope & deflection of simple beams and frames.

Deflection of trusses: deflection of statically determinate plain trusses by Castigliano's theorem.

Analysis of redundant trusses by Castigliano's second theorem.

Unit–II:	**No. of Lectures: 06 Hours**	**Marks: 12**

Influence lines: Basic concepts, ILD Patterns for reactions of beam, Shear force and bending moment for Simply supported, overhanging beams, Calculations for S.F. & B.M. in beam using influence lines.

Moving Load: Introduction to moving loads, conditions for maximum B.M. and maximum S.F. at a section due to moving point loads, uniformly distributed load, longer or shorter than span and train of moving loads, Absolute maximum B.M. & S.F.

Unit–III:	**No. of Lectures: 06 Hours**	**Marks: 12**

Fixed Beams: Concept, advantages and disadvantages, Nature of B.M. Diagrams, Fixed end moment due to various types of loads such as point, uniformly distributed, Uniformly varying, couples for beams, plotting of B.M. & S.F. diagrams.

Continuous Beams: Analysis of continuous beam by three moments (Clapyeron's theorem) up to Three unknowns, Effect of sinking of supports, plotting of B.M. & S.F. diagrams

Unit–IV:	**No. of Lectures: 06 Hours**	**Marks: 12**

Analysis of beams and frames (non – sway frames only) using slope & deflection methods. Numerical problems on analysis of shape factor. Numerical problems on portal frame method and cantilever frame method.

Unit–V:	**No. of Lectures: 06 Hours**	**Marks: 12**

Concept and analysis of Three Hinge Arches

Fundamental concept of stiffness method of analysis: formulation of stiffness method, Problem on continuous beams and frames (non – sway).

Text Books:

1. Structural analysis Vol –I, II by S.S. Bhavikatti, Vikas Publishing House Pvt. Ltd.

2. Mechanics of structures Vol – II by S. B.Junnarkar and Dr. H.J. Shah, Charotar Publishing House.

Reference Books:

1. Analysis of structures (Volume - I & II) by V.N.Vazirani, M.M. Ratwani and Dr. S.K.Duggal, Khanna Publications.
2. Theory of structures by S. Rammamrutham, Dhanpatrai Publishing Company.
3. Basic structural analysis by C.S.Reddy
4. Punmia B. C. – Theory of Structure, Laxmi Publication.
5. Pandit& Gupta -Structural Analysis, TataMcGrawHill,Pub. Co.Ltd ., New Delhi
6. Wang C.K.-Intermediate structural analysis, McGraw Hill, New York.

NPTEL Links:

1. https://nptel.ac.in/courses/105101085 Structural Analysis by Dr. R.S. Jangid, Dr. Siddhartha Ghosh, IIT Bombay.
2. http://digimat.in/nptel/courses/video/105105180/L10.html Matrix Method of Structural Analysis by Prof. Amit Shaw, IIT Kharagpur.

Guidelines for ICA:

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Kavayitri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Third Year Bachelor of Engineering

in

(Common for all)

(As per NEP 2020 Guidelines)

Faculty of Science and Technology



COURSE OUTLINE FOR OPEN ELECTIVE - III

For Affiliated Colleges

Semester – V

W. E. F. 2026 – 27

Open Elective – III

A Student can opt for any one subject out of available institute wide subjects defined in the following list as Open Elective provided, he/she has not taken that particular subject in his/her Programme core, Programme elective, Multidisciplinary Minor, other Open elective and Vocational and Skill Enhancement courses etc. throughout his / her four years of UG Engineering Programme. The student must opt a subject that is compulsorily from faculty other than that of the Major discipline.

Course Code	Name of the Subject / Course	Faculty Offered by	Department Offered by
Open Elective - III (w. e. f. 2025 - 26 at Semester - V, Third Year Engineering)			
OE – 509 A	Legal Aspects of Business	Comm. & Mgmt.	Management
OE – 509 B	Modern Office Management	Comm. & Mgmt.	Commerce
OE – 509 C	Food Adulteration and Safety	Sci. & Tech.	Environment
OE – 509 D	Insurance Management	Comm. & Mgmt.	Commerce
OE – 509 E	Indian Social Problems	Humanities	Sociology
OE – 509 F	Disaster Management	Sci. & Tech.	Environment
OE – 509 G	Pharma Marketing Management	Sci. & Tech.	Pharmacy
OE – 509 H	Circular Economy	Humanities	Economics

LEGAL ASPECTS OF BUSINESS (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**LEGAL ASPECTS OF BUSINESS**	**Short Title:**	**LAB**	**Course Code:**	**OE – 509 A**

Course Description:

This course provides a concise overview of the legal framework governing business in India, covering contracts, sale of goods, negotiable instruments, intellectual property rights, company law, and cyber law. It equips students with basic legal knowledge and practical understanding required for lawful, ethical, and effective business decision-making in a digital environment.

Lecture	**Hours/week**	**No. of weeks**	**Total Hours**	**Semester Credits**
	02	15	30	02

Prerequisite Course(s):

Basics of Law, Legal Environment of Business, Mercantile Law

Course Objectives:

The objective of this course is to impart knowledge so that the student will:

1. To understand the basic concepts and rules of contracts as per the Indian Contract Act.
2. To learn the legal provisions related to sale of goods and negotiable instruments.
3. To know the importance and protection of intellectual property rights with reference to the Patents Act, Copyright Act, and Trade Marks Act.
4. To understand the basic structure and working of companies according to the Companies Act.
5. To understand digital laws, cybercrimes, and data protection as guided by the Information Technology Act.

Course Outcomes:

After successful completion of this course the student will be able to:

1. Understand the basic principles and essentials of contracts under the Indian Contract Act.
2. Apply provisions of Sale of Goods and Negotiable Instruments laws in business transactions.
3. Explain the importance and protection of Intellectual Property Rights in business.
4. Understand the formation and legal framework of companies under company law.
5. Identify cyber laws, digital transactions, and data protection under the Information Technology Act.

COURSE CONTENT		
LEGAL ASPECTS OF BUSINESS	**Semester:**	**V**

Teaching Scheme:		**Examination scheme**	
Lectures:	**2 Hours/Week**	**Internal Continuous Assessment (ICA) CA:**	**25 Marks**

Unit–I:	**No. of Lectures:** 06 Hours	

INDIAN CONTRACT ACT, 1872

Contract: Definition and meaning-Essentials of contract Classification of Contracts, Offer and Acceptance Consideration: Definition, Essentials of a Valid Consideration –Capacity to contract Free Consent: Coercion, Undue influence, Fraud, Misrepresentation and Mistake

Unit–II:	**No. of Lectures:** 06 Hours	

SALES OF GOODS ACT, 1930 & Negotiable Instruments Act 1881

Sale of Goods Act 1930: Sale and agreement to sell, Conditions and warranties, Transfer of ownership, rights of unpaid seller.

Negotiable Instruments Act 1881: Meaning, type of negotiable instruments; promissory note, bill of exchange, cheque. Endorsement and negotiation, Dishonour and legal remedies

Unit–III:	**No. of Lectures: 06 Hours**	

INTELLECTUAL PROPERTY RIGHTS

Intellectual Property Rights-Meaning, Need and Importance of Intellectual Property Patents Act, 1970 (2002): Definition, Objectives, Nature, and Types of Patents, Transfer of Patent Rights, Rights of Patentee. Copyright Act, 1957-Concept, Objectives, Nature, Criteria for protection, Ownership, Duration, and Copy Right in Computer Programmes. Trademark Act 1999 (Amendment Act 2010)- Concept, Registration, rights of registered proprietor, infringement and defenses.

Unit–IV:	**No. of Lectures: 06 Hours**	

COMPANIES ACT, 1956 (Amended 2013)

Meaning, Definition and characteristics and kinds of company. Memorandum of Association - Meaning, Purpose, Contents Doctrine of Ultra-Vires Articles of Association - Meaning Purpose, Content. Alternation, Constructive Notice

Unit–V:	**No. of Lectures: 06 Hours**	

The Information Technology Act, 2000 (Amended 2008)

Introduction, Digital Signatures and Electronic records, Electronic governance Cyber-crimes: hacking, phishing, identity theft, cyber fraud and remedies Data protection, privacy and digital compliance Important Provision of Information Technology Act 2000

Text Books:

1. Legal Aspects of Business (8th ed.). McGraw Hill Education. - Akhileshwar Pathak

Reference Books:

1. Legal Aspects of Business – David Albuquerque
2. Business Law – N.D.Kapoor
3. Mercantile Law – M. C. Kuchhal and Vivek Kuchhal

NPTEL Links:

1. https://nptel.ac.in/courses/129106006
2. https://onlinecourses.swayam2.ac.in/e-learning/preview/cec21_mg02
3. https://onlinecourses.nptel.ac.in/noc26_mg30/preview

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MODERN OFFICE MANAGEMENT (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**MODERN OFFICE MANAGEMENT**	**Short Title:**	MOM	**Course Code:**	OE – 509 B

Course Description:

This course introduces the concepts and practices of modern office management in a technology-driven environment. It covers office structure, layout, communication, documentation, and record management, along with digital office tools and automation. The course also focuses on office personnel management, professional behaviour, productivity skills, and emerging trends preparing students to manage contemporary offices effectively.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	02	15	30	02

Prerequisite Course(s):

Fundamentals of Office Administration, Business Communication, Office Administration and Secretarial Practice

Course Objectives:

The objective of this course is to impart knowledge so that the student will:

1. To understand basics of modern office management and emerging office trends.
2. To learn office layout, systems, and workplace environment management.
3. To develop skills in office communication, documentation, and services.
4. To understand records management, meetings, and office automation.
5. To build competencies in personnel management and productivity skills.

Course outcomes:

After successful completion of this course the student will be able to:

1. Explain concepts and modern trends of office management.
2. Apply office layout, systems, and environmental principles.
3. Demonstrate office communication, documentation, and services.
4. Analyze records management, meetings, and office automation.
5. Evaluate personnel management, productivity, and emerging trends.

COURSE CONTENT

MODERN OFFICE MANAGEMENT		Semester:	V
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 marks**
Unit–I:	**No. of Lectures: 06 Hours**		

Introduction to Modern Office Management		
Modern Office: Meaning, Definition, Characteristics, Functions and Past–Present–Future Office Management: Meaning, Elements and Office as Service & Information Centre Office Organisation: Office Manager- Functions, Duties, Responsibilities Modern Trends in Office: Paperless Office and Virtual Office		
Unit–II:	**No. of Lectures: 06 Hours**	
Office Layout and Environment		
Office Systems: Objectives, Flow of Work, Planning and Scheduling Office Layout: Meaning, Objectives, Principles, Types Office Infrastructure & Facilities Management Office Environment: Meaning, Factors & Importance Office Safety & Remedies		
Unit–III:	**No. of Lectures: 06 Hours**	
Office Communication, Forms and Services		
Office Communication: Internal & External Communication, Digital Communication Business Documentation: Report Writing, Documentation and Office Correspondence Office Forms: Types, Control, Stationery- Standardisation and Issues Mail & Communication Services: Courier, Speed Post, Fax and E-mail Services		
Unit–IV:	**No. of Lectures: 06 Hours**	
Office Record Management		
Records Management: Meaning, Objectives and Organisation of Record Department Office Meetings - Meaning, Definition, Purpose, Types of meeting Filing & Retrieval Systems: Physical and Electronic Records, Retention and Disposal Digital Office & Automation: E-Office, Office Software Tools and Automation Systems		
Unit–V:	**No. of Lectures: 06 Hours**	
Office Personnel Management and Emerging Trends		
Office Personnel Management: Types, Qualities, Recruitment, and Training Professional Behaviour: Ethics, Discipline, Leadership and Team Coordination Productivity Skills: Time Management and Stress Management Emerging Trends in Office: Remote Work and Green Office Practices		
Text Books:		
1. Office Management & Control – G.R.Terry		
Reference Books:		
1. Office Organization and Management – S. P. Arora, Vikas Publishing House Pvt. Ltd., New Delhi. 2. Office Organisation & Management – R.K. Chopada & Ankita Chopada, Himalaya		

Publishing House, Mumbai.

3. Office Management – I. M. Sahai, Kitab Mahal, Allahabad.
4. Office Management – P. K. Ghosh, Sultan Chand & Sons, New Delhi.

NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou23_mg05
2. https://onlinecourses.swayam2.ac.in/e-learning/preview/cec21_mg24
3. https://onlinecourses.swayam2.ac.in/e-learning/preview/imb24_mg54

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FOOD ADULTERATION AND SAFETY (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**FOOD ADULTERATION AND SAFETY**	**Short Title:**	**FAS**	**Course Code:**	**OE – 509 C**

Course description:

This course is designed to impart basic knowledge on identifying major types of food adulterants and contamination, food safety hazards using engineering and microbiological principles, Interpret food laws and regulatory standards relevant to engineering practice.

Also, to emphasize the roles of students in basic food safety management frameworks.

	Hours/Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Theory	02	15	30	02

Prerequisite Course(s):

Course Objectives:

The objective of this course is to:

1. To introduce the principles of food safety, food adulteration, and regulatory standards.
2. To explain types, sources, and detection of food adulterants using scientific and engineering approaches.
3. To familiarize students with national and international food safety regulations including FSSAI, Codex, ISO and HACCP.
4. To develop understanding of food contaminants, toxicants, and risk assessment methodologies.
5. To apply quality assurance and analytical techniques relevant to food safety monitoring.

Course Outcomes:

Upon successful completion of this course the student will be able to:

1. Explain concepts of food safety, hazards, and adulteration mechanisms.
2. Identify and classify food adulterants and contaminants in different food matrices.
3. Apply analytical and instrumental techniques for detection of adulterants.
4. Interpret regulatory frameworks and food safety management systems.
5. Analyze risk assessment models and quality control measures in food systems.

COURSE CONTENT

FOOD ADULTERATION AND SAFETY		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 marks**

Unit–I:	No. of Lectures: 06 Hours	

Fundamentals of Food Safety and Adulteration

- Concept and importance of food safety
- Definitions: Food safety, food quality, food security
- Types of food hazards: Biological, Chemical, Physical
- Concept of food adulteration
- Intentional and incidental adulteration
- Food contamination vs adulteration
- Food safety challenges in developing countries
- Overview of global food safety issues
- Role of regulatory bodies
- Food standards and their significance

Unit–II:	No. of Lectures: 06 Hours	

Food Adulterants and Contaminants

- Common food adulterants in cereals, pulses, milk, fats & oils, spices
- Chemical contaminants: Pesticide residues, heavy metals, industrial chemicals
- Natural toxins: Mycotoxins, plant toxins, marine toxins
- Veterinary drug residues
- Food additives and misuse
- Packaging contaminants
- Emerging contaminants
- Health effects of adulterants
- Case studies of major food adulteration incidents.

Unit–III:	No. of Lectures: 06 Hours	

Detection and Analytical Techniques

- Sampling methods and protocols
- Classical methods of detection
- Chromatographic techniques (HPLC, GC)
- Analytical Methods (UV-Vis, IR, NMR, Mass Spectrometry)
- Biosensors in food safety
- Molecular methods (PCR-based detection)
- Rapid detection kits

- Validation of analytical methods

Unit–IV:	No. of Lectures: 06 Hours	

Food Safety Regulations and Standards

- Codex Alimentarius Commission
- WTO agreements (SPS & TBT)
- Food Safety and Standards Act (India)
- FSSAI regulations
- ISO 22000 and Food Safety Management Systems
- HACCP principles and implementation
- Good Manufacturing Practices (GMP)
- Good Hygienic Practices (GHP)
- Risk analysis framework
- Traceability and recall systems.

Unit–V:	No. of Lectures: 06 Hours	

Risk Assessment and Quality Assurance

- Risk assessment framework
- Hazard identification
- Exposure assessment
- Dose-response assessment
- Risk characterization
- Quality control tools
- Statistical quality control in food industry
- Validation and verification
- Food safety auditing
- Emerging technologies in food safety monitoring.

Text Books:

1. Food Safety and Standards, K. Ramawat & J. Kumar, CRC Press / Springer
2. Food Safety & Quality Assurance: Principles and Practices, Sunetra Roday, Wiley
3. Food Safety and Standards in India, B. Srilakshmi, New Age International

Reference Books:

1. Food Analysis, S. Suzanne Nielsen, Springer
2. Principles of Food Toxicology, D. R. Heldman & D. B. Lund (Ed.), Springer / CRC Press

NPTEL Links:

1. Food Safety and Quality Management
   https://nptel.ac.in/courses/126105011
2. Food Packaging Technology
   https://nptel.ac.in/courses/126105010
3. Food Chemistry and Technology
   https://nptel.ac.in/courses/126105013
4. Food Processing and Preservation
   https://nptel.ac.in/courses/126105012

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INSURANCE MANAGEMENT (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**INSURANCE MANAGEMENT**	**Short Title:**	**IM**	**Course Code:**	**OE – 509 D**

Course Description:

This course provides a fundamental understanding of insurance concepts, principles, and practices. It covers life and general insurance products, legal and regulatory frameworks, underwriting and claims management, and the role of insurance in economic development. The course equips students with essential knowledge of insurance operations and industry practices, preparing them for opportunities in the insurance and financial services sector.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	02	15	30	02

Prerequisite Course(s):

Basic knowledge of Commerce / Economics, Fundamental understanding of Financial Systems and Banking

Course Objectives:

The objective of this course is:

1. To introduce students to the basic concepts, principles, and functions of insurance.
2. To provide knowledge of life and general insurance products and their features.
3. To familiarize students with the legal and regulatory framework of insurance in India.
4. To understand the role of insurance in economic development and financial stability.
5. To develop understanding of insurance operations including underwriting and claims management.

Course Outcomes:

After successful completion of this course the student will be able to:

1. Explain the fundamental principles and functions of insurance.
2. Differentiate various life and general insurance products.
3. Describe the legal and regulatory framework governing insurance in India.
4. Analyze the contribution of insurance to economic development.
5. Understand underwriting, claims settlement, and operational practices in insurance companies.

COURSE CONTENT			
INSURANCE MANAGEMENT		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 marks**
Unit–I:	**No. of Lectures: 06 Hours**		

Fundamentals of Insurance		
Meaning and definition of insurance Nature, scope and functions of insurance Evolution and importance of insurance Principles of insurance – Utmost Good Faith, Insurable Interest, Indemnity, Subrogation, Contribution, Proximate Cause Types of insurance		
Unit–II:	**No. of Lectures: 06 Hours**	
Life and General Insurance Products		
Life Insurance – Term, Whole Life, Endowment, Annuities & Pension Plans Basic concept of premium and mortality table General Insurance – Fire, Marine, Motor and Health Insurance Crop, Rural and Group Insurance Maturity and Death Claims		
Unit–III:	**No. of Lectures: 06 Hours**	
Legal and Regulatory Framework of Insurance		
LIC Act, 1956 General Insurance Act, 1972 IRDA Act, 1999 and Functions of IRDA Actuaries Act, 2006 Regulatory and ethical practices in insurance		
Unit–IV:	**No. of Lectures: 06 Hours**	
Insurance and Economic Development		
Role of insurance in economic development Growth of life and general insurance in India Liberalization of insurance sector and its impact Issues, challenges and future potential of insurance industry		
Unit–V:	**No. of Lectures: 06 Hours**	
Insurance Operations and Governance		
Underwriting – Meaning and principles (Life & General Insurance) Claims Management – Life and General Insurance Insurance agents – Licensing, functions and code of conduct Consumer protection and grievance redressal mechanism		
Text Books:		
1. **Fundamentals of Insurance** – Dr. P.K. Gupta, Himalaya Publishing House		

Reference Books:

1. Insurance: Principles And Practice – M.N. Mishra & S B Mishra, S Chand Publishing
2. Principles of Insurance Management – Neelam C Gulati, Excel Books
3. **Principles and Practice of Insurance by P. Periasamy** A.K. Basu, Himalaya Publishing House

NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/cec20_mg24

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INDIAN SOCIAL PROBLEMS (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**INDIAN SOCIAL PROBLEMS**	**Short Title:**	**ISP**	**Course Code:**	**OE-509 E**

Course Description:

This course introduces students to the sociological understanding of major social problems in India. The course includes the concept, characteristics, and approaches to the study of social problems and proceeds to examine key issues such as poverty, unemployment, population growth, and urbanization. It further explores violence against women, child labour, crime, and corruption as structural challenges affecting Indian society.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	02	15	30	02

Prerequisite course(s):

Nil

Course Objectives:

The objective of this course is:

1. Understand the concept and approaches to social problems in the Indian context.
2. Analyze fundamental economic and demographic social issues in India.
3. Examine population growth and urbanization and their effects on society.
4. Understand gender and child-related social problems with sociological insight.
5. Identify and evaluate crime and corruption as structural social problems.

