THIRD YEAR
SYLLABI
2023 SCHEME

B.Tech
Civil Engineering

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

(AUTONOMOUS)

Mar Ivanios Vidyanagar, Nalanchira, Thiruvananthapuram – 695 015

May 2025

DETAILED SYLLABI OF THIRD YEAR

FOR

B. TECH. DEGREE PROGRAMME

IN

CIVIL ENGINEERING

SEMESTERS V & VI

2023 SCHEME

(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)
(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)
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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)

DEPARTMENT OF CIVIL ENGINEERING

B. TECH DEGREE PROGRAMME
IN
CIVIL ENGINEERING

DETAILED SYLLABI OF THIRD YEAR

Items	Board of Studies (BoS)	Academic Council (AC)
Date of Approval	02-05-2025	28-05-2025

Head of the Department
Chairman, Board of Studies

Principal
Chairman, Academic Council

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)

Vision and Mission of the Institution

Vision:

To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:

To transform the Youth as technically competent, ethically sound and socially committed professionals, by providing a vibrant learning ambience for the welfare of humanity.

DEPARTMENT OF CIVIL ENGINEERING

Vision and Mission of the Department

Vision:

To be a Centre of Excellence in Civil Engineering education with a global perspective, creating ethically strong engineers for the service of society.

Mission:

To provide Engineering Education which can create exemplary professional Civil Engineers of high ethics with strong conceptual foundation coupled with practical insight, to serve the industry and community.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduates of the Programme will have a successful career as Civil Engineering practitioners, entrepreneurs or professionals, addressing the needs of the industry with a global perspective.

PEO2: They will contribute to society as ethical and responsible citizens with proven expertise

PEO3: They will engage in continuous professional development and advance to leadership roles in their chosen career.

PROGRAMME OUTCOMES (POs)

Engineering graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: Provide feasible and sustainable solutions to problems in various Civil Engineering disciplines such as Structural, Environmental, Geo technical, Transportation and Construction Engineering.

PSO2: Apply the principles, methods, software and codes of practices to design various Civil Engineering Systems.

CURRICULUM THIRD YEAR

SEMESTER V							
Slot	**Category**	**Course Code**	**Courses**	**L-T-P-J**	**SS**	**Hours**	**Credit**
A	PCC	23CEL30A	Design of Reinforced Concrete Structures	3-0-0-0	5	3	3
B	PCC	23CEJ30B	Applications of Artificial Intelligence in Civil Engineering	2-0-0-1	4	3	3
C	PCC	23CEL30C	Soil Mechanics	3-1-0-0	5	4	4
D	PCC	23CEL30D	Transportation Engineering	3-0-0-0	5	3	3
E	PCC	23CEJ30E	Quantity Surveying and Valuation	3-0-0-2	7	5	5
F	PEC	23CEL31X	Program Elective I	3-0-0-0	5	3	3
S	PCC	23CEP30A	Material Testing Lab II	0-0-3-0	2	3	2
T	PCC	23CEP30B	Transportation Engineering Laboratory	0-0-3-0	2	3	2
M/ H	VAC		Minor/Honours Course	3-0-0-0	5	3	3
				TOTAL	**35/40**	**27/30**	**25/28**

Program Elective I							
Slot	**Category**	**Course Code**	**Courses**	**L-T-P-J**	**SS**	**Hours**	**Credit**
F	PEC	23CEL31A	Advanced Concrete Technology	3-0-0-0	5	3	3
F	PEC	23CEL31B	Structural health monitoring and retrofitting	3-0-0-0	5	3	3
F	PEC	23CEL31C	Geotechnical Investigation	3-0-0-0	5	3	3
F	PEC	23CEL31D	Mechanics of Fluid Flow	3-0-0-0	5	3	3
F	PEC	23CEL31E	Air Quality Management	3-0-0-0	5	3	3
F	PEC	23CEL31F	Urban and Regional Transportation Planning	3-0-0-0	5	3	3
F	PEC	23CEL31G	Advanced Materials And Sustainable Construction Practices	3-0-0-0	5	3	3