Course Outcomes:

After successful completion of this course the student will be able to:

1. Explain the sociological concept and approaches to social problems.
2. Discuss poverty and unemployment with causes and consequences.
3. Analyze the issues of population growth and urbanization in India.
4. Describe violence against women and child labour with social impacts.
5. Explain crime and corruption as social problems and suggest measures.

COURSE CONTENT

INDIAN SOCIAL PROBLEMS		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 marks**

Unit–I:	**No. of Lectures: 06 Hours**

Social Problems: Meaning, Characteristics of Social Problems, Types of Social Problems, Approaches to the Study of Social Problems: Social Pathology Approach, Social Disorganization

Approach, Value-Conflict Approach, Deviance Approach, Methods of Studying Social Problems		
Unit–II:	**No. of Lectures: 06 Hours**	
Poverty: Meaning & Types, Causes of Poverty, Consequences of Poverty, Measures for Eradication Unemployment: Meaning & Types, Causes, Consequences, Measures to Reduce Unemployment		
Unit–III:	**No. of Lectures: 06 Hours**	
Population Growth: Growth of Population in India, Causes & Consequences, Population Control Measures Urbanization: Meaning of Urbanization, Causes of Urbanization, Problems of Urbanization, Remedies for Urban Problems		
Unit–IV:	**No. of Lectures: 06 Hours**	
Violence Against Women: Meaning & Forms, Causes & Consequences, Measures to Control Child Labour & Child Abuse: Meaning & Causes, Problems of Child Labour & Abuse, Measures to Eliminate		
Unit–V:	**No. of Lectures: 06 Hours**	
Crime and Criminals: Meaning of Crime, Types of Crime, Causes, Prevention & Control Corruption: Meaning of Corruption, Causes & Consequences, Measures to Control Corruption		

Text Books:

1. Ahuja, Ram. Social Problems in India. 4th ed., Rawat Publications, 2021.

Reference Books:

1. G. R. Madan – Indian Social Problems, Allied Publishers
2. C. N. Shankar Rao – Sociology of Indian Society, S. Chand Publications
3. Vidya Bhushan & D. R. Sachdeva – Introduction to Sociology, Kitab Mahal Publications
4. M. N. Srinivas – Social Change in Modern India, Orient Longman / Oxford University Press
5. R. Desai – Rural Sociology in India, Bombay Popular Prakashan

NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/cec25_hs92/preview
2. https://onlinecourses.nptel.ac.in/noc24_hs140/preview

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DISASTER MANAGEMENT (Open Elective-III)					
COURSE OUTLINE					
Course Title:	**DISASTER MANAGEMENT**	**Short Title:**	**DM**	**Course Code:**	**OE – 509 F**

Course Description:

The course aims to develop an understanding of disaster management concepts, disaster risk reduction, preparedness, response, and recovery, with emphasis on managing natural and man-made disasters effectively.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	**02**	**15**	**30**	02

Prerequisite course(s):

Nil

Course Objectives:

The objective of this course is to:

1. Understand fundamental concepts of disasters, hazard, vulnerability, risk and their engineering relevance.
2. Identify and classify natural and anthropogenic disasters and their underlying causes.
3. Explain disaster management principles, phases of disaster cycle and mitigation strategies.
4. Describe institutional frameworks, stakeholders, tools, and technologies used in Disaster Management in India and globally.
5. Apply learned skills to analyze disaster case studies, ethical issues and engineering interventions for disaster risk reduction.

Course Outcomes:

Upon successful completion of the course, the students will be able to:

1. Define and explain key disaster concepts, types and impacts.
2. Distinguish between natural and man-made disasters and summaries control measures.
3. Illustrate stages of disaster management cycle and preparedness planning.
4. Evaluate roles of different stakeholders and tools in managing disaster events.
5. Analyze disaster case studies and articulate ethical, legal and policy issues.

COURSE CONTENT

DISASTER MANAGEMENT		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 Marks**
Unit–I:	**No. of Lectures: 06**		

Introduction & Disasters Fundamentals		
Overview of Disaster Management: Definitions: Disaster, Hazard, Risk, Vulnerability, Capacity, Historical perspective & impacts (environment, society, economy) **Understanding Disasters**: Nature, causes & classification of disasters, Concept of exposure, resilience, capacity		
Unit–II:	**No. of Lectures:06**	
Natural & Anthropogenic Disasters		
Natural Disasters: Earthquakes, Tsunami, Volcanoes, Cyclones, Floods, Droughts, Landslides, Extreme weather events and climate change impacts. **Anthropogenic (Man-made) Disasters**: Industrial accidents, fires, pollution events, Transportation failures, structural failures.		
Unit–III:	**No. of Lectures: 06**	
Pandemics, Environmental Disasters & Management Principles		
Pandemics and Environmental Disasters: COVID-19 case insights and environmental disaster context. **Objectives & Principles of Disaster Management**: Prevention, preparedness, mitigation, response and recovery concepts. **Disaster Management Cycle**: Phases, actions and key engineering considerations		
Unit–IV:	**No. of Lectures: 06 Hours**	
Stakeholders & Institutional Framework		
Stakeholders in Disaster Management: Government agencies, NGOs, community groups, Technological tools (Early Warning Systems, GIS, Remote Sensing). **International Cooperation & Organizational Structures**: UN agencies, regional alliances and global frameworks **Disaster Management in India**: Institutional framework, NDMA, policy & legal context.		
Unit–V:	**No. of Lectures: 06 Hours**	
Ethical Issues & Case Studies		
Ethical Issues in Disaster Management: Resource allocation, social equity and engineering ethics **Case Studies**: Natural and man-made disaster case analyses, Lessons learnt, best practices.		
Text Books:		
1. R. Subramanian, Disaster Management, Vikas Publishing House. 2. S.C.Sharma, Disaster Management Khanna Publishing House, New Delhi.		

3. G. K. Ghosh, Disaster Management, APH Publishing Corporation, New Delhi

Reference Books:

1. A.K. Singh, Disaster Management in India, New Royal Book Company, Lucknow
2. Anu Kapur Vulnerable India: A Geographical Study of Disasters, Sage Publications, New Delhi
3. Tushar Bhattacharya, Disaster Science and Management, McGraw-Hill Education (India)
4. Jagbir Singh (Ed.), Disaster Management: Future Challenges and Opportunities, Disaster, I.K. International Publishing House

Online Courses:

1. https://elearning.nidm.gov.in/local/home/index.php- NIDM E-Learning Courses (National Institute of Disaster Management)
2. https://archive.nptel.ac.in/courses/105/104/105104183/- SWAYAM & NPTEL MOOCs
3. https://igotkarmayogi.gov.in/#/ - iGOT Karmayogi (For Govt. Officials)

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PHARMA MARKETING MANAGEMENT (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**PHARMA MARKETING MANAGEMENT**	**Short Title:**	PMM	**Course Code:**	OE – 509 G

Pharmaceutical Marketing Management focuses on the planning, implementation, and control of marketing strategies specific to the pharmaceutical industry, where ethical considerations, regulatory compliance, and patient safety play a critical role. It involves understanding healthcare markets, consumer and physician behavior, product life-cycle management, pricing strategies, distribution channels, and promotional activities such as medical detailing, digital marketing, and relationship management with healthcare professionals. The discipline integrates market research, brand management, and strategic decision-making to ensure effective product positioning while complying with national and international regulations. In an increasingly competitive and technology-driven environment, pharmaceutical marketing management emphasizes value-based marketing, patient-centric approaches, and sustainable growth.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	02	15	30	02

Course objectives:

The objective of this course is to:

1. To study the scope of marketing.
2. To study the quantitative and qualitative aspects of pharmaceutical market.
3. To study the products decision in product life cycle, product portfolios, packaging and labelling decisions.
4. To study the promotion of products.
5. To study marketing channels and management of logistics.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand and explain core marketing concepts and their application in the pharmaceutical industry.
2. Understand quantitative and qualitative aspects of pharmaceutical market.
3. Understand the product cycle, product portfolios.
4. Assess promotional tools including personal selling, advertising, digital marketing, and ethical promotion practices.
5. Understand the marketing channels and management of logistics.

COURSE CONTENT		
PHARMA MARKETING	**Semester:**	**V**

MANAGEMENT			
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 marks**

Unit–I:	**No. of Lectures: 6 Hours**	

Marketing:

Definition, general concepts and scope of marketing; Distinction between marketing & selling; Marketing environment; Industry and competitive analysis; Analyzing consumer buying behavior; industrial buying behavior.

Pharmaceutical Market:

Quantitative and qualitative aspects; size and composition of the market; demographic descriptions and socio-psychological characteristics of the consumer; market segmentation & targeting. Consumer profile; Motivation and prescribing habits of the physician; patients' choice of physician and retail pharmacist. Analyzing the Market; Role of market research.

Unit–II:	**No. of Lectures: 6 Hours**	

Product Decision:

Classification, product line and product mix decisions, product life cycle, product portfolio analysis; product positioning; New product decisions; Product branding, packaging and labeling decisions, Product management in pharmaceutical industry.

Unit–III:	**No. of Lectures: 6 Hours**	

Promotion:

Methods, determinants of promotional mix, promotional budget; An overview of personal selling, advertising, direct mail, journals, sampling, retailing, medical exhibition, public relations, online promotional techniques for OTC Products.

Unit–IV:	**No. of Lectures: 6 Hours**	

Pharmaceutical Marketing Channels

Designing channel, channel members, selecting the appropriate channel, conflict in channels, physical distribution management: Strategic importance, tasks in physical distribution management.

Management of Logistics:

Supply Chain, Cold Chain, Applications of IT & management information systems for efficient marketing, controlling expiry and returned goods.

Unit–V:	**No. of Lectures: 6 Hours**	

Pricing:

Meaning, importance, objectives, determinants of price; pricing methods and strategies, issues in

price management in pharmaceutical industry. An overview of DPCO (Drug Price Control Order) and NPPA (National Pharmaceutical Pricing Authority).

Emerging concepts in marketing:

Vertical & Horizontal Marketing; Rural Marketing; Consumerism; Industrial Marketing; Global Marketing.

AI in Pharma Marketing:

Introduction to AI in Pharma Marketing: Role of AI in modern pharmaceutical marketing, Benefits, limitations, and future scope of AI in pharma, AI-driven market research and forecasting

Text Books:

1. Arun Kumar and N Menakshi: Marketing Management, Vikas Publishing, India.
2. Ramaswamy, U.S & Nanakamari, S: Marketing Management: Global Perspective, Indian Context, Macmilan India, New Delhi.

Reference Books:

1. Philip Kotler and Kevin Lane Keller: Marketing Management, Prentice Hall of India New Delhi

NPTEL Links:

1. https://youtu.be/iOZxUvq1JNE
2. https://nptel.ac.in/courses/110104068

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CIRCULAR ECONOMY (Open Elective – III)

COURSE OUTLINE

Course Title:	CIRCULAR ECONOMY	Short Title:	CE	Course Code:	OE-509 H

Course description:

This course introduces the concept of Circular Economy, its principles, and its relevance in sustainable development. Students will learn about linear economy limitations, circular economy frameworks, business models, and its implementation in India.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	02	15	30	02

Prerequisite course(s):

Basic understanding of **Linear Economy and environmental sustainability concepts**.

Course objectives:

The objective of this course is:

1. To understand the basics of Circular Economy and its significance.
2. To familiarize students with circular economy frameworks, business models, and case studies.
3. To compare linear and circular economies, and understand traditional circular practices.
4. To understand the prospect of circular economy in India.
5. To analyze the role of government and benefits of circular economy.

Course outcomes:

After successful completion of this course the student will be able to:

1. Describe the principles and benefits of Circular Economy.
2. Apply circular economy frameworks and business models.
3. Compare and contrast linear and circular economies.
4. Identify opportunities for circular economy in India.
5. Understand the role of government and benefits of circular economy for various stakeholders.

COURSE CONTENT

CIRCULAR ECONOMY		Semester:	V
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 marks**

Unit–I:	No. of Lectures: 06 Hours	

Linear Economy and Circular Economy Basics

Linear Economy - Our Crumbling Planet: Law of Obsolescence, Disadvantages of Linear Economy,

Circular Economy: Think Ahead - Our Last Chance:- Elements of a Circular Economy, Why do we need to switch to a circular economy?

Unit–II:	**No. of Lectures: 06 Hours**	

Circular Economy Frameworks and Business Models

Fundamental Characteristics of Circular Economy - A Resource Multiplier: Innovation, Collaboration, Value optimization, Design out Waste, Renewable Energy, Closed and tighter loops, Business Models in a Circular Economy- Circular supply chain, Product as a service, Collaborations and sharing, Recovery and recycling, Product life extension, McKinsey Center for Business and Environment - the ReSOLVE framework

Unit–III:	**No. of Lectures: 06 Hours**	

Linear Vs. Circular Economy and Traditional Practices

Linear Vs Circular Economy: Differential that whither the Planet and Us? - Material value preservation, Eco-effectiveness from eco-efficiency, Shift from Raw material to residual flows, Linear VS Circular economy, SWOT analysis of Circular Economy,

Circular Economy - Old wine in new bottle: - Yoga – a circular alternate to gyms, Ayurveda – An old circular alternate to modern medicine, Earthen Pots – An old circular practice, Sun Drying – A circular alternate to laundry dryers

Unit–IV:	**No. of Lectures: 06 Hours**	

Circular Economy in India

India and Circularity - Showcasing Sustainable Future - Circularity in India, Prospect of Circular Economy in India, Role of Indian businesses, Invest in circular economy opportunities

Unit–V:	**No. of Lectures: 06 Hours**	

Circular Economy Implementation and Benefits

Role of Government -Set direction and show commitment, Enabling regulatory frameworks, Platforms for multi-stakeholder collaboration, Support circular models through public procurement and infrastructure

Benefits of Circular Economy for India- Benefits for businesses and the Economy, Benefits for the environment, Benefits for citizens

Text Books:

Reference Books:

Circular Economy: (Re)Emerging Movement by Shalini Goyal Bhalla
NPTEL Links: SWAYAM https://onlinecourses.swayam2.ac.in/e-learning/preview/aic21_ge19
Guidelines for ICA:
Students must perform each practical and submit ICA in the form of journal. Each practical/assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design/drawing.

Kavayitri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Third Year Bachelor Engineering

in

(Civil)

(As per NEP 2020 Guidelines)

Faculty of Science and Technology



COURSE OUTLINE FOR

For Affiliated Colleges

Semester – VI

W. E. F. 2026 – 27

STRUCTURAL DESIGN AND DRAWING (PCC)					
COURSE OUTLINE					
Course Title:	STRUCTURAL DESIGN AND DRAWING	**Short Title:**	SDD	**Course Code: Theory**	CE- 601

Course Description:

Majority of civil engineering structures are normally made up of Reinforced Cement Concrete. Knowledge of designing and detailing of reinforced concrete structures is very important for civil engineers in order to make structures safe and serviceable during its life span. Limit State design philosophy is currently used worldwide for design of RC structures. Proper detailing of reinforcement in structural drawing is necessary in order to get the correct behaviour of structures and leads to smooth construction of RC structures. This course will provide detailed knowledge of design and reinforcement detailing as per related Indian standards.

	Hours/Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Theory	03	15	30	03
Practical	02	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. Understand properties and behaviour of reinforced concrete and working stress & limit state design philosophies.
2. Analyse and design singly and doubly reinforced beams.
3. Design slabs under various boundary conditions.
4. Design columns and isolated footings.
5. Design of staircase and to understand detailing principles as per IS code provisions.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand Various Design philosophies, properties and behavior of reinforced concrete
2. Design and detailing of beams for flexure, shear and torsion.
3. Design one-way and two-way slabs.
4. Design short columns and isolated footings.

5. Design Stair Case and structural drawings with proper reinforcement detailing.

COURSE CONTENT

STRUCTURAL DESIGN AND DRAWING		**Semester:**	**VI**	**Course Code**	**CE – 601**
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 Hours/Week**	**End Semester Exam (ESE) UA:**			**60 Marks**
		Duration of ESE:			**03 Hours**
		Internal Sessional Exam (ISE) CA:			**40 Marks**
Unit–I:		**No. of Lectures: 09 Hours**			**Marks:12**

Introduction & Design Philosophy:

Introduction to various design philosophies of R.C structures, working stress method, limit state method, characteristic strength, characteristic load, partial safety factors for material strengths and loads, structural properties of concrete.

Stress & strain diagram, Balanced, under reinforced &over reinforced RC sections, Stress block for Singly Reinforced section, analysis and design of singly reinforced beams.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks:12**

Design of Beams:

Design of doubly reinforced beam, Design of rectangular beams for flexure, shear and bond: Simply supported, cantilever beams using limit state method.

Analysis and design of flanged Beams (L and T beams)

Unit–III:	**No. of Lectures: 09 Hours**	**Marks:12**

Design of Slabs:

Design of slabs: One way simply supported, cantilever slab & continuous slab.

Design of two way simply Supported & continuous slabs.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**

Design of Column:

Introduction, stress and strain variation diagrams, axially loaded short column with minimum eccentricity requirements, Design of short column for axial load.

Concept of floating column, Analysis of floating Columns.

Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**

Design of Footing and staircase:

Design of isolated pad footing for axial load & uni-axial bending.

Design of Dog legged staircase.

Text Books:

1. S. R. Karve and V. L. Shah, Illustrated Design of Reinforced Concrete Buildings, Structures Publishers.
2. N. Krishna Raju, Advanced Reinforced Concrete Design, CBS Publishers.
3. S. UnnikrishnaPillai and DevdasMenon, Reinforced Concrete Design, Tata McGraw Hill.
4. H. J. Shah, Reinforced Concrete, Vol. I and II, Charotar Publishing.

Reference Books/IS Codes:

1. Punmia B.C "Advanced RCC Design" Laxmi Publications Pvt. Ltd". 2006.
2. Varghese A. V., Advanced Reinforced Concrete, Varghese, Prentice Hall of India.
3. Sinha S. N., Reinforced Concrete Design, Tata Mc-Graw Hill, Delhi.
4. IS Codes (latest) : IS:456-2000, IS:875 (all parts),

NPTEL Links:

1. https://onlinecourses-archive.nptel.ac.in/noc17_ce23/course Design of Reinforced Concrete structures by Prof. Nirjhar Dhang
2. https://onlinecourses.nptel.ac.in/noc25_ce132/preview? Advanced reinforced concrete design by Prof. S. Surya Prakash, IIT Hydrabad

<table>
<tr><th colspan="6">STRUCTURAL DESIGN AND DRAWING LAB (PCC)</th></tr>
<tr><th colspan="6">LAB COURSE CONTENT</th></tr>
<tr><td colspan="2">STRUCTURAL DESIGN AND DRAWING LAB (PCC)</td><td>Semester:</td><td>VI</td><td>Course Code</td><td>CE – 602</td></tr>
<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td rowspan="2">Practical:</td><td rowspan="2">2 Hours/Week</td><td colspan="3">Internal Continuous Assessment (ICA) CA:</td><td>25 Marks</td></tr>
<tr><td colspan="3">End Semester Exam (ESE) UA:</td><td>25 Marks (OR)</td></tr>
<tr><td colspan="2">End Semester Exam (ESE) Pattern</td><td colspan="4">Oral (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL:
Experiment 1: Structural Layout using Drafting Software.
a) To prepare a simple line plan G+2 building.
b) To draw structural plan indicating slabs, beams, columns, column footings.
Experiment 2: Design and Drawing of Beams
Design and drawing of singly reinforced rectangular beam including reinforcement detailing.
Design and drawing of doubly reinforced beam / T-beam with reinforcement layout.
Experiment 3: Design and Drawing of one way Slab
Design and detailing of one-way slab, One way continuous slab and preparation of reinforcement drawing.
Experiment 4: Design and Drawing of two-way slab
Design and detailing of two-way and two way continuous slab with reinforcement drawing.
Experiment 5
Design and drawing of RCC column and isolated footing with reinforcement details.
Experiment 6:
Design and reinforcement detailing of dog-legged staircase.
Site Visit:
Site visit for Reinforced Concrete Structure (RCC).</td></tr>
<tr><td colspan="6">Guide lines for ICA:</td></tr>
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</table>

journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.
Guide lines for ESE:
ESE will be based on practical/assignments submitted by the students in the form of journal/drawing sheet. Evaluation will be based on oral, paper work and performance in the ESE.

ENVIRONMENTAL ENGINEERING (PCC)					
Course Title:	**ENVIRONMENTAL ENGINEERING**	**Short Title:**	**EE**	**Course Code: Theory**	**CE – 603**

Course Description:

This course apprises a graduate student with the importance of water supply and wastewater engineering. The syllabus includes population forecast, assessment of design periods of water treatment and wastewater treatment facilities, their design, commissioning, operation, maintenance, trouble shooting and augmentation, water supply and wastewater carriage network design, importance and scope of sanitation.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	**03**
Practical	02	15	30	**01**

Prerequisite course(s):

Nil

Course Objectives:

The objective of this course is to:

1. To understand the importance of water quality in relation to public health.
2. The students will be able to explain, and design key units of water treatment system.
3. To make aware a student about importance, scope and methods of water treatment process and sewage treatment process.
4. The students will be able to analyze, design, and evaluate wastewater treatment systems
5. To provide fundamental knowledge of sewerage and hydraulics systems.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand the importance of water quality its parameter, sanitation and health.
2. To know the water quality parameters of significance and parameters of water pollution assessment.
3. To know the methods of water treatment process, their design, operation and maintenance.
4. To know the wastewater sources, mechanism of water pollution and self-purification capacity of environment.

5. Understand the design of wastewater treatment facilities and to do their operation and maintenance.

COURSE CONTENT

ENVIRONMENTAL ENGINEERING		**Semester:**	**VI**	**Course Code**	**CE – 603**
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**			**60 marks**
		Duration of ESE:			**03 hours**
		Internal Sessional Exam (ISE) CA:			**40 marks**

Unit–I:	**No. of Lectures:** 09 Hours	**Marks:** 12

Importance of water quality and its relation with public health, sources of water contamination, objectives of water treatment. Sources of water and their water quality.

Conventional water treatment schemes for river, lake, open well and tube well water. Water demand its type and factor affecting on it.

Population forecast by arithmetic, geometric and incremental methods, fire water demand. Physical chemical and biological parameters in water and their examination. Quality standards as per IS 10500

Unit–II:	**No. of Lectures:** 09 Hours	**Marks:** 12

Flow diagram of conventional water treatment plant, Aeration- necessity, theory, method, Sedimentation- principal, type, theory of plain sedimentation, design of rectangular plain sedimentation tank, Theory of chemical coagulation, jar test for optimum coagulant dose, quality criteria of a good coagulant, features and working of clariflocculator, theory of filtration, types of filters, simple design of rapid sand filter, back washing process, common disinfectants, Chlorination and its types.

Unit–III:	**No. of Lectures:** 09 Hours	**Marks:** 12

Hardness in water, effects, Softening of water by lime soda process, Zeolite and Demineralization method, use of copper sulphate in water treatment, introduction to de-fluoridation and colour removal.

Introduction of Self-cleaning velocity and Non Scouring velocity, Valves in water supply networks, pipes materials. Manhole and drop manhole- part, construction details, Materials used for sewer construction, types of sewers, simple design by using Manning's formula.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Sources of water pollution, important microorganisms, concept self-purification of water bodies, parameters of wastewater pollution, determination of DO in water, BOD and COD measurement, concept of MLSS and F/m

Flow diagram of wastewater treatment plant, necessary to treatment, Introduction to preliminary treatment and primary treatment unit, their functions and features, Activated sludge process-theory, introduction of Sludge digester tank,

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Trickling filter- Theory, working and process, design parameter, introduction of Activated Sludge Process, aerobic and anaerobic treatment, Theory of Oxidation Pond and Oxidation Ditch, Disposal of Sludge by various method.

Design parameter of septic tanks. Low cost toilets. Anaerobic digestion-theory, working of digester, design parameters.

Text Books:

1. Water Supply and Sanitary Engineering, by G. S. Birdie, J. S. Birdie, Dhanpatrai and sons publication.
2. Waste Water Engineering by Dr. B.C. Punmia, Ashok Kr. Jain, Arun Kr. Jain, Firewall Media publication
3. Water Supply Engineering by Dr. B.C. Punmia, Ashok Kr. Jain, Arun Kr. Jain, Firewall Media publication.
4. Water Supply Engineering by Santosh kumar Garg, (Vol. I), Khanna Publication.
5. Sewage Disposal and Air Pollution Engineering by Santosh kumar Garg, (Vol. II), Khanna Publication.
6. Water Supply and Sewerage by E. W. Steel and Terence J. McGhee, International Student Edition, McGraw Hill Publications.

Reference Books:

1. Wastewater Treatment and Disposal: Engineering and Ecology in Pollution Control by S J Arceivala, Marcel Dekker Inc Publications.

NPTEL Links:

1. https://nptel.ac.in/courses/103107215 Basic Environmental Engineering and Pollution Abatement, IIT Roorkee by Prof. P. Mondal,
2. https://onlinecourses.nptel.ac.in/noc26_ch40/ preview Environmental Quality Monitoring & Analysis, Prof. Ravikrishna R. , IIT Madras

ENVIRONMENTAL ENGINEERING LAB (PCC)					
LAB COURSE CONTENT					
ENVIRONMENTAL ENGINEERING LAB		**Semester:**	**VI**	**Course Code**	**CE – 604**
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) CA:**		**25 Marks**	
		End Semester Exam (ESE) UA:		**25 Marks (OR)**	
End Semester Exam (ESE) Pattern		**Oral (OR)**			

LIST OF PRACTICAL- Any **Six** practical should be performed.

1. To determination of pH and alkalinity of water sample.
2. a) To determination of turbidity of water.
   b) To determine optimum coagulant dose using jar test apparatus.
3. To determine hardness of water.
4. To determine conductivity of water sample.
5. a) To determine DO content of water sample.
   b) To determine BOD content of water sample.
   c) To determine COD content of wastewater sample.
6. To determine chlorine content of water sample.
7. To determine MPN of water sample.
8. To determine total solids, dissolved solids and suspended solids of the water sample.
9. To determine SVI of sludge.

Site Visit:

Site visit for water treatment plant / waste water treatment plant.

Guide lines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.

Guide lines for ESE:

ESE will be based on practical/assignments submitted by the students in the form of journal/drawing sheet. Evaluation will be based on oral, paper work and performance in the ESE.

ADVANCED SURVEYING LAB (PEC LAB – II)					
COURSE OUTLINE					
Cours	ADVANCED SURVEYING LAB	**Short**	ASL	**Course**	CE- 605

e Title:		Title:		Code: Theory	A

Course Description:

This course introduce the students about concept in surveying such as Scope of geodetic surveying and triangulation in civil engineering society, Adjustment of triangulation figure by using different methods, Terrestrial and aerial photography for large scale survey, Principles of remote sensing and its methods, Locating of sounding in hydro graphic surveying, Importance and principles of Total station, Setting of curves on roads and railways.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	03	15	45	05
Practical	04	15	60	

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. Identify and calculate the theory of errors in measurement in Triangulation survey
2. To operate Total station to perform all measurement.
3. Calculate air base distance, overlap, and height of object in photographs.
4. To relate the knowledge about Geodetic survey.
5. To setting out the curves on roads and railways.

Course Outcomes:

After successful completion of this course the student will be able to:

1. To be able to conduct Geodetic survey in remote areas.
2. To be able to determine probable error and its determination, distribution of error to the field measurements, adjustment of a geodetic triangle.
3. To be able to identify aerial photos with respect to overlap, air base distance.
4. To be able to carry hydrographic survey, soundings.
5. To be able to setting out curves on roads and railways.

COURSE CONTENT

ADVANCED SURVEYING LAB	**Semester:**	**VI**	**Course Code**	**CE – 605 A**
Teaching Scheme:	**Examination scheme**			

Lectures:	**3 Hours/Week**	**Internal Continuous Assessment (CA)**	**50 Marks**
		End Semester Examination (UA) (OR)	**25 Marks**
End Semester Exam		**Oral (OR)**	

Unit–I:	**No. of Lectures: 09 Hours**	

Geodetic surveying: Objects and methods in geodetic surveying. Triangulation figure, strength of figure, classification of triangulation system, Selection of stations , inter visibility of height of station towers, signals and their classification, phase signals, satellite station and reduction to centre eccentricity of signals , Base line measurement , apparatus used, base net; equipment used for base line measurement, extension of base.

Unit–II:	**No. of Lectures: 09 Hours**	

Triangulation Adjustments : Kinds of errors, laws of weights, determination of the most probable values f quantities , the method of least squares, indirect observations on independent quantities , normal equation , conditioned quantities, The probable error and its determination , distribution of error to the field measurements , methods of correlates , station adjustment , adjustment of a geodetic triangle, figure adjustment of a triangle calculation of spherical angles, adjustment of geodetic quadrilateral.

Unit–III:	**No. of Lectures: 09 Hours**	

Photogrammetry: Objects, application to various fields , terrestrial photogrammetry and aerial photogrammetry, aerial camera, comparison of map and vertical photographs, classification of photographs , concept of principal point, principal plane , Scale of vertical photograph ,computation of length and height from the photograph, relief displacement on vertical photograph , Mirror and lens stereoscopes.

Unit–IV:	**No. of Lectures: 09 Hours**	

Hydrographic surveying and Remote sensing : Objects, establishing controls, shore line survey , river survey, soundings tide gauges, equipment's for taking soundings signals, Nautical sextant measurement of horizontal and vertical angles with the nautical sextant, methods of locating soundings .Basic principles ,definition , importance scope of remote sensing, sensors and its classifications, platforms, applications of remote sensing, electromagnetic radiation and spectrum multispectral scanner MSS. Study and use of Total station.

Unit–V:	**No. of Lectures: 09 Hours**	

Curves : Horizontal and vertical curves and their purposes, simple circular curves its elements

and setting out by linear and angular methods, Compound curves and its elements and setting out of compound curves, Transition curves its types and uses length ,elements of cubic parabola, Introduction to reverse curves and its elements and uses.

LIST OF PRACTICAL- Any **Six** practical should be performed.

1. Measurement of horizontal angles (face left and right position) by One Second Theodolite
2. Measurement of vertical angles (face left and right position) by One Second Theodolite
3. Study and uses of component parts of One Second Theodolite.
4. Study and uses of aerial photogrammetry survey.
5. Study and use of mirror stereoscope
6. Measurement of air base distance by mirror stereoscope.
7. Study and use of components part of nautical sextant for measurement of angles.
8. Measurement of horizontal, vertical and oblique angle by nautical sextant.
9. Study of components parts of total station.
10. Measurement of horizontal and vertical angles by total station

At least one mini project is mandatory

Guide lines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.

Guide lines for ESE:

ESE will be based on practical/assignments submitted by the students in the form of journal/drawing sheet. Evaluation will be based on oral, paper work and performance in the ESE.

Text Books:

1. Surveying and leveling (vol-I&II) by T.P. Kanitkar, & S.V. Kulkarni, Pune Vidarthi Griha Prakashan, Pune,
2. Surveying Vol. I ,Vol .II and III ,by Dr B.C. Punmia, Ashok K Jain, Arun K Jain , Laxmi Publication (P) New Delhi.
3. Principles of surveying by Cliver and clendening

4. Advance surveying , Vol.I & II, Handbook by P.B. Shahani
5. A handbook of accurate surveying methods by S.P.Collins
6. Surveying by, S K Duggal , Vol.I & II, McGraw Hill Education (India) private Limited New Delhi.
7. Introduction to Geographic information systems, by Kang- tsung Chang, McGraw Hill Education (India) private Limited New Delhi.
8. Surveying by, C L Kochher , Dhanpat Rai publicating co. New Delhi

Reference Books:

1. Advance surveying by P. Som ,B.N.Ghosh, TMH Publication.
2. Surveying and leveling , by N NBasak, Vol.I&II,McGraw Hill Education (India) private Limited New Delhi.
3. Elements of Photogrammetry by Paul Richard Wolf, McGraw-Hill Education (India) Pvt Limited.
4. Plane and geodetic surveying by David Clark, J. E. Jackson
5. Principal of remote sensing by A. N. Patel .
6. Concept and techniques of Geographic Information System, by C P LO Albbert K W Yeung,Prentice Hall of India Private Limited , New Delhi.

NPTEL Links:

1. https://nptel.ac.in/courses/105107121 Modern Surveying Techiquies, Prof. S.K. Ghosh, IIT Roorkee
2. http://www.digimat.in/nptel/courses/video/105107121/L04.html Modern surveying technique , Prof. S. K Ghosh , IIT Roorkee

COMPUTER AIDED STRUCTURAL DRAWING LAB (PEC LAB – II)					
COURSE OUTLINE					
Course Title:	**COMPUTER AIDED STRUCTURAL DRAWING LAB (PEC)**	**Short Title:**	CASD LAB	**Course Code**	CE- 605 B

Course Description:

This laboratory course is designed to develop practical skills in preparing structural design and drawings using computer-aided drafting and design tools. The course introduces students to industry-relevant software such as AutoCAD and other structural detailing platforms, enabling them to create accurate and professional engineering design and drawings.

	Hours/Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Theory	03	15	45	**05**
Practical	04	15	60	

Prerequisite Course(s):

Nil

Course Objectives:

1. To provide hands-on training on structural analysis software.
2. To model and analyze structural elements using computer tools.
3. To perform design of RCC and steel structures using software.
4. To prepare reinforcement detailing as per IS codes.
5. To enable students to interpret and prepare complete structural drawings and Modelling of buildings.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Develop structural models using software tools
2. Apply loads and analyse structures using software
3. Design RCC elements using software.
4. Design steel structural members using software.
5. Interpret analysis and design outputs effectively.

COURSE CONTENT

COMPUTER AIDED STRUCTURAL DRAWING LAB (PEC)		**Semester:**	VI	**Course Code**	CE – 605 B
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 Hours/Week**	**Internal Continuous Assessment (CA)**			**50 Marks**
Practical	**4 Hours/Week**	**End Semester Examination (UA)**			**25 Marks Oral**
End Semester Exam		**Oral (OR)**			

Introduction to Structural Software

Introduction to structural analysis software, advantages and limitations of computer-aided structural analysis, structural modelling concepts, coordinate systems, nodes and elements, material properties, support conditions, types of loads, load combinations.

Structural Modelling and Analysis

Modelling of beams, frames, and truss structures, input of geometry and loading conditions, static analysis of determinate and indeterminate structures, generation and interpretation of shear force diagrams, bending moment diagrams, axial force diagrams, and deflection diagrams.

Analysis of Building Structures

Modelling of multi-storey building frames, floor load distribution, load combinations as per IS codes, analysis of building frames for gravity loads and lateral loads, interpretation of structural analysis results.

Design of RCC Structural Elements

Design concepts as per IS 456, software-based design of RCC beams, columns, slabs, and footings, checking of serviceability and strength criteria, reinforcement detailing from software outputs.

Design Documentation and Applications:

Preparation of structural design reports, interpretation of software output tables and diagrams, generation of structural drawings, limitations of software results, case studies of structural analysis using software.

Any **six** practical's

1. Introduction to structural analysis software interface (STAAD Pro / ETABS / SAP2000).
2. Modelling and analysis of a simply supported beam.
3. Analysis of a continuous beam.
4. Analysis of a truss structure.
5. Modelling and analysis of a multi-storey building frame.
6. Design of RCC beam using software.
7. Design of RCC column using software.

8. Design of steel beam using software.
9. Design of steel column using software.

Mini project: Analysis and design of a G+2 or G+3 building.

Text Books:

1. Bansal R.K., "Structural Analysis", Laxmi Publications.
2. Hibbeler R.C., "Structural Analysis", Pearson Education.
3. Punmia B.C., "Advanced RCC Design", Laxmi Publications.

Reference Books:

1. Duggal S.K., "Limit State Design of Steel Structures", McGraw Hill.
2. CSI Manuals for ETABS / SAP2000.
3. Bentley Systems, STAAD Pro User Manual.

Guide lines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.

Guide lines for ESE:

ESE will be based on practical/assignments submitted by the students in the form of journal/drawing sheet. Evaluation will be based on oral, paper work and performance in the ESE.

Any of the Software to be used

1. STAAD Pro
2. ETABS
3. SAP2000
4. SAFE / AutoCAD (optional)

NPTEL Links:

1. https://nptel.ac.in/courses/112104031 Computer Aided Engineering Design by Dr. Anupam Saxena, IIT Kharagpur

REMOTE SENSING AND GIS (PEC LAB – II)					
COURSE OUTLINE					
Course Title:	**REMOTE SENSING AND GIS (PCC)**	**Short Title:**	**RS & GIS**	**Course Code: Theory**	**CE- 605 C**

Course Description:

Remote Sensing and Geographic Information System explores the science of acquiring information about the Earth's surface from a distance using satellite and aerial sensors ,and the technology used to store, manipulate and analyse this special data.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	**05**
Practical	04	15	60	

Prerequisite course(s):

Nil

Course Objectives:

The objective of this course is to:

1. To introduce the basic concepts of GIS and remote sensing and their integration.
2. To understand spatial and attribute data models (raster and vector) used in GIS.
3. To develop knowledge of data acquisition, storage, and database management systems in GIS.
4. To familiarize students with GIS planning, implementation, and management concepts**.**
5. To apply GIS in civil engineering, environmental management, urban planning, and disaster management**.**

Course Outcomes:

After successful completion of this course the student will be able to:

1. Understand fundamental concepts of GIS and remote sensing systems**.**
2. Understand remote sensing, its type and characteristic.
3. Apply knowledge of digital imaging and photogrammetry
4. Analysis of spatial data model and data management.
5. Develop critical thinking about application of GIS

COURSE CONTENT					
REMOTE SENSING AND GIS (PEC II)		**Semester:**	**VI**	**Course Code**	**CE – 605 C**
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 hours/week**	**Internal Continuous Assessment (CA)**			**50 Marks**

	End Semester Examination (UA)	**25 (OR) Marks**
End Semester Exam	**Oral (OR)**	
Unit–I:	**No. of Lectures: 09 Hours**	

Concept of Remote Sensing: Introduction**,** Definition**,** Distance**,** Art and / or Science, Data, Process, Source of Energy, Interaction with Atmosphere, Interaction with Target, Interaction with Atmosphere Again, Recording of energy by sensor, Transmission, Reception, and Processing, Interpretation and Analysis, Application of Remote Sensing, Advantage of Remote Sensing, Limitation of Remote Sensing, Ideal Remote Sensing System

Concept of Geographic Information System: Introduction, Definition, key components of GIS, GIS- An Integration of spatial and Attribute Information, GIS- Three Views of Information System, GIS and Related Term, GIS- A Knowledge Hub, GIS-A set of Interrelated subsystem, GIS- An Information Infrastructures, Origin of GIS

Function and Advantages of GIS: Introduction, Function of GIS, Application Area of GIS, Application of GIS, Functional Requirements of GIS, Limitation of GIS.