SEMESTER VI							
Slot	**Category**	**Course Code**	**Courses**	**L-T-P-J**	**SS**	**Hours**	**Credit**
A	PCC	23CEL30F	Design of Steel Structures	3-1-0-0	5	4	4
B	PCC	23CEL30G	Foundation Engineering	3-0-0-0	5	3	3
C	PEC	23CEL32X	Program Elective II	3-0-0-0	5	3	3
E	IEC	23IEL31X	Institute Elective I	3-0-0-0	5	3	3
F	HSC	23HSL30A	Business Economics and Accountancy	3-0-0-0	5	3	3
S	PCC	23CEP30C	Geotechnical Engineering Laboratory	0-0-3-0	2	3	2
T	PCC	23CEP30D	Design Studio II	0-0-3-0	2	3	2
U	PWS	23CES38A	Seminar	0-0-4-0	2	4	2
M/ H	VAC		Minor/Honours Course	3-0-0-0	5	3	3
				TOTAL	**31/36**	**26/29**	**22/25**

Program Elective II							
Slot	**Category**	**Course Code**	**Course Name**	**L-T-P-J**	**SS**	**Hours**	**Credit**
C	PEC	23CEL32A	Advanced Structural Analysis	3-0-0-0	5	3	3
C	PEC	23CEL32B	Prestressed Concrete	3-0-0-0	5	3	3
C	PEC	23CEL32C	Ground Improvement Techniques	3-0-0-0	5	3	3
C	PEC	23CEL32D	Applied soil Engineering	3-0-0-0	5	3	3
C	PEC	23CEL32E	Applied Hydrology	3-0-0-0	5	3	3
C	PEC	23CEL32F	Municipal Solid Waste Management	3-0-0-0	5	3	3
C	PEC	23CEL32G	Traffic Flow Modelling	3-0-0-0	5	3	3

	Institute Elective I						
Slot	**Category**	**Course Code**	**Courses**	**L-T-P-J**	**SS**	**Hours**	**Credit**
E	IEC	23IEL31A	Green Building and Energy Management	3-0-0-0	5	3	3
E	IEC	23IEL31B	Engineering Project Management	3-0-0-0	5	3	3
E	IEC	23IEL31C	Disaster Mitigation and Management	3-0-0-0	5	3	3
E	IEC	23IEL31D	Environmental Impact Assessment and Life Cycle Analysis	3-0-0-0	5	3	3

SEMESTER VII							
Slot	**Category**	**Course Code**	**Courses**	**L-T-P-J**	**SS**	**Hours**	**Credit**
A	PCC	23CEJ40B	Traffic Engineering and Management	3-0-0-2	7	5	5
B	PEC	23CEL43X	Program Elective III	3-0-0-0	5	3	3
C	PCC	23CEB40B	Construction Project Management	3-0-2-0	6	5	4
E	IEC	23IEL42X	Institute Elective II	3-0-0-0	5	3	3
T	PWS	23CEV48A	Comprehensive Course Viva	0-0-2-0	1	2	1
U	PWS	23CEJ48A	Project	0-0-10-0	10	10	5
		23CEI48A	Internship*				
H	VAC		Honours Course	3-0-0-0	5	3	3
M	VAC		Minor Course	0-0-6-0	6	3	3
			TOTAL		**34/39/40**	**28/31**	**21/24**

* Students can opt for Internship either in S7 or S8. However, in S7, the internship can be permitted only if there are no pending Programme/Course requirements in the semester, that need to be completed in College in the offline mode, such as laboratory sessions.

MINOR BASKET

Semester	Basket I				Basket II				Basket III			
	Infrastructure Development and Management				Environmental and Water Resource Engineering				Transportation Engineering			
	Course Code	Course	L-T-P-J	Credits	Course Code	Course	L-T-P-J	Credits	Course Code	Course	L-T-P-J	Credits
S3	23CEL2MA	Building Information Modelling	3-0-0-0	3	23CEL2MC	Climate Change and Disaster Mitigation	3-0-0-0	3	23CEL2ME	Traffic Engineering	3-0-0-0	3
S4	23CEL2MB	Infrastructure Health Monitoring	3-0-0-0	3	23CEL2MD	Watershed Management	3-0-0-0	3	23CEL2MF	Urban Transportation Planning	3-0-0-0	3
S5	23CEL3MA	Infrastructure Project Management	3-0-0-0	3	23CEL3MC	Air Pollution and Control Techniques	3-0-0-0	3	23CEL3ME	Traffic Flow Theory and Modelling	3-0-0-0	3
S6	23CEL3MB	Performance and Risk Assessment of Infrastructure Systems	3-0-0-0	3	23CEL3MD	Integrated Waste Management for Smart Cities	3-0-0-0	3	23CEL3MF	Transportation and logistics management	3-0-0-0	3
S7/ S8	23CEJ4MA	Mini Project	0-0-6-0	3	23CEJ4MC	Mini Project	0-0-6-0	3	23CEJ4ME	Mini Project	0-0-6-0	3

Semester	Basket IV				Basket V			
	Virtual Reality and Automation Technologies in Construction				Engineering Project Management			
	Course Code	Course	L-T-P-J	Credits	Couse Code	Course	L-T-P-J	Credits
S3	23CEL2MG	Infrastructure Management with Informatics	3-0-0-0	3	23CEL2MI	Advanced Project Management	3-0-0-0	3
S4	23CEL2MH	Construction Automation and Robotics	3-0-0-0	3	23CEL2MJ	Building Information Modelling in Management	3-0-0-0	3
S5	23CEL3MG	Machine Learning for Construction Automation	3-0-0-0	3	23CEL3MI	Contract Management	3-0-0-0	3
S6	23CEL3MH	Virtual Reality in Construction	3-0-0-0	3	23CEL3MJ	Quality, Risk and Safety Management	3-0-0-0	3
S7/ S8	23CEJ4MG	Mini Project	0-0-6-0	3	23CEJ4MI	Mini Project	0-0-6-0	3

HONOURS BASKET

Semester	Basket I				Basket II				Basket III			
	Course Code	Course	L-T-P-J	Credits	Course Code	Course	L-T-P-J	Credits	Course Code	Course	L-T-P-J	Credits
S4	23CEL2HB	Advanced Mechanics of Solids	3-0-0-0	3	23CEL2HD	Environmental Pollution Control Techniques	3-0-0-0	3	23CEL2HF	Geographical Information System	2-0-2-0	3
S5	23CEL3HA	Modern Construction Materials	3-0-0-0	3	23CEL3HC	Groundwater Hydrology	3-0-0-0	3	23CEL3HE	Pavement Construction and Management	3-0-0-0	3
S6	23CEL3HB	Finite Element Method	3-0-0-0	3	23CEL3HD	Environmental Pollution Modelling	3-0-0-0	3	23CEL3HF	Transportation System Management	3-0-0-0	3
S7	23CEL4HA	Structural Dynamics	3-0-0-0	3	23CEL4HC	Earth Dams and Earth Retaining Structure	3-0-0-0	3	23CEL4HE	Soil Dynamics and Machine Foundation	3-0-0-0	3
S8	23CEJ4HB	Mini Project	0-0-6–0	3	23CEJ4HD	Mini Project	0-0-6–0	3	23CEJ4HF	Mini Project	0-0-6–0	3

SEMESTER 5

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL30A	DESIGN OF REINFORCED CONCRETE STRUCTURES	PCC	3	0	0	0	3	2023

i) PRE-REQUISITE: 23ESL10B APPLIED MECHANICS, 23CEL20A MECHANICS OF STRUCTURES

ii) COURSE OVERVIEW

This course is aimed to provide the fundamental concepts in reinforced concrete design and enable students to design and detail reinforced concrete structural members such as beams, slabs, columns and footings. The course also provides an introduction to analysis of prestressed concrete structures and concepts of earthquake resistant design.

iii) COURSE OUTCOMES

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

CO 1	Explain the fundamental concepts and codal provisions for limit state design, earthquake resistant design and ductile detailing design of concrete members for various requirements.	Understand
CO 2	Solve the ultimate capacity of reinforced concrete sections in bending, shear, compression, and torsion.	Apply
CO 3	Design structural elements such as beams, slabs, stairs, columns, and footings using relevant IS code provisions and provide its detailing.	Analyze
CO 4	Analyze prestressed concrete sections in order to determine the loss of prestress in members.	Analyze

iv) SYLLABUS

Introduction to methods of design, Types of limit states; Introduction to ductile detailing and earthquake resistant design.