Unit–II:	**No. of Lectures: 09 Hours**	

Types of Remote Sensing and Sensor Characteristics: Introduction, Types of Remote Sensing, Characteristics of Images, Orbital Characteristics of Satellite, Remote Sensing Satellites, Concept of Swath, Concept of Nadir, Sensor Resolutions, Image Referencing System, Path, Row, Orbital Calendar.

History of Remote Sensing and Indian Space Program : Introduction, The Early Age, The Middle Age, The Modern Age or Space Age, Indian Space Programs.

Photographic Imaging: Introduction, Camera Systems, Types of Camera, Filter, Film, Geometry of Aerial Photography, Ideal Time and Atmosphere for Aerial Remote Sensing

Unit–III:	**No. of Lectures: 09 Hours**	

Digital Imaging: Introduction, Digital image, Sensor, Imaging by Scanning Technique, Hyper-spectral imaging, Imaging by Non- scanning Techniques, Thermal Remote Non-scanning Technique, and Other Sensors.

Photogrammetry: Introduction, Development of Photogrammetry, Classification, Process, Acquisition of imagery and its support, data, Orientation and Triangulation, Stereo Model Compilation, Stereoscopic 3Dviewing, Stereoscopic Measurement, DTM/ DEM Generation,

Contour Map Generation, Orthorectification, 3D future Extraction, 3D Scene Modelling, Photogrammetry and LiDAR, Radargrammetry and Radar Interferometry, Limitations of Photogrammetry.

Unit–IV:	**No. of Lectures: 09 Hours**	

Spatial Data Model: Introduction, Spatial, Thematic, and Temporal Dimension of Geographic Data ,Spatial Entity and Object, Spatial Data Model, Raster Data Model, Vector Data Model, Raster versus Vector, Object- Oriented Data Model, File Formats of Spatial Data

Attribute Data Management and Metadata Concept: Introduction, Concept of Database and DBMS, Advantages of DBMS, Functions of DBMS, File and Data Access, Data Models, Database Models, Data Models in GIS, Concept of SQL, Concept of Metadata.

Unit–V:	**No. of Lectures: 09 Hours**	

Geospatial Analysis: Introduction, Geospatial Data Analysis, Integration and Modelling of Spatial Data, Geospatial Data Analysis Methods, Database Query, Geospatial Measurements, Overlay Operations, Network Analysis, Surface Analysis

Planning, Implementation, and Managements of GIS: Introduction, Planning of Project, Implementation of project, Management of Project, Human Resource Management, Contract/Procurement Management, Communication Management, Communications Management, Scope Management, Risk Management, Project Integration Management

Assignment: Any six Assignments

1. Concept of Remote Sensing
2. Concept of Geographic Information System
3. Function and advantages of GIS
4. Remote Sensing and Sensor Characteristics
5. History of Remote sensing and Indian Space Program
6. Photographic Imaging
7. Digital Imaging
8. Photogrammetry
9. Special Data Model
10. Attribute Data Management and & Metadata Concept
11. Geospatial Analysis
12. Planning, Implementation and managements of GIS

Guide lines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.

Guide lines for ESE:

ESE will be based on practical/assignments submitted by the students in the form of journal/drawing sheet. Evaluation will be based on oral, paper work and performance in the ESE.

Text Books:

1. Remote Sensing and GIS – Basudeb Bhatt
2. Textbook of Remote Sensing and Geographical Information System – M. Anji Reddy

Reference Books:

1. Paul Bolstad – GIS Fundamentals.
2. Michael N. DeMers – Fundamentals of Geographic Information Systems.

NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc25_ce23/preview Geographic Information Systems by Prof. Arun K. Saraf, IIT Roorkee

FOUNDATION ENGINEERING (PROGRAMM ELECTIVE COURSE III)					
COURSE OUTLINE					
Course Title:	FOUNDATION ENGINEERING	**Short Title:**	FE	**Course Code: Theory**	CE- 606 A

Course Description:

Foundation Engineering is a civil engineering course covering the analysis and design of different types of foundation for different types of soil.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The primary objective of foundation engineering to understand, predict, and analyse the bearing capacity, settlement behaviour of soil under different loading condition. Analyse and design of suitable and economic type of foundation for different structures.

Course Outcomes:

After successful completion of this course the student will be able to understand:

1. Soil, Soil mechanics, Classification of soil.
2. Index (Elementary) engineering properties of soil.
3. Soil Hydraulics.
4. Consolidation and compaction of soil.
5. Shear Strength of soil and Earth Pressure.

COURSE CONTENT

FOUNDATION ENGINEERING		**Semester:**	**VI**	**Course Code**	**CE – 606 A**
Teaching Scheme:		**Examination scheme**			
Lectures:	3 Hours/Week	**End Semester Exam (ESE) UA:**			**60 Marks**
		Duration of ESE:			**03 Hours**
		Internal Sessional Exam (ISE) CA:			**40 Marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Site Investigation and Sub Soil Exploration: Introduction, Site reconnaissance, site exploration, methods of soil exploration, soil samples and samplers, disturbed sampling, undisturbed sampling penetration and sounding tests, Geophysical methods. Numerical on Soil Sample and Soil Samplers.

Stress Distribution: Introduction, stresses due to self-weight, Concentrated Force Boussinesq's

equation, pressure distribution diagram, vertical pressure under a uniformly loaded circular area, vertical pressure due to line load, vertical pressure under strip load, Equivalent point load method, Newmark's influence chart, Westerguard's analysis, contact pressure, Numerical.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**
Bearing Capacity: Definitions, Minimum depth of foundation: Rankin's Analysis, Types of bearing capacity failure, Terzaghi's analysis, General bearing capacity failures (Brinch Hansen's Analysis), Meyerhof's analysis, Vasic's bearing capacity equation, Comparison of bearing capacity factors, Effect of water table on bearing capacity, Effect of eccentricity of loading, I. S. code method for computing bearing capacity, Plate load test, Penetration test, Safe bearing pressure based on tolerable settlement, permissible total and differential settlement. Numerical on bearing capacity by Terzaghi's Analysis.		

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**
Bulk Heads and Coffer Dams: Introduction: Sheet Pile walls, Classification of Bulkheads, Cantilever Sheet Pile wall, Cantilever sheet pile wall in cohesive soil, Design of anchored bulkheads: free earth support method, and fixed earth method, design of anchors and bulk heads, Coffer dam, No numerical. **Shallow Foundation:** Types of foundation, Spread footing, Safe Bearing Pressure, Settlement of Footing, Combined footing and strap footing, Mat or Raft Footing. Numerical.		

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Pile Foundation: Types of pile, Pile driving, Load carrying capacity of piles, Dynamic formulae, Static formulae, Pile load test, Penetration test, Group action on piles, Negative skin friction, Laterally loaded piles, Under-reamed pile foundation, Bores compaction pile, Cased Cast – In situ concrete piles, Incased Cast – In situ concrete piles, Bores piles. Numerical. **Well Foundation:** Introduction, Caissons, Shapes of well and component part, Depth of well foundation and bearing capacity, Forces acting on well foundation, Heavy wells, Well curb, Cutting edge, Staining and bottom plug, well sinking, Pneumatic Caisson.		

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Machine Foundation: Soil dynamics, The mass spring system, Vibrating spring – mass system with damping, Forced vibrations, Transmitted force, Natural frequency of foundation soil system, Barken's Method, Bulb of pressure concept, Dynamic analysis of block foundation, Indian standard code of practice for design of foundation for reciprocating and impact type		

machine. Examples (Numerical)

Stabilization of Soil: Introduction, Mechanical stabilization, Cement Stabilization, Lime Stabilization, Bitumen Stabilization, Chemical Stabilization, Stabilization by heating, Electrical Stabilization.

Text Books:

1. Text book of Soil Mechanics and Foundation Engineering: Geotechnical Engineering Series, V. N. S. Murthy, CRC Press
2. Geotechnical Engineering: Principles and Practices of soil mechanics and foundation engineering, V. N. S. Murthy, CRC Press
3. Soil Mechanics and Foundation Engineering (Geotechnical Engineering), P N Modi, Standard Book House.
4. Fundamentals of Soil Mechanics, Dr A. V. NarasimhaRao, University Science Press

Reference Books:

1. Soil Mechanics and Foundations, Dr B. C. Punmia, Laxmi Publications, Pvt. Ltd.
2. Foundation Engineering, Dr B J Kasmalkar, Pune VidyarthiGruhPrakashan.
3. Soil Mechanics and Foundation Engineering, S. K. Gerg, Khanna Publisher.
4. Soil Mechanics in Engineering Practice, Karl Terzaghi, Ralph B. Peck, and GholamrezaMesri, Third Edition (1996), Wiley/Chapman & Hall.
5. Soil Mechanics fundamentals, Muni Budhu, John Wiley and Sons.

NPTEL Links:

1. https://nptel.ac.in/courses/105105185 - Geotechnical Engineering II Foundation Engineering, Prof. Dilip Kumar Baidya, IIT Kharagpur
2. https://onlinecourses.nptel.ac.in/noc22_ce03/preview Geotechnical Engineering - 1, Prof. D. N. Singh, IIT Bombay.
3. https://nptel.ac.in/courses/105105168 Soil Mechanics/Geotechnical Engineering I, IIT Kharagpur, Prof. Dilip Kumar Baidya, IIT Kharagpur.
4. https://onlinecourses.nptel.ac.in/noc21_ce39/preview Foundation Engineering, Prof. Kousik Deb, IIT Kharagpur.
5. https://onlinecourses.nptel.ac.in/noc26_ce41/preview Advanced Foundation Engineering, Prof. Kousik Deb, IIT Kharagpur

FOUNDATION ENGINEERING LAB (PEC – III LAB)					
LAB COURSE CONTENT					
FOUNDATION ENGINEERING LAB (PROGRAMM ELECTIVE COURSE III LAB)		**Semester:**	**VI**	**Course Code**	CE – 607 A
Teaching Scheme:		**Examination scheme**			
Practical:	2 Hours/Week	**Internal Continuous Assessment (ICA) CA:**		25 Marks	

LIST OF PRACTICAL (Assignments with required drawing and curves, graph, IS Codes etc. should be performed)

1. Standard Penetration Test.
2. Plate Load Test.
3. Bearing capacity of soil numerical for different condition of water level, settlement, size of footing.
4. Design of Rigid Pavement.
5. Design of Flexible Pavement

Guide lines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.

NPTEL Links:

1. https://nptel.ac.in/courses/105105185 - Geotechnical Engineering II Foundation Engineering, Prof. Dilip Kumar Baidya, IIT Kharagpur
2. https://onlinecourses.nptel.ac.in/noc22_ce03/preview Geotechnical Engineering - 1, Prof. D. N. Singh, IIT Bombay.
3. https://nptel.ac.in/courses/105105168 Soil Mechanics/Geotechnical Engineering I, IIT Kharagpur, Prof. Dilip Kumar Baidya, IIT Kharagpur.
4. https://onlinecourses.nptel.ac.in/noc21_ce39/preview Foundation Engineering, Prof. Kousik Deb, IIT Kharagpur.
5. https://onlinecourses.nptel.ac.in/noc26_ce41/preview Advanced Foundation Engineering, Prof. Kousik Deb, IIT Kharagpur

HYDRAULIC ENGINEERING (PEC – III)					
COURSE OUTLINE					
Course Title:	HYDRAULIC ENGINEERING	**Short Title:**	HDE	**Course Code:**	CE 606 B

Course Description:

Hydraulic Engineering is an advanced course in fluid mechanics focusing on the application of fluid flow principles in civil engineering, particularly involving water. The course covers boundary layer theory, flow around submerged bodies, pipe flow analysis, open channel flow , hydraulic jump, and hydraulic machines such as turbines and centrifugal pumps. It bridges theoretical concepts with practical hydraulic engineering problems.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	3	15	45	3
Practical	2	15	30	1

Prerequisite Course(s):

Basic Fluid Mechanics, Engineering Mathematics, Fundamental knowledge of Mechanics

Course Objectives:

1. To understand the concept of boundary layer formation
2. To evaluate drag and lift forces acting on bodies
3. To introduce the students to various advanced hydraulic engineering problems like open channel flows.
4. To learn uniform and non-uniform flow, specific energy, critical depth, and channel transitions.
5. To study working principles, efficiency, and selection of pumps and turbines..

Course Outcomes:

After successful completion of this course the student will be able to:

1. Analyze laminar and turbulent flows and boundary layer characteristics.
2. Evaluate drag and lift forces on submerged bodies.
3. Analyze uniform and gradually varied flow in open channels.
4. Determine critical depth, specific energy, and hydraulic jump characteristics.
5. Understand working principles and performance characteristics of hydraulic turbines and centrifugal pumps.

6. Understand working principles and performance characteristics of hydraulic turbines and centrifugal pumps.

COURSE CONTENT			
HYDRAULIC ENGINEERING		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 Hours/Week**	**End semester exam (ESE):**	**60 Marks**
		Duration of ESE:	**03 Hours**
		Internal Sessional Exams (ISE):	**40 Marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Boundary Layer Analysis: Assumption and concept of boundary layer theory. Boundary-layer thickness, displacement, momentum & energy thickness, laminar and Turbulent boundary layers on a flat plate; Laminar sub-layer, Local and average friction coefficients. Separation and Control.

Fluid flow around submerged bodies: Practical problems involving fluid flow around submerged objects, definitions and expressions of drag and lift, drag and lift coefficients, types of drag, drag on cylinder .Circulation, Magnus effect, lift on cylinder and airfoil, polar diagram.

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Introduction to Open Channel Flow- open channel flow, geometrical parameters of a channel, classification of open channels.

Uniform Flow-Continuity Equation, Energy Equation and Momentum Equation, Chezy's formula, Manning's formula .Most economical section of channel for rectangular, triangular, circular and trapezoidal sections.

Non-Uniform Flow- Specific energy, Specific energy curve, critical flow, Specific force and Critical depth. Measurement of Discharge – VenturiFlume

Gradually Varied Flow: Dynamic Equation of Gradually Varied Flow, Classification of channel bottom slopes, Classification of surface profile, Characteristics of surface profile. Computation of water surface profile by graphical, numerical and analytical approaches. Direct Step method, Graphical Integration method and Direct integration method.(No mathematical Treatment for methods of computation of water surface profile)

Hydraulic Jump- Theory of hydraulic jump, Elements and characteristics of hydraulic jump, length and height of jump, Types, applications of hydraulic jump. Energy dissipation and other uses.

Unit-III:	No. of Lectures: 09 Hours	Marks: 12

Impact of Jet: Impact of jet on stationary & moving , flat & curved surfaces using linear momentum principle, work done, principle of angular momentum , Eulers momentum equation for turbine & pumps (No derivation) (No mathematical treatment)

Hydraulic Turbine: Elements of hydro elastic power plant, unit & specific quantities, hydraulic turbines, classification of hydraulic turbines, heads & efficiencies of hydraulic turbines. Theory & design of hydraulic turbines (mathematical treatment only for Pelton Wheel turbine)

Unit–IV:	No. of Lectures: 09 Hours	Marks: 12

Centrifugal Pumps: General classification of pumps, Classification of centrifugal pump, specific speed, priming, and introduction to work done by impeller, head and efficiencies, Characteristic curves of hydraulic turbines and centrifugal pumps.

Reciprocating Pump: Introduction to reciprocating pump

Unit–V:	No. of Lectures: 09 Hours	Marks: 12

Flow through opening – Orifices-type, coefficient of velocity, contraction and discharge, small and large orifice Mouthpieces – Types ,external cylindrical mouthpiece Flows over notches and weirs(No Mathematical Treatment) – Rectangular, triangular and trapezoidal notches and weirs, Cipolletti weir, empirical formulae for discharge over rectangular weirs, correction for velocity of approach and end contractions(No Mathematical Treatment)

Text Books:

1. Fluid Mechanics and fluid power engineering by D S Kumar S K Kataria Publications.
2. A Textbook of Fluid Mechanics and hydraulic machines by Dr R. K. Bansal, Laxmi Publication.

Reference Books:

1. Fluid Mechanics – Dr. A. K. Jain, Khanna publisher, Delhi.
2. Flow in open Channels –Dr. K. Subramanya, Tata Mcgraw-Hill education Pvt. Ltd., New Delhi. Hydraulic Machines- Dr. JagdishLal, Metropolitan Book Co. Pvt. Ltd., New Delhi.
3. Hydraulic Machines- Dr. R. K. Rajput.

NPTEL Links:

1.nptel.ac.in/courses/105105203 by Prof.M.Saud Afzal, IIT Kharagpur

2.nptel.ac.in/courses/112106453 by Prof.VageshD.Narasimhamurthy, IIT Madras

3. nptel.ac.in/courses/112106190 by Dr.Rinku Mukhejee, IIT Madras

HYDRAULIC ENGINEERING LAB (PEC – III LAB)					
LAB COURSE CONTENT					
HYDRAULIC ENGINEERING LAB		**Semester:**	**VI**	**Course Code**	CE – 607 **B**
Teaching Scheme:		**Examination scheme**			
Practical:	2 Hours/Week	**Internal Continuous Assessment (ICA) CA:**		25 Marks	

LIST OF PRACTICALS (Any **Six** experiments should be performed)

1. Study of boundary layer on flat plate.
2. Measurement of drag and lift on airfoil
3. Determination and analysis of pressure distribution over circular cylinder
4. Determination of friction factor and calibration equation for given pipe
5. Study of uniform flow formulae in open channel
6. Study of specific energy and specific force in open channel flow
7. Calibration of venturiflume
8. Measurement of different parameters of hydraulic jump in laboratory
9. Study of operating characteristic of Pelton Wheel Turbine
10. Study of operating characteristic of Francis Turbine
11. Study of performance of centrifugal pump

Guide lines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.

EARTHQUAKE ENGINEERING (PEC – III)					
COURSE OUTLINE					
Course Title:	EARTHQUAKE ENGINEERING	**Short Title:**	EQE	**Course Code:**	CE -606 C

Course Description:

The Earthquake Engineering course introduces students to the principles and practices used to analyse, design, and construct structures that can safely resist seismic forces. The course focuses on understanding earthquake characteristics, ground motion behaviour, and their effects on buildings and infrastructure. Students learn how seismic waves interact with soil and structures, leading to vibrations, damage mechanisms, and potential structural failure. The subject covers seismic hazard assessment, structural dynamics, and codal provisions for earthquake-resistant design, with emphasis on guidelines issued by the Bureau of Indian Standards (such as IS 1893 and IS 13920). Students are introduced to design philosophies including ductility, energy dissipation, base isolation, and retrofitting techniques for existing buildings. The course also includes practical exposure to seismic analysis methods, response spectra, and modelling of structures using modern analysis tools. By the end of the course, students will be able to evaluate seismic risk, apply design codes, and develop earthquake-resistant structural solutions suitable for real-world engineering practice.

	Hours/Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Theory	3	15	45	03
Practical	2	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. To understand causes and characteristics of earthquakes.
2. To study seismic forces on structures.
3. To learn earthquake-resistant design principles.
4. To interpret seismic codes and detailing provisions.
5. To evaluate structural response under dynamic loading.