Analysis and design of beams - rectangular beams - singly reinforced, doubly reinforced, cantilever beam; concept of flanged beams.

Concept of Bond and development length and torsion.

Design of slabs - one-way and two-way action of slabs, flat slabs; Stair cases.

Limit state of collapse by compression, Columns - short columns, long columns - design using SP16 charts for limit state.

Foundations - classification - design of isolated footings.

Introduction to Prestressed concrete – concept, loss of prestress; Special RC structures.

v) a) TEXTBOOKS

1. B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, R. C. C. Designs, 10th edition, Laxmi Publications Ltd., 2015, ISBN: 978-8131809426.
2. P. C. Varghese, Limit State Design of Reinforced Concrete, 2nd edition, Prentice Hall of India Pvt Ltd, 2017, ISBN: 978-8120320390.

3. S. K. Duggal, Earthquake Resistant Design of Structures, 2nd edition, Oxford University Press, 2013, ISBN: 0198083528.
4. H. J. Shah and S. N. Sinha, Reinforced Concrete Vol. II, 12th edition, Charotar Publishing House Pvt. Ltd., 2021, ISBN: 9385039485.
5. Praveen Nagaraj, Prestressed Concrete Design, 1st edition, Pearson, 2013, ISBN: 9332513754.

b) CODES OF PRACTICE

1. IS 456: 2000, Indian Standard Plain and Reinforced Concrete - Code of practice, 4th Revision, Bureau of Indian Standards, New Delhi.
2. SP 16: 1980, Design Aids for Reinforced Concrete to IS 456: 1978, Bureau of Indian Standards, New Delhi.
3. IS 1343: 2012 (Reaffirmed 2022), Indian Standard Prestressed Concrete – Code of Practice, 2nd Revision, Bureau of Indian Standards, New Delhi.
4. IS 1893: (Part I) 2016, Indian Standard Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi.
5. IS 13920: 2016 (Reaffirmed 2021), Indian Standard Ductile Detailing of RCC Structures subjected to seismic forces- Code of practice, Bureau of Indian Standards, New Delhi

c) REFERENCES

1. S Unnikrishna Pillai and Devdas Menon, Reinforced Concrete Design, 4th edition, Tata McGraw Hill Book Co., 2021. ISBN: 9789354601026.
2. P. C. Varghese, Advanced Reinforced Concrete Design, 2nd edition, Prentice Hall of India Pvt Ltd, 2017. ISBN: 9788120327870.
3. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice Hall, 5th edition, 2011, ISBN: 978-81-203-2892-1.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Design Philosophies, Codal provisions of IS 456, IS 1893, IS 13920. Introduction to Limit State Design: Limit State of Collapse by flexure, shear and torsion: Assumptions - stress-strain relationship of steel and concrete; Types of sections - balanced, under reinforced, over reinforced sections, Moment of resistance. Limit state of Serviceability: classification (concept only). Ductile Detailing for earthquake resistant design: Significance of ductility in earthquake resistant design. Design of beams: Analysis and design of singly reinforced rectangular beams – detailing.	**12**

II	Design of beams: Analysis and design of doubly reinforced beams, design of cantilever beam – detailing; Design examples on Torsion. Design of slabs: Introduction - one-way and two-way action of slabs - load distribution in a slab - IS recommendations for design of slabs - Design of one-way slab, two-way slabs – detailing.	**9**
III	Staircase: Types, distribution of loads – codal provisions – Concepts of tread-riser type stairs (detailing only), Design of dog legged stair – detailing. Limit State of Collapse by compression: Columns - Introduction, classification - short column, slender column; IS specifications – Design of axially loaded short columns - design examples with rectangular ties and helical reinforcement.	**8**
IV	SP16 charts for limit state of collapse by compression: Analysis and design of short columns subjected to compression and uniaxial bending, biaxial bending moments-code procedure for design. Slender columns (concept only) Foundations: Classification - IS code provisions for design of isolated footings - Design principles of rectangular footings- detailing, Combined footings (design principles only)	**9**
V	Special RC elements: Flanged beams, flat slabs, retaining walls (concept only). Introduction to Prestressed Concrete: Types, Codal Provisions, Analysis of prestressed concrete sections, Loss of prestress, Analysis of prestressed concrete beams.	**9**
	Total hours	**45**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

IX) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEJ30B	Applications of Artificial Intelligence in Civil Engineering	PCC	2	0	0	1	3	2023

i) COURSE OVERVIEW

The goal of this course is to introduce the applications of Artificial Intelligence (AI) in Civil Engineering. It covers foundational concepts of artificial intelligence and machine learning techniques, focusing on real-world applications in civil engineering. The project component enhances practical skills to solve domain-specific challenges using AI.

ii) COURSE OUTCOMES

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

CO 1	Explain the concepts of Artificial Intelligence	Understand
CO 2	Apply supervised and unsupervised models for predictions and forecasting data	Apply
CO 3	Solve real world problems using deep learning models	Apply
CO 4	Apply AI models for solving Civil Engineering problems with data visualisation	Apply

iii) SYLLABUS

Introduction to Artificial Intelligence: History of AI. Intelligent agents- agents and Environment, Structure of agent's programs, General AI workflow.

Supervised Machine Learning: Basics of Machine Learning, Regression and classification models- linear regression, logistic regression, support vector models. Introduction to neural networks, Performance evaluation.

Unsupervised learning- Dimensionality Reduction- Principal Component Analysis, Clustering- Types, Clustering algorithms. Clustering Performance Evaluation Measures.

Deep learning applications- Generic deep learning modelling framework for civil engineering applications. Applications of Artificial Neural Networks (ANN), Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN). Perception and multilevel perception.

AI Applications and Data-Driven Visualizations- Data Science Process, ML implementation using Python, MATLAB, or R. Visualization tools - Tableau, Power BI. Case studies on civil engineering applications.

Capstone Project Topics: Structural Health Monitoring-Crack detection using CNNs, Water Resources & Hydrology-Rainfall-runoff prediction using LSTM, Transportation Engineering-Traffic volume/speed prediction, signal optimization with ML and Pavement condition

assessment, Geotechnical Engineering-Soil classification, Slope stability prediction, Construction Management- Project delay prediction, Resource planning and forecasting. Remote Sensing-Land use classification from satellite images and energy consumption prediction.

iv) a) TEXTBOOKS

1) Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, 4th edition, Pearson Education, 2022, ISBN: 9781292401133
2) Ethem Alpaydin, Introduction to Machine Learning, 4th edition, MIT Press, 2020, ISBN: 9780262043793
3) Ian Goodfellow, Yoshua Bengio & Aaron Courville, Deep Learning, 1st edition, MIT Press, 2016, ISBN: 9780262035613
4) Rakesh K. Jain, Prashant S. Dhotre, Deepak T. Mane & Parikshit N. Mahalle, Data Science for Civil Engineering: A Beginner's Guide, 1st edition, CRC Press, 2023, ISBN: 9781032327808

b) REFERENCES

1) Aurelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, 3rd edition, O'Reilly Media, 2022, ISBN: 9789355421982
2) Sivanandam & S. N. Deepa, Principles of Soft Computing, 2nd edition, Wiley, 2011, ISBN: 9788126527410
3) Marco Cremonini, Data Visualization in R and Python, 1st edition, Wiley, 2024. ISBN: 9781394289516
4) Cole Nussbaumer Knaflic, Storytelling with Data: Lets practise, 1st Edition, Wiley, 2019, ISBN: 9781119621492

V) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Artificial Intelligence:** Foundation and History of AI. Intelligent agents- agents and Environment, concept of rationality, Nature of Environments- Properties and classification, Specifying the task environment. Structure of agents-Types, agent programs. Overview of the AI Process-General AI workflow.	9
II	**Introduction to Machine Learning:** Basics of Machine Learning (ML)-types of Machine Learning Systems and Challenges. **Supervised learning**- Regression Techniques- Linear Regression, Multiple linear Regression, Polynomial Regression (concepts only), Decision Tree Regression (concepts only). Classification techniques (Basic concepts only)- Logistic Regression, Support Vector Machines. Application in prediction, Relevant case studies.	9
III	**Unsupervised learning-** Dimensionality Reduction- Need, Principal Component Analysis, Clustering- Basic concepts,	9

	Types of Clustering, similarity/dissimilarity measures. Clustering algorithms - K-means algorithm, Hierarchical clustering (Basic concepts only), Density-based clustering (Basic concepts only). Performance Evaluation Measures – Clustering. Relevant case studies.	
IV	**Deep learning applications-** Differences between Machine learning and deep learning, Generic deep learning modelling framework for civil engineering applications. Applications of Artificial Neural Networks (ANN) in deep learning. Convolutional Neural Networks (CNN) (Basic concepts only)– for image processing and spatial data applications, Recurrent Neural Networks (RNN) (Basic concepts only)- Applications on time series data. Perception and multilevel perception, Relevant case studies.	**9**
V	**AI Applications and Data-Driven Visualizations-** Role of Statistics and ML in Data Science, Data Science Process, Statistics- Central Tendency, Dispersion, Correlation. ML implementation using Python, MATLAB, or R. Importance of Data Visualization, Visualization tools - Tableau, Power BI. Relevant case studies	**9**
	Total hours	**45**

VI) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 60: 40

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Project Work	:	20 marks
Total Continuous Assessment	:	**60 marks**
End Semester Examination	:	**40 marks**
TOTAL	:	**100 marks**

VII) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours

Topics	:	2 ½ modules

VIII) END SEMESTER EXAMINATION

Maximum Marks	:	40
Exam Duration	:	2 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL30C	SOIL MECHANICS	PCC	3	1	0	0	4	2023

i) PRE-REQUISITE: 23ESL10B Applied Mechanics

ii) COURSE OVERVIEW

To introduce students to the fundamental concepts of soil origin, classification, and engineering properties, including permeability, shear strength, consolidation, and compaction. The course also covers key aspects of structural geology relevant to foundation design.

iii) COURSE OUTCOMES

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

CO 1	Explain the fundamentals of geological and geotechnical properties of soil origin, structural geology of rocks, soil phase diagram, soil classification, index properties and engineering properties of the soil	Understand
CO 2	Apply the concept of permeability to determine the filtration capacity of soil	Apply
CO 3	Apply the concept of Mohr – Coulomb failure criteria to determine the shear strength parameters of the soil	Apply
CO 4	Apply the concept of one-dimensional consolidation to determine the behaviour of soil deformation and predict the rate of settlement of foundations.	Apply
CO 5	Apply the concept of compaction, to determine a suitable field compaction method and calculate relative compaction in the field.	Apply

iv) SYLLABUS

Origin of soil, Soil and rock types of Kerala, Major soil deposits of India, Introduction to soil mechanics, soil properties.

Index properties of soil, Engineering properties of soil, permeability of soil, effective stress principle, problems due to water in soil, Geological processes by rivers.

Shear strength of soil, discussion on various methods to determine shear strength.

Compressibility and Consolidation in soil, Terzaghi's theory of one-dimensional consolidation, practical applications.