Course Outcomes:

Students will be able to:

1. Identify seismic hazards and their effects.
2. Compute seismic forces on buildings.
3. Apply seismic design codes.

4. Design earthquake-resistant structural components.
5. Suggest retrofitting solutions.

COURSE CONTENT

EARTHQUAKE ENGINEERING		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 Hours/Week**	**End Semester Exam (ESE) UA:**	**60 Marks**
		Duration of ESE:	**03 Hours**
		Internal Sessional Exam (ISE) CA:	**40 Marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Interior of earth, Engineering geology of earthquakes, plate tectonics, Seismicity of the world, tectonic features of India, Faults, Propagation of earthquake waves, Quantification of earthquake (magnitude, energy, intensity of earthquake), Measurements of earthquake (Accelerograph, Accelerogram recording), Determination of magnitude, Epi-center distance, focal depth, etc. Ground motion and their characteristics, Factors affecting ground motions.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Guidelines for achieving efficient seismic resistant planning, selection of sites, importance of architectural, features in earthquake resistant buildings , continuity of construction, Projection & suspended parts, special construction features like separation of adjoining structure, Crumble section, Stair case etc. Twisting of building, seismic effects on structures, inertia forces, horizontal & vertical shaking.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Non-Engineered structures: Behaviour of masonry structure during earthquake, bands & reinforcement inmasonry building, openings in wall, importance of flexible structures. Concept of earthquake Resistant design, design philosophy.

Four virtues of EQRD: Stiffness, Strength, ductility and Configurations, Redundancy &Over strength, Damping, Supplemental Damping, Base Isolation.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Review of Limit State Design of RC members. Confinement of concrete, Codal Provisions (IS 1893[I]-2016, IS 13920-2016). Seismic behaviour of concrete, Beams (Flexural, Shear and torsion) Uni-axial and biaxial Beam-column (Axial, shear and moments)

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Building frames, frame-shear wall buildings, Braced Buildings, Preliminary sizing and Mathematical modelling of buildings with different structural systems with and without

diaphragms. Earthquake load calculations along with dead load and live loads and their combinations. Special aspectsin Multi-storied buildings: Effect of torsion, flexible first story, P-delta effect, effect of soil-structure interaction onbuilding response, drift limitation

Textbooks:

1. Earthquake Resistant Design of Structures — by PankajAgarwal and Manish Shrikhande
   Comprehensive book covering seismic design concepts, IS codes, and practical examples. Highly suitable for Indian universities.
2. Dynamics of Structures — by Anil K. Chopra
   Internationally recognized textbook on structural dynamics and earthquake response analysis.
3. Earthquake Engineering — by S. K. Duggal
   Good introductory text with Indian seismic design provisions and solved examples.

Reference Books:

1. Seismic Design of Reinforced Concrete and Masonry Buildings — by Tom Paulay and M. J. N. Priestley
   Excellent for ductile detailing and advanced design philosophy.
2. Introduction to Earthquake Engineering — by Bruce A. Bolt
   Clear explanation of seismology and earthquake effects on structures.
3. Earthquake-Resistant Structures — by Hari D. Agrawal
   Focused on structural behavior and design strategies.

➢ Indian Code-Based References (Important for Practice)

- IS 1893 – Criteria for Earthquake Resistant Design of Structures
- IS 13920 – Ductile Detailing of Reinforced Concrete Structures
- IS 4326 – Earthquake Resistant Design and Construction of Buildings

NPTEL Link

https://nptel.ac.in/courses/ Introduction to Earthquake Engineering By Dr.R.S.Jangid IIT Bombay

https://onlinecourses.nptel.ac.in/ Geotechnical Earthquake Engineering By Prof. Kousik Deb | IIT Kharagpur

https://onlinecourses.nptel.ac.in/ Earthquake Geotechnical Engineering By Prof. B. K. Maheshwari | IIT Roorkee

EARTHQUAKE ENGINEERING LAB					
LAB COURSE CONTENT					
EARTHQUAKE ENGINEERING LAB		**Semester:**	VI	**Course Code**	CE-607-C
Teaching Scheme:		**Examination scheme**			
Practical:	2 Hours/Week	**Internal Continuous Assessment (ICA) CA:**		25 Marks	

LIST OF EXPERIMENTS (Any **Six** experiments should be performed)

1. Study of seismograph and earthquake recording instruments
2. Determination of natural frequency of model structures
3. Study of resonance using vibration apparatus
4. Response of SDOF system under harmonic loading
5. Demonstration of damping effect on structures
6. Shake table test on building models
7. Study of base isolation models
8. Effect of structural irregularities on seismic response
9. Determination of soil liquefaction potential (demonstration)
10. Computer-based seismic analysis using structural software

Guide lines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.

Guide lines for ESE:

ESE will be based on practical/assignments submitted by the students in the form of journal/drawing sheet. Evaluation will be based on oral, paper work and performance in the ESE.

DESIGN OF STEEL STRUCTURE (MDM)					
COURSE OUTLINE					
Course Title:	**Design of Steel Structure**	**Short Title:**	**DSS**	**Course Code: Theory**	**CE 608**

Course Description:

The primary objective of design of steel structure is to understand connection and design of compression, tension member, beam, column, bases for column.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	02	15	30	02

Prerequisite course(s):

Nil

Course Objectives:

1. To understand the behaviour and design philosophy of steel structures and connections.
2. To analyse tension and compression members.
3. To analyse steel structural systems like simple beams and castellated beams.
4. To analyse and design built-up columns
5. To analyse and design column bases.

Course Outcomes:

After successful completion of this course the student will be able to:

1. Analyse and design bolted and welded connections.
2. Analyse and design steel tension and compression members.
3. Analyse and design Simple laterally supported beams and castellated beams
4. Analyse and design Lacing and battening system.
5. Analyse and design slab base and gusseted base.

COURSE CONTENT

Design of Steel Structure		**Semester:**	**VI**	**Course Code**	**CE – 608**
Teaching Scheme:		**Examination scheme**			
Lectures:	**02 hours/week**	**End Semester Exam (ESE) UA:**			**60 Marks**
		Duration of ESE:			**03 Hours**
		Internal Sessional Exam (ISE) CA:			**40 Marks**
		Internal Continuous Assessment (ICA):			**25 marks**

Unit–I:	**No. of Lectures: 06 Hours**	**Marks: 5**
Introduction to Steel Structures: Types of steel structures, grades of structural steel, various rolled steel sections, Limit state method of design for strength and serviceability, partial safety factor for load and resistance, and various design load combinations. **Connections:** Efficiency and Strength of bolted & welded Connections, Design of connections subjected to Axial Forces & Moments.		
Unit–II:	**No. of Lectures: 06 Hours**	**Marks: 12**
Tension members: Behavior, Modes of failure– Yielding of cross-section, Net section Rupture, and block shear. Design of single and double angle sections with gusset plate with bolted and welded end connections. **Behavior of Compression member**– effective length, and slenderness ratio, Modes of failure-failure with full strength, local buckling, and torsion buckling. Classification of cross sections, Buckling curves. Design of compression members with bolted and welded connection using single and double angle sections.		
Unit–III:	**No. of Lectures: 06 Hours**	**Marks: 12**
Design of Beams: Introduction, Types of sections, lateral stability of beams, Built-up beams, Bending stress, bearing stress, web buckling, web crippling, diagonal buckling. Design of laterally supported and unsupported beams, design of purlins. **Castellated beams** - Concept, fabrication of the castellated beam from rolled steel Section, Effect of hole in beam. Design of castellated beam for bending and shear as per codal provisions by limit state method.		
Unit–IV:	**No. of Lectures: 06 Hours**	**Marks: 12**
Lacing System: Definition and purpose of lacing, Types of lacing, Inclination of lacing bars, Forces in lacing bars (tension/compression) , Design of lacing bars, Spacing and slenderness requirements, Design procedure as per IS 800:2007, Connection details. **Battening Systems:** Definition and purpose of battening, Types of batten systems, Behavior of battened columns Shear and bending in batten plates, Design of batten plates, Spacing and detailing requirements, Design procedure as per IS 800:2007.		
Unit–V:	**No. of Lectures: 06 Hours**	**Marks: 12**
Slab Base: Concept and applications, Assumptions in design, Determination of base plate area,		

Bearing pressure on concrete, Design of base plate thickness, Design of anchor bolts, Detailing of slab base.

Gusseted Base: Concept and necessity, Components: base plate, gusset plates, gusset angles, Load transfer mechanism, Design of gusset plates and angles, Design of base plate, Design of anchor bolts, Detailing requirements.

Text Books:

3. Duggal S. K. – Limit State Design of Steel Structures
4. Bansal R. K. – Design of Steel Structures
5. Punmia B. C. – Comprehensive Design of Steel Structures
6. Dr. N. R. Chandak- Design of steel structures

Reference Books:

1. Narayanan R. – Steel Structures Design and Practice
2. Salmon & Johnson – Steel Structures: Design and Behaviour
3. IS 800:2007 – General Construction in Steel (Code of Practice)
4. Subramanian N.- Design of Steel Structures., Oxford University Press, New Delhi, 2008

NPTEL Links:

1. http://www.digimat.in/nptel/courses/video/105105162/L01.html, Design of steel structure by Prof. Damodar Maity, IIT Kharagpur.

Guidelines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each practical/assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design/drawing.

At least one site visit for steel structure.

CONCRETE MATERIAL LAB (VSEC)					
COURSE OUTLINE					
Course Title:	**CONCRETE MATERIAL LAB**	**Short Title:**	**CM LAB**	**Course Code: Theory**	**CE – 609**

Course description:

This course provides knowledge of construction materials, their properties, testing methods, mix design and applications in construction projects**.**

	Hours/week	No. of weeks	Total hours	Semester credits
Lecture	01	15	15	02
Practical	02	15	30	

Prerequisite course(s): Nil

Course Objectives:

This course aims the students to

1. To understand the properties of constituent materials used in concrete such as cement, aggregates, and water.
2. To perform standard laboratory tests on concrete materials as per relevant IS codes.
3. To develop skills for proportioning and designing concrete mixes for required strength and durability.
4. To evaluate fresh and hardened concrete properties through experimental methods.
5. To interpret test results and apply them in practical construction scenarios.

Course outcomes:

After successful completion of this course the student will be able to:

1. Identify and test the properties of cement, fine aggregates, and coarse aggregates.
2. Conduct tests on fresh concrete such as workability and setting characteristics.
3. Design concrete mix proportions as per IS 10262 guidelines.
4. Evaluate strength properties of hardened concrete (compressive, tensile, flexural).
5. Analyze test results and recommend suitable mix for field applications.

CONCRETE MATERIAL LAB (VSEC)				
LAB COURSE CONTENT				
CONCRETE MATERIAL LAB	**Semester:**	**VI**	**Course Code**	**CE – 609**

Teaching Scheme:		**Examination scheme**	
Lecture	**1 hours/week**	**Internal Continuous Assessment (ICA) CA:**	**25 Marks**
Practical:	**2 hours/week**		

Cement - chemical composition, properties and testing of cement

Aggregates and testing of aggregates: sources, coarse and fine aggregates. Fineness modulus, crushing value, impact value, abrasion value. Recycled aggregates: their uses in concrete.

Water: role of water, water quality for concrete

Fresh Concrete: - Definition and its ingredients, grades of concrete, concreting process, Admixtures, classification and their effects on various properties. quality control during concreting.

Strength of concrete: water cement ratio, compressive strength, Flexural strength of concrete**,** tensile strength of concrete ,

Concrete mix design – Introduction, object of mix design, concept of mix design, terms and terminologies, factors to be considered , statistical quality control, introduction to mix design ,Concrete mix design by I.S.(10262-456) method

Hardened Concrete: Testing of hardened concrete, creep. Shrinkage of concrete, Non destructive testing of concrete by common methods

Text Books:

Concrete Technology by M.S. Shetty.

Concrete Technology by M. L. Gambhir, TMH Publication.

Concrete Technology by S. V. Deodhar, Central Techno Publication

Reference Books:

Properties of Concrete- A. M. Neville

American Society for Testing and Materials (ASTM), *Annual Book of ASTM Standards* (post 2000)

NPTEL Links:
1. https://archive.nptel.ac.in/courses/105/104/105104030/ by Sudhir Mishra, IIT Kanpur

List of Practical :

1. Test on Cement
2. Test on Aggregate
3. Test on Concrete

   (Practical's on material required for Mix Design)

   Mix design for M20 grade concrete (as per IS 10262)

Guide lines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.

EXIT COURSE FOR U. G. DIPLOMA in Civil (Duration 8 weeks)

Internship / Apprenticeship:

Internship / Apprenticeship / OJT shall be corresponding to the programme (Major) subject. Internship / Apprenticeship / OJT shall be monitored jointly by faculty and Industry / organization mentor.

The role of a Mentor, nominated by institute, shall be to provide professional/research guidance to the student during the internship. They shall also facilitate networking with other subject matter experts/professionals, which will enhance the internship experience and learning of the students.

Internship / Apprenticeship / OJT corresponding to the programme (Major) subject in Exit course with an external organization / entity is desirable. External organization may be industries, research institutions, University research centers or CSIR laboratories. Internship / Apprenticeship / OJT shall be preferably in offline mode, however online mode may also be permitted.

Preferably the Mini Project in Exit course shall be based on Internship / Apprenticeship / OJT.

Activities under Internship / Apprenticeship / OJT include Project work, Seminar, Industrial Training (excluding credits for Advanced Courses). This can be Industrial / Govt. / NGO/MSME/ Rural Internship/ Innovation / Entrepreneurship / academic / industry research project.

After completion of Internship, students shall prepare a comprehensive report highlighting their learnings and takeaways during the internship period. The students are mandated to give a seminar based on the internship undertaken before an expert committee constituted by the concerned department and the assessment of internship shall be based on the following criteria:

1) Quality and effectiveness of presentation
2) Depth of knowledge and demonstrated skills
3) Variety and relevance of learning experience
4) Practical applications and relationships with concepts taught in the course
5) Internship Report
6) Attendance record, student diary (log), supervisor evaluation

Attendance record shall include daily attendance with IN and OUT time. It shall be signed by Industry supervisor.

Student Diary (log) shall include daily activities carried out by the student during Internship with Task assigned, Activities performed, key learnings etc. It shall be signed by Industry supervisor.

Supervisor evaluation form shall include the following with ratings in FIVE-point scale.

1) Behaviours
2) Performs in a dependable manner
3) Cooperates with co-workers and supervisors
4) Shows interest in work
5) Learns quickly
6) Shows initiative
7) Produces high quality work
8) Accepts responsibility
9) Accepts criticism
10) Demonstrates organizational skills
11) Uses technical knowledge and expertise
12) Shows good judgment
13) Demonstrates creativity/originality
14) Analyzes problems effectively
15) Is self-reliant
16) Communicates well
17) Writes effectively
18) Has a professional attitude
19) Gives a professional appearance
20) Is punctual
21) Uses time effectively

Supervisor evaluation form shall be signed by Industry supervisor.

Mini project:

The student shall carry out a Mini project based on the knowledge acquired during the degree course and/or Internship. The project may be either fully theoretical/practical or involving both theoretical and practical work to be assigned by the guide / mentor / department. The work may also be Study/Survey/Design or R&D work. The work may also

be on specified task or project assigned to the students during Internship. The project may also be a sponsored project. The project shall be corresponding to the programme (Major) subject.

Upon completion of the Mini project, the student shall submit project report in the form of hard bound. Assessment for the Mini project shall also include presentation by the student. Assessment of Mini project shall be based on the following criteria:

1) Problem Identification / Project Objectives
2) Methodology / Design
3) Implementation
4) Results and Discussion
5) Conclusion
6) Report
7) Depth of Understanding
8) Presentation
9) Demonstration of the project

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Kavayitri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Third Year Batchelor of Engineering

In

(Civil)

(As per NEP 2020 Guidelines)

Faculty of Science and Technology

(Honors in Infra Structural Engineering)

'A' Grade
NAAC Re-Accredited
(4th Cycle)

COURSE OUTLINE FOR

For Affiliated Colleges for
Honors Degree
W. E. F. 2026 –27

Syllabus Structure for Honors in infra Structural Engineering: Additional Credit (Semester – V) (w. e. f. 2026 – 27)
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE -510A	Highway Engineering	PCC	3			3	40	60			100	3
CE -511A	Highway Engineering Lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Honors in Infra Structural Engineering: Additional Credit (Semester – VI) (w.e.f. 2026 – 27)
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE -612A	Prestressed Concrete Structures	PCC	3			3	40	60			100	3
CE -613A	Prestressed Concrete Structures Lab	PCC			2	2			25	25 (OR)	50	1

HIGHWAY ENGINEERING (PCC)					
COURSE OUTLINE					
Course Title:	HIGHWAY ENGINEERING	**Short Title:**	HE	**Course Code:**	CE – 510 A

Course Description:

The course aims to develop a comprehensive understanding of the principles and practices of highway engineering, including planning, geometric design, pavement materials, construction techniques, traffic engineering, and highway maintenance. It emphasizes the application of engineering concepts to design safe, economical, and sustainable roadway systems, while addressing modern challenges such as traffic congestion, environmental impact, road safety, and infrastructure management.

	Hours/Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Theory	3	15	45	03
Practical	2	15	30	01

Prerequisite Course(s):

Nil

Course Cbjectives:

The objective of this course is to:

1. To learn principles and practices of highway planning
2. To describe traffic studies, their analysis and their interpretation
3. To learn Geometric Design of Cross Sectional Elements of pavement.
4. To study characteristic, properties and testing procedures of highway materials.
5. To enumerate different types of pavements and design of flexible and rigid pavement.

Course Outcomes:

Upon successful completion of the course, the students will be able to:

1. Understand principles and practices of highway planning.
2. Demonstrate knowledge of traffic studies, analysis and their interpretation.
3. Design Geometric Elements of road pavement.
4. Evaluate properties of highway materials as a part of road pavement.
5. Appraise different types of pavements and their design.

COURSE CONTENT

HIGHWAY ENGINEERING		**Semester:**	V
Teaching Scheme:		**Examination scheme**	
Lectures:	3 Hours/Week	**End Semester Exam (ESE) UA:**	60 Marks
		Duration of ESE:	03 Hours
		Internal Sessional Exam (ISE) CA:	40 Marks

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**
Highway development and planning		
History , development plans, classification of roads, road patterns, road development in India: vision 2021, rural road development vision 2025, current road projects in India, highway alignment, highway project report preparation, (planning surveys & master plans based on saturation system).problems based on saturation system.		
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**
Geometric Design of Highways		
Introduction, highway cross section elements, sight distance, design of horizontal alignment, problems of horizontal alignment, design of vertical alignment, design of intersections.		
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**
Pavement Materials		
Materials used in highway construction and related tests: soil subgrade and CBR Test, stone aggregates, bituminous binders, bituminous paving mixes, viscosity based gradation of bitumen, modified bitumen cutbacks, emulsions, crumbed rubber modified bitumen, polymer modified bitumen, foamed bitumen, Marshall stability mix design and test (All 5 test parameters).		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Pavement Design		
Introduction to various types of pavement, flexible pavements: computation of design traffic (vehicle damage factor, lane distribution factor, and traffic growth rate), flexible pavements, computation of design traffic, problems, stresses in flexible pavements, design guidelines for flexible pavements as per IRC 37-2018 without numerical. Rigid pavements: components and functions, factors affecting design, ESWL, Stresses in rigid pavements, wheel load stresses and temperature stresses, design guidelines for concrete pavements as per IRC 58-2015 without numerical, Joints in CC pavements, problems, highway drainage: subsurface and surface drainage.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Traffic Engineering and Control		
Traffic characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control devices (signs, signals, islands, road markings), accident studies, types of road intersections, parking studies; highway lighting, problems.		
Text Books:		
1. Highway Engineering, S. K. Khanna, C. E. G. Justo and A. Veeraragavan, Nem Chand and Brothers. 2. Principles and Practices of Highway Engineering, Dr. L .R. Kadiyali, Khanna Publishers		

Delhi

3. Principles of Highway Engineering and Traffic Analysis (4th edition), F. L. Mannering and Scott S. Washburn, Wiley India.
4. Highway and Bridge Engineering, B. L. Gupta and Amit Gupta, Standard publishers Distributors
5. Highway Engineering, Rangawala, Charotar publishing House.

Reference Books:

1. A Course in Highway Engineering, S. P. Bindra, DhanpatRai and Sons.
2. Principles of Transportation Engineering, G. V. Rao, Tata MacGraw Hill Publication
3. Principles of Transportation Engineering, ParthaChakraborty and Animesh Das, Prentice Hall of India Pvt. Ltd.
4. Handbook of Road Technology, Lay M. G., Gorden Breach Science, Newyork
5. Civil Engineering Handbook, Khanna S. K.
6. Specifications for Road and Bridge works (MORTH) - IRC, New Delhi.

NPTEL Links:

1. https://nptel.ac.in/courses/105105107
2. https://onlinecourses.nptel.ac.in/noc22_ce94/preview
3. https://onlinecourses.nptel.ac.in/noc24_ce35/preview

<table>
<tr><th colspan="6">HIGHWAY ENGINEERING LAB (PCC)</th></tr>
<tr><th colspan="6">LAB COURSE CONTENT</th></tr>
<tr><td colspan="2">HIGHWAY ENGINEERING LAB</td><td>Semester:</td><td>V</td><td>Course Code</td><td>CE–511A</td></tr>
<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td rowspan="2">Practical:</td><td rowspan="2">2 Hours/Week</td><td colspan="2">Internal Continuous Assessment (ICA) CA:</td><td colspan="2">25 Marks</td></tr>
<tr><td colspan="2">End Semester Exam (ESE) UA:</td><td colspan="2">25 Marks (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL (Any five practical’s should be performed)

1. Tests on Bitumen (Any Five)
• Penetration Test
• Ductility Test
• Softening Point Test
• Flash Point & Fire Point Test
• Viscosity Test (Tar Viscometer)
• Specific Gravity Test
2. Tests on Aggregate Bitumen Combined:
• Marshall Stability Test
4. Mandatory Assignments
• Construction process of GSB, WBM, WMM; Cemented base, Introduction to bituminous works such as prime coat, tack coat, seal coat
• Built-up Spray Grout (BSG), Asphaltic Concrete (AC) or Bituminous Concrete (BC), Bituminous Macadam (BM), Dense Bituminous Macadam (DBM) and premix carpet, Dry lean Concrete (DLC), Pavement Quality Concrete (PQC)
5. Technical visits
• Road Construction Site
• Hot Mix Plant with detailed report</td></tr>
<tr><td colspan="6">Guide lines for ICA:</td></tr>
<tr><td colspan="6">Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.</td></tr>
<tr><td colspan="6">Guide lines for ESE:</td></tr>
<tr><td colspan="6">ESE will be based on practical/assignments submitted by the students in the form of</td></tr>
</table>

journal/drawing sheet. Evaluation will be based on oral, paper work and performance in the ESE.

PRESTRESSED CONCRETE STRUCTURES (PCC)					
COURSE OUTLINE					
Course Title:	PRESTRESSED CONCRETE STRUCTURES	**Short Title:**	PCS	**Course Code:**	CH – 612 A

Course Description:

The course aims to develop a comprehensive understanding of the principles and behavior of prestressed concrete structures, including the concept of prestressing, materials and properties of high-strength concrete and steel, losses in prestress, and analysis and design of prestressed members such as beams, slabs, and girders. The course also addresses practical aspects such as pre-tensioning and post-tensioning techniques, anchorage systems, serviceability and ultimate strength criteria, and the use of prestressed concrete in bridges, buildings, and other infrastructure, while considering economy, safety, and long-term performance.

	Hours/Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Theory	3	15	45	03
Practical	2	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. To introduce the students to the basic concepts and principles of prestressed concrete structures.
2. Develop an insight into the behaviour of prestressed concrete structural members both at service loads and overloads.
3. To explain fundamentals of prestressed concrete design.

To understand the applications of precast prestressed components in civil infrastructures.

Course Outcomes:

Upon successful completion of the course, the students will be able to:

1. Know the prestressed members.
2. Determining the stresses and various losses in prestressed concrete members.
3. Design the prestressed concrete structures.
4. Design the prestressed concrete slab.
5. Design the prestressed concrete flat slab.
6. Analysis and design the prestressed continuous beams

COURSE CONTENT		
PRESTRESSED CONCRETE STRUCTURES	**Semester:**	V
Teaching Scheme:	**Examination scheme**	

Lectures:	3 Hours/Week	**End Semester Exam (ESE) UA:**	60 Marks
		Duration of ESE:	03 Hours
		Internal Sessional Exam (ISE) CA:	40 Marks

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Prestressing Systems, Material Properties and Composite Sections

Basic concept, early attempts of prestressing, brief history, development of building materials, definitions, advantages of prestressing, limitations of prestressing, types of prestressing, prestressing systems and devices, introduction of composite sections of prestressed concrete beam and cast in-situ RC slab.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Analysis of Prestressed Members and Losses in Prestress

Analysis of prestressed concrete member, stress calculations and concept of cable profile and losses in prestressed concrete.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Design of Determinate Beam

Design of post tensioned prestressed concrete simply supported rectangular and flanged sections for flexure and shear including end block.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Design of Slab and Flat Slab

Design of one way and two way post tensioned slabs. Introduction to flat slab, design of prestressed two way flat slab by direct design method

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Statically Indeterminate PSC Beams

Analysis and design of two span continuous beams, choice of cable profile, linear transformation and concordancy.

Text Books:

1. Advanced Design of Structures, Krishnaraju, McGraw Hill.
2. Prestressed Concrete, N. Krishna Raju, Tata McGraw Hill Publication Co.
3. Earthquake Resistant Design of Structures, Agarwal and Shrikhande, PHI learning

Reference Books:

1. Prestressed Concrete: A Fundamental Approach, Edward Nawy, PHI.
2. Design of Prestressed Concrete Structures, T Y Lin and N H Burns.

NPTEL Links:

1. https://nptel.ac.in/courses/105106117
2. https://onlinecourses.nptel.ac.in/noc25_ce89/preview

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<tr><td colspan="2">PRESTRESSED CONCRETE STRUCTURES LAB</td><td>Semester:</td><td>VI</td><td>Course Code</td><td>CH – 613A</td></tr>
<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td rowspan="2">Practical:</td><td rowspan="2">2 Hours/Week</td><td colspan="3">Internal Continuous Assessment (ICA) CA:</td><td>25 Marks</td></tr>
<tr><td colspan="3">End Semester Exam (ESE) UA:</td><td>25 Marks (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL (Any five practical’s should be performed)
1. Assignment on introduction, prestressing systems and material properties, composite sections
2. Assignment on calculation of losses in prestress and stress calculation
3. Design and detailing of design of prestressed concrete determinate beam
4. Design and detailing of prestressed concrete slab
5. Design and detailing of prestressed concrete flat slab.
6. Design and detailing statically indeterminate PSC beams
7. One site visit reports, on prestressed concrete structure.
8. Minimum Two full imperial sheets based on two projects on design of prestressed concrete structural elements</td></tr>
<tr><td colspan="6">Guide lines for ICA:</td></tr>
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Kavayitri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Third Year Bachelor of Engineering
in
(Civil)
(As per NEP 2020 Guidelines)

Faculty of Science and Technology

(Honors in Sustainability Engineering)

'A' Grade
NAAC Re-Accredited
(4th Cycle)

COURSE OUTLINE FOR
For Affiliated Colleges for
Honors Degree
W. E. F. 2026 – 27

Syllabus Structure for Honors in Sustainability Engineering: Additional Credit (Semester – V) (w. e. f. 2026 – 27)
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / Week	Tutorial Hrs / Week	Practical Hrs / Week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE -510B	Smart Cities and Smart Villages	PCC	3			3	40	60			100	3
CE -511B	Smart Cities and Smart Villages Lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Honors in Sustainability Engineering: Additional Credit (Semester – VI) (w. e. f. 2026 – 27)
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / Week	Tutorial Hrs / Week	Practical Hrs / Week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE -612B	Watershed Development Engineering	PCC	3			3	40	60			100	3
CE -613B	Watershed Development Engineering Lab	PCC			2	2			25	25 (OR)	50	1

SMART CITIES AND SMART VILLAGES (PCC)					
COURSE OUTLINE					
Course Title:	SMART CITIES AND SMART VILLAGES	**Short Title:**	SCSV	**Course Code:**	CH – 510 B

Course Description:

The course provides an understanding of Smart Cities and Smart Villages, focusing on the use of ICT and digital technologies to improve infrastructure, governance, and public services. It covers smart transportation, energy, water, waste management, healthcare, and e-governance, while emphasizing sustainability, resource efficiency, and inclusive development for better quality of life in urban and rural areas.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	3	15	45	03
Practical	2	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. To make aware about code of practice for Smart & sustainable City
2. To understand the concept of smart city and associated challenges.
3. To carry out feasibility study for infrastructure planning.

Course Outcomes:

Upon successful completion of the course, the students will be able to:

1. Understand the concept of smart & sustainable city and associated challenges
2. Identify latest technologies used in Infrastructural Planning
3. Evaluate feasibility analysis for infrastructural planning
4. Apply various smart technique used for Smart City development

COURSE CONTENT

SMART CITIES AND SMART VILLAGES		**Semester:**	V
Teaching Scheme:		**Examination scheme**	
Lectures:	3 Hours/Week	**End Semester Exam (ESE) UA:**	60 Marks
		Duration of ESE:	03 Hours
		Internal Sessional Exam (ISE) CA:	40 Marks

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Smart cities

Introduction to smart & sustainable cities- Definition, dimensions, scope Smart Cities –Global

Standards and Performance Benchmarks, Practice Code, Principal stakeholders, key trends in smart cities developments, Concept of Sustainable cities

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Smart Cities Planning and Development

Planning for Urban Infrastructure, Introduction to city planning, key trends in smart cities developments, Sustainable features for smart cities. Role of Planner in the provision of urban networks for different services, Case Study.

Unit–III:	No. of Lectures: 09 Hours	Marks: 12

Infrastructure Planning and Development for smart Cities

Feasibility studies for infrastructure projects, planning for major infrastructure projects, Various Infrastructure Program and policies by MOUD, PPP (DBOOT, BOOT, etc.) in infrastructure projects. Dimension of smart cities, Financing smart cities development, Governance of smart cities, Smart Cities Regulations & Smart Techniques, Case Study.

Unit–IV:	No. of Lectures: 09 Hours	Marks: 12

Transportation system for Smart Cities

Urbanization and urban mobility, urban land use and transport. Concepts of sustainable mobility, public transportation, pedestrians and bicyclists and parking, fundamentals of the intelligent transportation systems (ITS), Case Study.

Unit–V:	No. of Lectures: 09 Hours	Marks: 12

Introduction to Smart Technologies in smart cities

Enabling Technologies for Smart Cities, Smart City Infrastructure, and Applications of Smart Technologies in Urban Planning, Case Studies of Smart City Projects, Challenges and Future Trends.

Text Books:

1. Jo Beall (1997); “A city for all: valuing differences and working with diversity”; Zed books limited, London (ISBN: 1-85649-477-2).
2. UN-Habitat; “Inclusive and sustainable urban planning: a guide for municipalities”; Volume 3: Urban Development Planning (2007); United Nations Human Settlements Programme (ISBN: 978- 92-1-132024-4).
3. Arup Mitra; “Insights into inclusive growth, employment and wellbeing in India”; Springer (2013), New Delhi (ISBN: 978-81-322-0655-2
4. Mission statement &guidelines on Smart City Scheme". Government of India - Ministry of Urban Development http://smartcities.gov.in/upload/uploadfiles/files/Smart City

Reference Books:

1. Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia by Anthony M. Townsend.
2. GIS for Urban and Regional Planning" by Peter O'Connell.
3. Artificial Intelligence in the 21st Century" by Stephen Lucci and Danny Kopec
4. Internet of Things for Smart Cities: Technologies, Big Data and Security by Zaigham Mahmood

Online Courses:

1. https://tomorrow.city/a/technology-for-smart-cities-the-pillars-of-urban-planning-of-the-future
2. https://www1.nyc.gov/assets/forward/documents/NYC-Smart-Equitable-City-Final.pdf
3. https://smartcity.go.kr/wp-content/uploads/2019/08/Smart-city-broschureENGLISH.pdf

<table>
<tr><th colspan="6">SMART CITIES AND SMART VILLAGES LAB (PCC)</th></tr>
<tr><th colspan="6">LAB COURSE CONTENT</th></tr>
<tr><td colspan="2">SMART CITIES AND SMART VILLAGES LAB</td><td>Semester:</td><td>V</td><td>Course Code</td><td>CH – 511B</td></tr>
<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td rowspan="2">Practical:</td><td rowspan="2">2 Hours/Week</td><td colspan="3">Internal Continuous Assessment (ICA) CA:</td><td>25 Marks</td></tr>
<tr><td colspan="3">End Semester Exam (ESE) UA:</td><td>25 Marks (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL- Any five practical’s should be performed.
1. Experiment 1: Introduction to GIS and Remote Sensing Software- Part 1
2. Experiment 2: Introduction to GIS and Remote Sensing Software- Part 2
3. Experiment 3: Using GIS- Identification of Roads, Buildings, Green spaces etc using aerial maps
4. Experiment 4: Introduction to Sewer Networks / Water Treatment / Software
5. Experiment 5: IoT Network Integration for Smart Cities: Connecting Various Sensors to Central Hub for Monitoring Environmental Parameters
6. Experiment 6: Artificial Intelligence (AI) in Urban Planning: Analyzing -Population Demographics (or) Land Use, (or) Forecasting Urban Growth
7. Experiment 7: Environmental Management with Smart Technologies
8. Experiment 8: Disaster Management with Smart Technologies
9. Experiment 9: Pandemic Management with Smart Technologies.</td></tr>
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WATERSHED DEVELOPMENT ENGINEERING (PCC)					
COURSE OUTLINE					
Course Title:	**WATERSHED DEVELOPMENT ENGINEERING**	**Short Title:**	**WDE**	**Course Code:**	**CH – 612 B**

Course Description:

The course provides an understanding of Watershed Development Engineering, focusing on planning and management of land and water resources for soil and water conservation. It covers watershed characteristics, runoff estimation, erosion control measures, rainwater harvesting, groundwater recharge, and watershed structures such as check dams and contour bunds, while emphasizing sustainable development, agricultural productivity, and environmental protection.

	Hours/Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Theory	3	15	45	03
Practical	2	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. Understand watershed characteristics and rainfall–runoff relationship.
2. Estimate runoff, infiltration, evapotranspiration, and soil loss.
3. Select suitable soil and water conservation measures.
4. Design small watershed structures (check dams, farm ponds, bunds).
5. Apply GIS and remote sensing in watershed planning.
6. Prepare sustainable integrated watershed development plan.

Course Outcomes:

Upon successful completion of the course, the students will be able to:

1. Understand watershed hydrology and rainfall–runoff process.
2. Calculate runoff and soil erosion parameters.
3. Select suitable soil and water conservation techniques.
4. Design basic watershed structures.
5. Use GIS/RS tools for watershed planning.
6. Develop sustainable watershed management plans.

COURSE CONTENT

WATERSHED DEVELOPMENT ENGINEERING	**Semester:**	VI

Teaching Scheme:		**Examination scheme**	
Lectures:	**3 Hours/Week**	**End Semester Exam (ESE) UA:**	60 Marks
		Duration of ESE:	03 Hours
		Internal Sessional Exam (ISE) CA:	40 Marks

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to watershed engineering

Concept of watershed development, objectives of watershed development, need for watershed development, Integrated and multidisciplinary approach for watershed management.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Characteristics of Watersheds

Size, shape, physiographic, slope, climate, drainage, land use, vegetation, geology and soils, hydrology and hydrogeology, socio-economic characteristics, basic data on watersheds.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Principles of Erosion and Measures to Control Erosion

Principles of Erosion: Types and causes of erosion, factors affecting erosion, estimation of soil loss due to erosion- Universal soil loss equation.

Measures to Control Erosion: Contour techniques, ploughing, furrowing, trenching, bunding, terracing, gully control, check dams , rock-fill dams, brushwood dam, Gabion.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Water Harvesting

Techniques of rain water harvesting- rain water harvesting from roof top, surface flow harvesting, subsurface flow harvesting, stop dams, farm ponds and dugout ponds, percolation tanks.

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Land Management and Watershed Modelling

Land Management: Land use and Land capability classification, management of forest, agricultural, grassland and wild land, land grading operation, Reclamation of saline and alkaline soils.

Watershed Modelling: Data of watershed for modelling, application and comparison of watershed models, model calibration and validation, advances of watershed models.

Text Books:

1. ‘Watershed Management’ by Das MM and M.D Saikia, PHI Learning Pvt. Ltd, 2013.
2. ‘Land and Water Management’ by Murthy.VVN, Kalyani Publications, 2007.
3. ‘Watershed Management’ by Murthy J V S, New Age International Publishers, 2006.

Reference Books:

1. 'Water Resource Engineering' by Wurbs R A and James R A, Prentice Hall Publishers, 2002.
2. 'Watershed Hydrology' by Black P E, Prentice Hall, 1996.

Online Courses:

1. https://nptel.ac.in/courses/126105334
2. https://onlinecourses.nptel.ac.in/noc24_ag05/preview

<table>
<tr><th colspan="6">WATERSHED DEVELOPMENT ENGINEERING LAB (PCC)</th></tr>
<tr><th colspan="6">LAB COURSE CONTENT</th></tr>
<tr><td colspan="2">WATERSHED DEVELOPMENT ENGINEERING LAB</td><td>Semester:</td><td>VI</td><td>Course Code</td><td>CH – 613B</td></tr>
<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td rowspan="2">Practical:</td><td rowspan="2">2 Hours/Week</td><td colspan="3">Internal Continuous Assessment (ICA) CA:</td><td>25 Marks</td></tr>
<tr><td colspan="3">End Semester Exam (ESE) UA:</td><td>25 Marks (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL (Any five practical should be performed.)
1. Delineation of watershed boundary using toposheet / satellite image
2. Calculation of watershed characteristics – area, perimeter, drainage density & stream order
3. Slope analysis and preparation of contour map of watershed
4. Determination of infiltration rate using double ring infiltrometer
5. Estimation of soil loss using Universal Soil Loss Equation (USLE)
6. Design of contour bund / graded bund (model or calculation)
7. Design of check dam / gully control structure (gabion or loose boulder structure)
8. Design of rooftop rainwater harvesting system
9. Estimation of runoff and design of farm pond storage capacity</td></tr>
<tr><td colspan="6">Guide lines for ICA:</td></tr>
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Kavayitri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Third Year Batchelor of Engineering

in

(Civil)

(As per NEP 2020 Guidelines)

Faculty of Science and Technology

(Honors in Construction Technology)

'A' Grade
NAAC Re-Accredited
(4th Cycle)

COURSE OUTLINE FOR
For Affiliated Colleges for
Honors Degree
W.E.F. 2026 – 27

Syllabus Structure for Honors in Construction Technology: Additional Credit (Semester – V) (w.e.f. 2026 – 27)
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE -510C	Construction Safety	PCC	3			3	40	60			100	3
CE -511C	Construction safety Lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Honors in Construction Technology: Additional Credit (Semester – VI) (w.e.f. 2026 – 27)
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Cate`gory	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE -612C	Operations Research	PCC	3			3	40	60			100	3
CE -613C	Operations Research Lab	PCC			2	2			25	25 (OR)	50	1

CONSTRUCTION SAFETY (PCC)					
COURSE OUTLINE					
Course Title:	CONSTRUCTION SAFETY	**Short Title:**	CS	**Course Code:**	CH – 510 C

Course Description:

The course provides an understanding of Construction Safety, focusing on identification, evaluation, and control of hazards in construction activities to ensure safe working conditions. It covers safety regulations, risk assessment, personal protective equipment, safe practices in excavation, scaffolding, material handling, electrical works, fire prevention, and emergency response, while emphasizing accident prevention, health protection, legal compliance, and development of a strong safety culture for sustainable and efficient construction projects.

	Hours/Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Theory	3	15	45	03
Practical	2	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The course aims to:

1. Understand principles of safety management in construction projects.
2. Identify hazards in construction activities and methods of risk prevention.
3. Learn safety regulations, standards, and legal requirements.
4. Develop ability to prepare safety plans and emergency procedures.
5. Promote safety culture and accident-free construction practices.

Course Outcomes:

After completion of the course, students will be able to:

1. Identify construction hazards and analyze associated risks.
2. Apply safety standards and legal provisions in construction projects.
3. Design safety plans and use personal protective equipment effectively.
4. Implement accident prevention and emergency response measures.
5. Promote health, safety, and environmental awareness at construction sites.

COURSE CONTENT			
CONSTRUCTION SAFETY		**Semester:**	V
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**	60 Marks
		Duration of ESE:	03 Hours
		Internal Sessional Exam (ISE) CA:	40 Marks
Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**	

Introduction to Construction Safety		
Importance of safety in construction industry, Safety terminology: hazard, risk, accident, incident, near miss, Causes of accidents in construction sites, Safety culture and responsibilities of stakeholders, Role of safety engineer and safety committee		
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**
Safety Regulations and Legislation		
National and international safety standards (BIS, OSHA concepts), Factory Act and Labour safety provisions, Building and Other Construction Workers (BOCW) Act, Safety documentation and reporting procedures, Safety audit and inspection		
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**
Hazard Identification and Risk Assessment		
Types of hazards: physical, chemical, electrical, mechanical, ergonomic, Risk assessment techniques (qualitative & quantitative), Job Safety Analysis (JSA), Permit-to-work system, Safety signage and barricading		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Safety in Construction Operations		
Excavation and trenching safety, Scaffolding and working at heights, Formwork and concreting safety, Material handling and lifting equipment safety (cranes, hoists), Electrical safety at site, Demolition safety		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Health, Fire and Emergency Management		
Occupational health hazards and prevention, Personal Protective Equipment (PPE) selection and usage, Fire prevention and fire-fighting systems, Emergency response plan and evacuation procedures, First aid at construction site, Environmental safety and waste management		
Text Books:		
1. K. K. Chitkara – Construction Project Management Planning & Safety 2. V. J. Davies & K. Tomasin – Construction Safety Handbook		
Reference Books:		
1. Charles D. Reese – Construction Safety and Health Management 2. BOCW Safety Manual 3. National Building Code (Safety Provisions)		
NPTEL Links:		
1. https://onlinecourses.nptel.ac.in/noc23_ce42/preview		

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<tr><th colspan="6">CONSTRUCTION SAFETY LAB (PCC)</th></tr>
<tr><th colspan="6">LAB COURSE CONTENT</th></tr>
<tr><td colspan="2">CONSTRUCTION SAFETY LAB</td><td>Semester:</td><td>V</td><td>Course Code</td><td>CH – 511C</td></tr>
<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td rowspan="2">Practical:</td><td rowspan="2">2 Hours/Week</td><td colspan="2">Internal Continuous Assessment (ICA) CA:</td><td colspan="2">25 Marks</td></tr>
<tr><td colspan="2">End Semester Exam (ESE) UA:</td><td colspan="2">25 Marks (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL (Any five practical should be performed.)
1. Study and use of Personal Protective Equipment (PPE)
2. Hazard identification at construction site
3. Risk assessment using risk matrix method
4. Job Safety Analysis (JSA) of construction activity
5. Scaffolding safety inspection
6. Excavation and trench safety study
7. Fire safety and emergency evacuation plan
8. Safety audit report</td></tr>
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OPERATIONS RESEARCH (PCC)					
COURSE OUTLINE					
Course Title:	OPERATIONS RESEARCH	**Short Title:**	CS	**Course Code:**	CH – 612 C

Course Description:

The course introduces Operation Research methods for scientific decision-making and optimal resource utilization. It covers modelling, linear programming, simplex and duality, assignment and transportation problems, and emphasizes practical application of computational techniques to solve engineering and industrial problems.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	3	15	45	03
Practical	2	15	30	01

Prerequisite course(s):

Nil

Course Objectives:

The course aims to:

1. Understand basic concepts and tools of Operation Research.
2. Formulate real-life problems into mathematical models.
3. Apply optimization techniques like LPP, simplex, assignment, and transportation.
4. Analyze results to support effective decision-making.

Course Outcomes:

After completion of the course, students will be able to:

1. Adopt Operation Research tools and techniques while working in industry
2. Analyze the problem statement with computational approach
3. Apply various models to propose suitable outcomes.
4. Apply various decision-making tools to propose best suitable alternatives, at large.

COURSE CONTENT

OPERATION RESEARCH		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**	60 Marks
		Duration of ESE:	03 Hours
		Internal Sessional Exam (ISE) CA:	40 Marks

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Introduction to Operation Research

Introduction, History of operation research, Stages of development operation research, OR tools and techniques, Applications of Operation research, Modelling approach, Defining the problem and gathering data, Formulating a mathematical model, Deriving solutions from the model, Testing the model, Preparing to apply the model, Implementation, Limitations of operation research

Unit–II:	No. of Lectures: 08 Hours	Marks: 12

Linear Programming and graphical analysis

Introduction to linear programming, Assumptions, Linear programming model, Formulation with different types of constraints, Graphical analysis of linear programming, Graphical linear programming solution.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Simplex method and Duality method

Simplex Method: Introduction, Basics of simplex method, Simplex method computation, Algebra of the simplex method, Simplex method in tabular form, Simplex method in matrix form, Tie breaking in the simplex method, Adapting to other model forms, Post optimality analysis.

Duality: Introduction, Economic interpretation of duality, Primal–Dual relationships, Duality problems, Duality results, Dual problem and the simplex table, Role of duality theory in sensitivity analysis, Sensitivity analysis.

Unit–IV:	No. of Lectures: 09 Hours	Marks: 12

Assignment Problems

Introduction, Assignment problems, Unbalanced assignment problem, Balanced assignment problem, Infeasible assignment problem, Minimization & Maximization, special algorithm for the assignment problem.

Unit–V:	No. of Lectures: 09 Hours	Marks: 12

Transportation Problems

Introduction, Methods for initial basic feasible solution, balanced transportation problem, Minimization & Maximization, Vogel's approximation method, Optimization, Modified distribution method, Streamlined simplex method for the transportation problem, Dual of the transportation problem.

Text Books:

1. Gupta P. K., Hira D. S. "Operation Research" S Chand Publishers, 2006
2. Taha H. A. "Operation Research", Pearson, 2014

3. G.Srinivasan "Operations Research:Principles and Applications", PHI Learning Pvt. Ltd.
4. Ishizika A., Nemery P., “Multi-criteria Decision Analysis”, John Wiley & Sons, 2013

Reference Books:

1. Vohra, N. D. “Operations Research”, Tata McGraw Hill Co., New Delhi.
2. Wagner, “Operation Research”, Wiley Eastern Ltd., New Delhi
3. Zhamb L.C., “Quantitative Techniques in Management”, Vol. I,
4. Miller and Stars, “Executive Decisions & Operation Research”, Prentice Hall of India
5. Hillier and Liberman "Operations Research: Concepts and Cases" McGraw-Hill

Online Courses:

1. https://nptel.ac.in/courses/110106062

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<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td rowspan="2">Practical:</td><td rowspan="2">2 Hours/Week</td><td colspan="3">Internal Continuous Assessment (ICA) CA:</td><td>25 Marks</td></tr>
<tr><td colspan="3">End Semester Exam (ESE) UA:</td><td>25 Marks (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL (Any five practical’s should be performed.)
a. Formulation of real-life problems into Linear Programming Problem (LPP).
b. Solution of LPP using Graphical Method.
c. Solution of LPP using Simplex Method (tabular form).
d. Duality and Primal–Dual relationship verification.
e. Sensitivity (post-optimality) analysis of LPP.
f. Assignment Problem using Hungarian Method (balanced & unbalanced).
g. Transportation Problem – Initial solution using NW Corner / Least Cost / VAM.
h. Transportation Problem – Optimal solution using MODI Method.</td></tr>
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Kavayitri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Third Year Bachelor of Engineering

in

(Civil)

(As per NEP 2020 Guidelines)

Faculty of Science and Technology

(Specialization Minor in Sustainability and Industrial Pollution Control)

'A' Grade
NAAC Re-Accredited
(4th Cycle)

COURSE OUTLINE FOR
For Affiliated Colleges for
Minors Degree
W.E.F. 2026 – 27

Syllabus Structure for Specialization Minor in Sustainability and Industrial Pollution Control**: Additional Credit (Semester – V) (w.e.f. 2026 – 27)**
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE-512A	Industrial Water Pollution Control	PCC	3			3	40	60			100	3
CE-513A	Industrial Water Pollution Control Lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Specialization Minor in Sustainability and Industrial Pollution Control**: Additional Credit (Semester – VI) (w.e.f. 2026 – 27)**
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE-614A	Air Pollution	PCC	3			3	40	60			100	3
CE-615A	Air Pollution Lab	PCC			2	2			25	25 (OR)	50	1

INDUSTRIAL WATER POLLUTION CONTROL(PCC)					
COURSE OUTLINE					
Course Title:	INDUSTRIAL WATER POLLUTION CONTROL	**Short Title:**	IWPC	**Course Code: Theory**	CE-512A

Course Description:

This course focuses on the sources, characteristics, treatment, and management of industrial wastewater. It covers physical, chemical, and biological treatment processes, industry-specific effluent treatment methods, design principles, and regulatory standards. The course also emphasizes pollution prevention, waste minimization, resource recovery, and sustainable industrial water management practices.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. To understand the sources and characteristics of industrial wastewater.
2. To study physical, chemical, and biological treatment methods for industrial effluents
3. To design and analyze treatment systems for specific industries.
4. To understand industrial wastewater regulations and environmental standards.
5. To explore advanced treatment technologies and resource recovery methods.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Identify and characterize different types of industrial wastewater.
2. Select appropriate treatment methods for various industrial effluents.
3. Design basic components of industrial wastewater treatment systems.
4. Evaluate pollution prevention and waste minimization strategies.
5. Interpret environmental standards and ensure regulatory compliance.

COURSE CONTENT

INDUSTRIAL WATER POLLUTION CONTROL		**Semester:**	V	**Course Code**	CE – 512A
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**			60 Marks
		Duration of ESE:			03 Hours
		Internal Sessional Exam (ISE) CA:			40 Marks
Unit–I:	**No. of Lectures: 09 Hours**		**Marks: 12**		

Introduction to Industrial Wastewater

Industrial growth and water pollution scenario, Sources of industrial wastewater, Characteristics of industrial effluents (Physical, Chemical, Biological), Sampling and analysis techniques, Environmental impacts of industrial discharge

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Physical and Chemical Treatment Methods

Preliminary treatment: Screening, grit removal & equalization,, Primary treatment: Sedimentation, flotation, Chemical treatment: Coagulation and flocculation, Neutralization of acidic and alkaline wastes, Precipitation of heavy metals, Adsorption (Activated carbon), Membrane processes (UF, RO, NF)

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Biological Treatment of Industrial Wastewater

Aerobic treatment processes (Activated sludge, Trickling filters), Anaerobic treatment processes (UASB reactor),Lagoons and oxidation ponds, Nutrient removal (Nitrification– Denitrification), Biological treatment of high-strength industrial wastewater, Sludge handling and disposal

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Treatment of Effluents from Specific Industries

Textile industry wastewater treatment, Tannery industry effluent treatment, Pulp and paper industry wastewater, Sugar and distillery wastewater, Dairy and food processing industry, Chemical and pharmaceutical industry effluents, Case studies of Effluent Treatment Plants (ETP)

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Advanced Treatment & Sustainable Practices

Advanced oxidation processes (AOP), Ion exchange process, Zero Liquid Discharge (ZLD) systems, Resource recovery from wastewater, Water reuse and recycling in industries, Cleaner production and waste minimization, Industrial wastewater management planning

Text Books:

1. Industrial Water Pollution Control – W. Wesley Eckenfelder, McGraw-Hill (3rd Edition). A classic textbook focused specifically on industrial wastewater sources, characterization, and control methods.

2. Waste Water Treatment for Pollution Control – Soli J. Arceivala& S.R. Asolekar, Tata

McGraw-Hill. Practical engineering approach to wastewater treatment design.

3. Environmental Engineering – G.N. Pandey& G.C. Carney. Covers fundamentals of environmental systems including industrial pollution control.

4. Industrial Waste Water Source Control – Nancy Rilkmen& Clay Jones. Focuses on process source control and treatment.

5. Pollution Control in Process Industries – S.P. Mahajan. Industrial-specific pollution control strategies.

Reference Books:

1. Principles of Industrial Waste Treatment – C. Fred Gurnham. Broad intro to industrial wastewater treatment methods.
2. Industrial Water Pollution and Its Management – ShraddhaPandey& Shiv Shankar Dhuria (Walnut Publications). Good overview of industrial impacts and mitigation strategies.
3. Handbook of Environment and Waste Management: Air and Water Pollution Control – Lawrence K. Wang, Nazih K. Shammas, Yung-tse Hung. Useful as a general reference for pollution control methods including case studies.
4. Water & Wastewater Technology – Mark J. Hammer & Mark J. Hammer Jr. (John Wiley). Includes industrial aspects within broader wastewater treatment context.
5. Industrial Waste (Industrial Waste Engineering) – M.N. Rao& A.K. Dutta (CBS Publishers). A detailed look at industrial waste treatment engineering.
6. **Industrial and Hazardous Waste Treatment** – N.L. Nemerow& A. Dasgupta. Focus on treatment and management of hazardous industrial effluents.

NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc24_ce53/preview
2. https://onlinecourses.nptel.ac.in/noc26_ce72/preview
3. https://onlinecourses.nptel.ac.in/noc26_ch50/preview

INDUSTRIAL WATER POLLUTION CONTROL LAB (PCC)					
LAB COURSE CONTENT					
INDUSTRIAL WATER POLLUTION CONTROL LAB (PCC)		**Semester:**	V	**Course Code**	CE – 513A
Teaching Scheme:		**Examination scheme**			
Practical:	2 Hours/Week	**Internal Continuous Assessment (ICA) CA:**		25 Marks	
		End Semester Exam (ESE) UA:		25 Marks (OR)	

LIST OF PRACTICAL (Any five practical should be performed.)

1. Determination of pH and Electrical Conductivity of Industrial Wastewater
2. Determination of Total Solids (TS), TDS and TSS
3. Determination of Chemical Oxygen Demand (COD)
4. Determination of Biochemical Oxygen Demand (BOD_5)
5. Jar Test for Coagulation–Flocculation
6. Adsorption Study using Activated Carbon
7. Determination of Oil and Grease in Industrial Effluent

Guide lines for ICA:

Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.

Guide lines for ESE:

ESE will be based on practical/assignments submitted by the students in the form of journal/drawing sheet. Evaluation will be based on oral, paper work and performance in the ESE.

AIR POLLUTION (PCC)					
COURSE OUTLINE					
Course Title:	AIR POLLUTION	**Short Title:**	AP	**Course Code: Theory**	CE-614A

Course Description:

This course introduces the fundamental principles of air pollution, its sources, transport, transformation, monitoring, control, and management. It covers atmospheric chemistry, dispersion modeling, air quality standards, control technologies, and environmental regulations. The course also emphasizes sustainable practices and recent advances in air pollution mitigation relevant to civil and environmental engineers.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite course(s):

Nil

Course Objectives:

The objective of this course is to:

1. To understand the sources and types of air pollutants and their effects.
2. To study atmospheric processes governing pollutant dispersion and transformation.
3. To learn techniques for air quality monitoring and modeling.
4. To understand design principles of air pollution control equipment.
5. To familiarize students with air quality standards, legislation, and management strategies.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Identify sources and classify air pollutants.
2. Explain atmospheric chemistry and meteorological influences on pollution dispersion.
3. Analyze air quality data using monitoring and modeling techniques.
4. Design basic air pollution control devices for particulate and gaseous pollutants.
5. Apply environmental regulations and management practices for sustainable air quality control.

COURSE CONTENT

AIR POLLUTION		**Semester:**	VI	**Course Code**	CE – 614A
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 Hours/Week**	**End Semester Exam (ESE) UA:**			60 Marks
		Duration of ESE:			03 Hours

		Internal Sessional Exam (ISE) CA:	40 Marks
Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**	
Introduction to Air Pollution Definition and scope, Sources and classification of air pollutants, Primary and secondary pollutants Effects of air pollution on health, vegetation, materials, and climate, Air pollution episodes (e.g., Great Smog of London), Global issues: Greenhouse effect, Ozone depletion			
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**	
Meteorology and Atmospheric Dispersion Structure and composition of atmosphere, Atmospheric temperature lapse rate, Wind patterns and atmospheric stability, Plume behavior and dispersion, Gaussian plume model, Mixing height and inversion			
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**	
Air Quality Monitoring and Modeling Ambient air quality standards (e.g., National Ambient Air Quality Standards), Sampling and analysis of particulate matter (PM_{10}, $PM_{2.5}$), Monitoring instruments and techniques, Air Quality Index (AQI) Emission inventory, Basics of air quality modeling software			
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**	
Control of Particulate and Gaseous Pollutants Control of particulates, Settling chambers, Cyclone separators, Fabric filters (baghouse), Electrostatic precipitators, Wet scrubbers, Control of gaseous pollutants: Absorption, Adsorption, Condensation, Combustion			
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**	
Air Pollution Management and Legislation Air pollution control strategies, Indoor air pollution, Vehicular emissions and control technologies, Environmental Impact Assessment (EIA), Air (Prevention and Control of Pollution) Act, 1981, Role of regulatory bodies like Central Pollution Control Board			
Text Books:			
1. M.N. Rao and H.V.N. Rao, Air Pollution, Tata McGraw Hill Publishing Co. 2. K.V.S.G. Murali Krishna**,** Air Pollution and Control, Kaushal& Co. 3. C.S. Rao, Environmental Pollution Control Engineering, Wiley Eastern Ltd.			

Reference Books:

1. Wark and Warner, Air Pollution: Its Origin and Control, Harper & Row.
2. Arthur C. Stern, Air Pollution (Vol I–VIII), Academic Press.
3. David H.F. Liu and Bela G. Liptak, Air Pollution, Lewis Publishers.
4. Noel de Nevers, Air Pollution Control Engineering, McGraw Hill.

NPTEL Links:

1. https://nptel.ac.in/courses/105105107
2. https://nptel.ac.in/courses/120104009
3. https://nptel.ac.in/courses/105107123
4. https://nptel.ac.in

<table>
<tr><th colspan="6">AIR POLLUTION LAB (PCC)</th></tr>
<tr><th colspan="6">LAB COURSE CONTENT</th></tr>
<tr><td colspan="2">AIR POLLUTION LAB (PCC)</td><td>Semester:</td><td>VI</td><td>Course Code</td><td>CE – 615A</td></tr>
<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td rowspan="2">Practical:</td><td rowspan="2">2 Hours/week</td><td colspan="3">Internal Continuous Assessment (ICA) CA:</td><td>25 Marks</td></tr>
<tr><td colspan="3">End Semester Exam (ESE) UA:</td><td>25 Marks (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL- (Any five practical should be performed.)
1. Determination of Suspended Particulate Matter (SPM) using High Volume Sampler
2. Determination of $PM_{2.5}$ concentration using Fine Particulate Sampler
3. Estimation of Sulphur Dioxide (SO_2) in ambient air
4. Estimation of Nitrogen Oxides (NOx) in ambient air
5. Measurement of stack emission velocity and flow rate
6. Determination of Noise Level using Sound Level Meter
7. Study of performance of cyclone separator model</td></tr>
<tr><td colspan="6">Guide lines for ICA:</td></tr>
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Kavayitri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Third Year Bachelor of Engineering

In

(Civil)

(As per NEP 2020 Guidelines)

Faculty of Science and Technology

(Specialization Minor in Structural Design)

'A' Grade
NAAC Re-Accredited
(4th Cycle)

COURSE OUTLINE FOR
For Affiliated Colleges for
Minors Degree
W.E.F. 2026 – 27

Syllabus Structure for Specialization Minor in Structural Design**: Additional Credit (Semester – V) (w.e.f. 2026 – 27)**
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE-512B	Civil Engineering Materials and Concrete	PCC	3			3	40	60			100	3
CE-513B	Civil Engineering Materials and Concrete Lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Specialization Minor in Structural Design**: Additional Credit (Semester – VI) (w.e.f. 2026 – 27)**
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE-614B	Design of Concrete Structures	PCC	3			3	40	60			100	3
CE-615B	Design of Concrete Structures Lab	PCC			2	2			25	25 (OR)	50	1

CIVIL ENGINEERING MATERIALS AND CONCRETE (PCC)					
COURSE OUTLINE					
Course Title:	CIVIL ENGINEERING MATERIALS AND CONCRETE	**Short Title:**	CEMC	**Course Code: Theory**	CE-512B

Course Description:

This course provides a comprehensive understanding of construction materials used in civil engineering with special emphasis on concrete technology. It covers the properties, testing, selection, and applications of traditional and modern construction materials such as cement, aggregates, steel, bitumen, and concrete. The course also includes concrete mix design, durability, special concretes, and quality control practices. The aim is to equip students with both theoretical knowledge and practical insights required for material selection and concrete construction in infrastructure projects.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. To understand the physical, chemical, and mechanical properties of construction materials.
2. To study the manufacturing process and testing of cement and aggregates.
3. To understand fresh and hardened concrete behavior.
4. To learn concrete mix design principles as per standards.
5. To explore durability, special concretes, and modern advancements in materials.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Identify and evaluate different construction materials.
2. Perform laboratory tests on cement, aggregates, and concrete.
3. Design concrete mixes as per codal provisions.
4. Analyze durability and performance of concrete structures.
5. Recommend suitable materials for specific engineering applications.

COURSE CONTENT

CIVIL ENGINEERING MATERIALS AND CONCRETE		**Semester:**	V	**Course Code**	CE – 512B
Teaching Scheme:		**Examination scheme**			
Lectures:	3 Hours/Week	**End Semester Exam (ESE) UA:**			60 Marks
		Duration of ESE:			03 Hours
		Internal Sessional Exam (ISE) CA:			40 Marks

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Construction Materials

Classification of construction materials, Stones: Types, properties, tests, and uses, Bricks and blocks: Manufacturing, properties, tests, Aggregates: Classification, grading, properties, Steel: Types, properties, stress-strain behavior, Timber: Properties and uses

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Cement

1. Manufacturing of Ordinary Portland Cement
2. Chemical composition and Bogue's compounds
3. Types of cement (OPC, PPC, PSC, etc.)
4. Physical tests: Fineness, consistency, setting time, soundness, strength
5. Storage and handling of cement

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Fresh and Hardened Concrete

Ingredients of concrete, Water-cement ratio and Abram's law, Workability: Factors affecting workability, Tests on fresh concrete (Slump, Compaction factor, Vee-Bee), Strength of concrete: Compressive, tensile, flexural strength, Modulus of elasticity, Creep and shrinkage

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Concrete Mix Design and Durability

1. Objectives of mix design
2. Mix design as per IS 10262
3. Factors affecting durability
4. Permeability and corrosion of reinforcement
5. Quality control and acceptance criteria
6. Non-destructive testing (Rebound hammer, UPV)

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Special Concretes and Modern Materials

1. High strength concrete

2. High performance concrete
3. Self-compacting concrete (SCC)
4. Fiber reinforced concrete
5. Lightweight concrete
6. Geopolymer concrete
7. Green building materials

Text Books:

1. Properties of Concrete – A.M. Neville
2. Concrete Technology – M.S. Shetty
3. Concrete Technology – M.L. Gambhir
4. Building Materials – S.K. Duggal

Reference Books:

1. Design of Concrete Mixes – N. Krishna Raju
2. Concrete Microstructure Properties and Materials – P. Kumar Mehta & P.J.M. Monteiro
3. Advanced Concrete Technology – Zongjin Li

NPTEL Links:

1. https://nptel.ac.in/courses/105102012
2. https://nptel.ac.in/courses/105106176
3. https://nptel.ac.in/courses/105102088

<table>
<tr><th colspan="6">CIVIL ENGINEERING MATERIALS AND CONCRETE LAB (PCC)</th></tr>
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<tr><td colspan="2">CIVIL ENGINEERING MATERIALS AND CONCRETE LAB (PCC)</td><td>Semester:</td><td>VI</td><td>Course Code</td><td>CE – 513B</td></tr>
<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td rowspan="2">Practical:</td><td rowspan="2">2 Hours/Week</td><td colspan="3">Internal Continuous Assessment (ICA) CA:</td><td>25 Marks</td></tr>
<tr><td colspan="3">End Semester Exam (ESE) UA:</td><td>25 Marks (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL (Any five practical should be performed.)
1. Sieve Analysis of Aggregates
2. Specific Gravity and Water Absorption of Aggregates
3. Consistency and Setting Time of Cement (Vicat Test)
4. Slump Test of Fresh Concrete
5. Compressive Strength Test of Concrete
6. Compaction Test (Proctor Test)
7. Flexural Strength Test of Concrete (Beam Test)</td></tr>
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DESIGN OF CONCRETE STRUCTURES (PCC)					
COURSE OUTLINE					
Course Title:	**DESIGN OF CONCRETE STRUCTURES**	**Short Title:**	**DCS**	**Course Code: Theory**	**CE-614B**

Course Description:

This course introduces principles and practice of designing reinforced concrete structural elements. It covers behavior of concrete and reinforcing steel under various loads, design philosophies (working stress and limit state methods), and design of structural members such as beams, slabs, columns, footings, and stairs, primarily as per IS 456:2000 provisions.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	03	14	45	03
Practical	02	14	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. Understand basic mechanics and behavior of reinforced concrete elements.
2. Learn design philosophies and methods for concrete structures.
3. Design fundamental reinforced concrete members subjected to flexure, shear, and axial forces.
4. Apply relevant Indian Standards (e.g., IS 456:2000 and SP16).
5. Develop ability to solve real-world structural design problems.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Analyze reinforced concrete elements under bending, shear, and combined forces.
2. Design singly and doubly reinforced beams using proper design procedures.
3. Design slabs, columns, footings, and staircases per limit state principles.
4. Evaluate serviceability requirements such as deflection and cracking.
5. Interpret and apply relevant codes in structural design.

COURSE CONTENT

DESIGN OF CONCRETE STRUCTURES		**Semester:**	VI	**Course Code**	CE- 614B
Teaching Scheme:		**Examination scheme**			
Lectures:	3 Hours/Week	**End Semester Exam (ESE) UA:**			60 Marks
		Duration of ESE:			03 Hours
		Internal Sessional Exam (ISE) CA:			40 Marks

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**
Introduction & Design Philosophies Properties of concrete and steel, Methods of design (Working Stress vs. Limit State), Fundamentals of Reinforced Concrete behavior, Design codes and specifications (IS 456:2000, SP16), Load combinations and basic design steps		
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**
Flexural & Shear Design of Beams Limit state of collapse — flexure, Design of singly reinforced beams, Doubly reinforced beams, Shear and diagonal tension design, Bond and development length considerations		
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**
Design of Slabs 1. One-way slab design 2. Two-way slab design 3. Analysis methods (Moment coefficient method) 4. Redistribution of moments and serviceability limits		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Compression Members & Footings 1. Design of short and slender columns 2. Axial and combined bending design 3. Design of isolated footings and foundations 4. Interaction diagrams and eccentric loads		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Staircase & Serviceability Requirements 1. Design of dog-leg and straight flight staircases 2. Serviceability — deflection, cracking, durability 3. Detailing for ductility and earthquake considerations 4. Design examples and case studies		
Text Books:		
1. "Design of Concrete Structures" – J.N. Bandyopadhyay, Prentice-Hall of India. 2. "Limit State Design of Reinforced Concrete" – P.C. Varghese, Prentice Hall. 3. "Reinforced Concrete Design (Limit State Method)" – A.K. Jain, Nem Chand & Bros.		

Reference Books:

1. Reinforced Concrete Design – S. Unnikrishna Pillai & Devdas Menon.
2. IS 456:2000 – Code of Practice for Plain and Reinforced Concrete (Bureau of Indian Standards).
3. SP16 – Design Aids for Reinforced Concrete to IS 456**.**
4. "Reinforced Concrete: Limit State Design" – N. Krishna Raju.

NPTEL Links:

1. https://nptel.ac.in/courses/105105105/
2. https://archive.nptel.ac.in/courses/105/105/105105105/

<table>
<tr><th colspan="6">DESIGN OF CONCRETE STRUCTURES LAB (PCC)</th></tr>
<tr><th colspan="6">LAB COURSE CONTENT</th></tr>
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<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td rowspan="2">Practical:</td><td rowspan="2">2 Hours/Week</td><td colspan="3">Internal Continuous Assessment (ICA) CA:</td><td>25 Marks</td></tr>
<tr><td colspan="3">End Semester Exam (ESE) UA:</td><td>25 Marks (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL (Any five practical should be performed.)
1. Compression Test on Concrete Cubes/Cylinders – Determining compressive strength of concrete.
2. Tensile Strength Test (Split Cylinder Test) – Measuring indirect tensile strength of concrete.
3. Flexural Strength Test on Concrete Beams – Studying bending behavior and modulus of rupture.
4. Workability Test of Fresh Concrete (Slump Test) – Assessing ease of placement and consistency.
5. Mix Design of Concrete – Calculating and preparing concrete mixes for target strength.
6. Concrete Curing and Strength Development – Observing strength gain over different curing periods.
7. Non-Destructive Testing (NDT) of Concrete – Using rebound hammer or ultrasonic pulse velocity to evaluate concrete quality.</td></tr>
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Kavayitri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Third Year Batchelor of Engineering

In

(Civil)

(As per NEP 2020 Guidelines)

Faculty of Science and Technology

(**Specialization Minor in Building Science and Planning)**

COURSE OUTLINE FOR
For Affiliated Colleges for
Minors Degree
W.E.F. 2025 – 26

Syllabus Structure for Specialization Minor in Building Science and Planning**: Additional Credit (Semester – V) (w. e. f. 2026 – 27)**
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE-512C	Building Construction Technology	PCC	3			3	40	60			100	3
CE-513C	Building Construction Technology Lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Specialization Minor in Building Science and Planning**: Additional Credit (Semester – VI) (w. e. f. 2026 – 27)**
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
CE-614C	Green Building	PCC	3			3	40	60			100	3
CE-615C	Green Building Lab	PCC			2	2			25	25 (OR)	50	1

BUILDING CONSTRUCTION TECHNOLOGY (PCC)					
COURSE OUTLINE					
Course Title:	BUILDING CONSTRUCTION TECHNOLOGY	**Short Title:**	BCT	**Course Code: Theory**	CE-512C

Course Description:

Building Construction Technology focuses on the principles, materials, methods, and practices used in the construction of residential, commercial, and industrial buildings. The course covers traditional and modern construction techniques, structural and non-structural components, green building concepts, building services integration, and emerging construction technologies. Emphasis is given to practical construction details, site practices, and sustainability in building projects.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. To understand building components and their functional requirements.
2. To learn construction techniques for substructure and superstructure.
3. To study different types of building materials and finishes.
4. To understand services integration (water supply, sanitation, electrical, HVAC).
5. To introduce sustainable and modern construction technologies.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Explain building components and construction sequences.
2. Illustrate construction details of foundations, walls, roofs, floors, and stairs.
3. Select appropriate materials and finishes for buildings.
4. Integrate building services into construction planning.
5. Apply modern and sustainable construction technologies in projects.

COURSE CONTENT

BUILDING CONSTRUCTION TECHNOLOGY		**Semester:**	VI	**Course Code**	CE – 512C
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**			60 Marks

	Duration of ESE:	03 Hours
	Internal Sessional Exam (ISE) CA:	40 Marks

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction & Building Materials

Overview of building construction process, Building planning and site selection, Soil investigation basics, Types of foundations (shallow & deep foundations),

Building materials: Bricks, cement, lime, sand, aggregates, Mortars and concrete basics, Construction site practices and safety

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Substructure and Superstructure

Excavation and earthwork, Foundation construction (isolated, combined, raft, pile), Plinth, DPC (Damp Proof Course), Load-bearing structures, Framed structures (RCC & Steel), Masonry construction (brick, stone, block)

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Floors, Roofs, Doors, Windows & Finishes

1. Roof types (flat, pitched, shell roofs)
2. Doors, windows, ventilators (materials & fittings)
3. Plastering and pointing
4. Painting and surface finishes
5. False ceilings and partitions

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Building Services

1. Water supply systems
2. Sanitation and drainage
3. Electrical installations
4. HVAC basics
5. Fire safety systems
6. Elevators and escalators basics

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Modern & Sustainable Construction Practices

1. Green building concepts
2. Sustainable materials
3. Precast and prefabricated construction
4. Modular construction

5. Building Information Modeling (BIM)
6. Smart buildings and energy-efficient design

Text Books:

1. Building Construction – Arora&Bindra
2. Building Construction – S.C. Rangwala
3. Building Construction – Sushil Kumar

Reference Books:

1. Construction Technology – Roy Chudley
2. Building Materials – S.K. Duggal
3. ArchiCAD and BIM Handbook – BIM Reference Guide

NPTEL Links:

1. https://nptel.ac.in/courses/105102088
2. https://nptel.ac.in/courses/105104160
3. https://nptel.ac.in
4. https://nptel.ac.in

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<tr><td colspan="2">BUILDING CONSTRUCTION TECHNOLOGY LAB</td><td>Semester:</td><td>V</td><td>Course Code</td><td>CE – 512C</td></tr>
<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td rowspan="2">Practical:</td><td rowspan="2">2 Hours/Week</td><td colspan="3">Internal Continuous Assessment (ICA) CA:</td><td>25 Marks</td></tr>
<tr><td colspan="3">End Semester Exam (ESE) UA:</td><td>25 Marks (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL (Any five practical should be performed.)
1. Study of Foundations (Shallow and Deep Foundations)
2. Brick Masonry Construction (English Bond & Flemish Bond)
3. Stone Masonry – Types and Construction Method
4. Concrete Mixing and Casting Procedure
5. Formwork (Shuttering) – Types and Installation
6. Reinforcement Detailing in RCC Members
7. Damp Proof Course (DPC) – Materials and Methods
8. Flooring Types and Laying Techniques
9. Roof Construction – Flat Roof and Sloping Roof</td></tr>
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GREEN BUILDING (PCC)					
COURSE OUTLINE					
Course Title:	GREEN BUILDING	**Short Title:**	GB	**Course Code: Theory**	CE-614 C

Course Description:

This course introduces the principles, practices, and technologies involved in the planning, design, construction, and operation of green buildings. It emphasizes sustainable site planning, energy efficiency, water conservation, sustainable materials, indoor environmental quality, and green building rating systems such as Indian Green Building Council (IGBC), Leadership in Energy and Environmental Design (LEED), and Building Research Establishment Environmental Assessment Method (BREEAM). The course integrates environmental, economic, and social aspects of sustainability with civil engineering practices.

	Hours/Week	No. of Weeks	Total Hours	Semester Credits
Theory	03	15	45	03
Practical	02	15	30	01

Prerequisite Course(s):

Nil

Course Objectives:

The objective of this course is to:

1. Understand the concept and principles of sustainable development in construction.
2. Analyze environmental impacts of conventional buildings.
3. Apply energy-efficient and water-efficient strategies in buildings.
4. Select sustainable building materials and technologies.
5. Understand green building rating systems and certification processes.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Explain the principles and need for green buildings.
2. Evaluate sustainable site planning and resource efficiency techniques.
3. Design basic energy-efficient and water-efficient building systems.
4. Assess building materials based on life cycle analysis.
5. Interpret green building rating systems and certification procedures.

COURSE CONTENT

GREEN BUILDING		**Semester:**	VI	**Course Code**	CE- 614 C
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 hours/week**	**End Semester Exam (ESE) UA:**			60 Marks
		Duration of ESE:			03 Hours

		Internal Sessional Exam (ISE) CA:	40 Marks
Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**	
Introduction to Green Buildings Concept of Sustainability and Sustainable Development, Environmental impact of buildings Principles of Green Building, Benefits of Green Buildings (Environmental, Economic, Social), Global trends in green construction			
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**	
Sustainable Site Planning and Water Management 1. Site selection criteria 2. Sustainable landscaping 3. Stormwater management 4. Rainwater harvesting systems 5. Water-efficient fixtures and grey water reuse 6. Heat island effect mitigation			
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**	
Energy Efficiency and Renewable Energy 1. Energy consumption in buildings 2. Building orientation and passive design 3. Daylighting techniques 4. Energy-efficient HVAC systems 5. Renewable energy integration (Solar, Wind) 6. Energy modeling basics			
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**	
Sustainable Materials and Indoor Environmental Quality 1. Life Cycle Assessment (LCA) 2. Green building materials 3. Recycled and locally available materials 4. Low-VOC materials 5. Indoor air quality standards 6. Thermal and acoustic comfort			
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**	

Green Building Rating Systems and Case Studies

1. Overview of IGBC Rating System
2. LEED Rating System
3. BREEAM Rating System
4. GRIHA Rating System
5. Documentation and Certification process
6. Case studies of green buildings in India and worldwide

Text Books:

1. Kibert, C.J. – Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons.
2. ArvindKrishan et al. – Climate Responsive Architecture, Tata McGraw Hill.
3. Charles J. Kibert – Green Buildings: Principles and Practices in Residential Construction, Wiley.

Reference Books:

1. Gevorkian, P. – Green Building Design and Construction, McGraw Hill.
2. Ross Spiegel &Dru Meadows – Green Building Materials: A Guide to Product Selection and Specification, Wiley.
3. IGBC Reference Guide – Latest Version, Indian Green Building Council.
4. GRIHA Manual – TERI Publication.

NPTEL Links:

1. https://nptel.ac.in/courses/124107011
2. https://nptel.ac.in/courses/121106014
3. https://nptel.ac.in/courses/108105058
4. https://nptel.ac.in/courses/120108004

<table>
<tr><th colspan="6">GREEN BUILDING LAB (PCC)</th></tr>
<tr><th colspan="6">LAB COURSE CONTENT</th></tr>
<tr><td colspan="2">GREEN BUILDING LAB</td><td>Semester:</td><td>VI</td><td>Course Code</td><td>CE– 615C</td></tr>
<tr><td colspan="2">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td>Practical:</td><td>2 Hours/Week</td><td colspan="3">Internal Continuous Assessment (ICA) CA:</td><td>25 Marks</td></tr>
<tr><td></td><td></td><td colspan="3">End Semester Exam (ESE) UA:</td><td>25 Marks (OR)</td></tr>
<tr><td colspan="6">LIST OF PRACTICAL (Any five practical should be performed.)
1. Green Building Materials & Sustainable Construction Lab
2. Energy-Efficient Building Systems Practice
3. Sustainable Architecture Laboratory
4. Eco-Friendly Construction Techniques Lab
5. Renewable Energy Integration in Buildings Lab
6. Green Building Design & Simulation Practice
7. Water Conservation & Waste Management Lab
8. Environmental Performance Testing Lab
9. Climate-Responsive Building Design Studio
10. Sustainable Building Technology & Innovation Lab</td></tr>
<tr><td colspan="6">Guide lines for ICA:</td></tr>
<tr><td colspan="6">Students must perform each practical and submit ICA in the form of journal. Each assignment/design/drawing should be well documented. Faculty in charge will assess the journal/assignments continuously and grade or mark each assignment on completion date declared for each practical/assignment/design.</td></tr>
<tr><td colspan="6">Guide lines for ESE:</td></tr>
<tr><td colspan="6">ESE will be based on practical/assignments submitted by the students in the form of journal/drawing sheet. Evaluation will be based on oral, paper work and performance in the ESE.</td></tr>
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