Compaction of soil, Structural Geology.

v) a) TEXTBOOKS

1) Braja, M. Das, "Principles of Geotechnical Engineering", 10th Edition, Cengage India Private Limited; 2022. ISBN-13: 978-0357420478
2) Gopal Ranjan and Rao A.S.R., "Basic and Applied Soil Mechanics", 3rd Edition, New Age International (P) Ltd., New Delhi, 2016. ISBN-13: 978-8122440393

3) K.R. Arora, "Soil Mechanics & Foundation Engineering", 7th Edition, Standard Publishers, Distribution, 2009 (Reprint 2017). ISBN-13: 978-8180141126

4) B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, "Soil Mechanics and Foundation Engg.", 17th Edition, Laxmi Publications Co., New Delhi, 2017. ISBN-13: 978-8170087915

b) CODES OF PRACTICE

1) IS: 1498 - 1970 (Reaffirmed 2021), Classification and Identification of Soils for General Engineering Purposes, 1st Revision, Bureau of Indian Standards, New Delhi.

2) IS: 2720 (Part 1 to 41) - Methods of Tests for Soil, Bureau of Indian Standards, New Delhi. (Only relevant codes)

c) REFERENCES

1) VNS Murthy, "Textbook of Soil Mechanics and Foundation Engineering: Geotechnical Engineering series", CBS publishers, 2015. ISBN-13: 978-8123913629

2) Jonathan Knappett, R.F. Craig, "Soil Mechanics", 9th edition, CRC press, Taylor and Francis Group, New York, 2019. ISBN - 9781138070066

3) T.W. Lambe, R.V. Whitman, "Soil Mechanics", Reprint, John Wiley & Sons, New York, 2012, ISBN-13: 978- 8126539918

V) COURSE PLAN

Module	Contents	No. of hours
I	**Origin of soil** - Surface process of earth - Weathering of rocks – Rock Cycle – soil and rock types of Kerala, Major soil deposits of India Introduction to soil mechanics - Basic soil properties - Void ratio, porosity, degree of saturation, air content, percentage air voids, moisture content, specific gravity, unit weight - Relationship between basic soil properties and phase diagram - numerical problems.	**12**
II	Index properties – particle size analysis – sieve analysis - sedimentation analysis (no derivation required for percentage finer and diameter) - Stoke's law – grading of soils – numerical problems - Relative density. Consistency - Atterberg Limits - Practical Applications - Sensitivity – Thixotropic - numerical problems - I.S. classification of soils. Permeability of soils - Darcy's law – Factors affecting permeability - Practical Applications - Constant head and falling head permeability tests - Average permeability of stratified deposits (no derivation required) - numerical problems. Effective Stress Concept – pore water pressure - liquefaction Problems created by groundwater to civil engineering structures, effect of water table - Methods to control groundwater problems Geological processes by rivers – Landslides - types, causes and	**14**

	controlling measures	
III	Shear strength of soils - Practical Applications – Mohr - Coulomb failure criterion – Mohr circle method for determination of principal planes and stresses- numerical problems – relationship between shear parameters and principal stresses [no derivation required]. Numerical problems Brief discussion of direct shear test, tri-axial compression test [UU Test], unconfined compression test and vane shear test	**12**
IV	Compressibility and Consolidation - Terzaghi's theory of one-dimensional consolidation (no derivation required) - average degree of consolidation – Time factor - Coefficient of consolidation - Square root of time and logarithm of time fitting methods - Numerical problems Void ratio versus pressure relationship – Coefficient of compressibility and volume compressibility – Compression index Change in void ratio method - Height of solids method - Normally consolidated, under consolidated and over consolidated states - Estimation of pre consolidation pressure. Practical Applications - Estimation of magnitude of settlement of normally consolidated clays - Numerical problems	**12**
V	Compaction of soils - Standard Proctor, Modified Proctor, I.S. light & Heavy Compaction Tests – Determination of MDD and OMC - Zero Air voids line. Field compaction methods - Control of compaction - numerical problems Structural Geology – Attitude of rocks – Dip and Strike. Terminology, brief classification and Engineering significance of folds, faults and joints.	**10**
	Total hours	**60**

VI) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

VII) CONTINUOUS ASSESSMENT TEST

No. of Test	:	2
Maximum Marks	:	30 marks
Test Duration	:	1.5 hours
Topic	:	2.5 module

VIII) END SEMESTER EXAMINATION

Maximum Marks	:	**60 marks**
Exam Duration	:	3 Hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL30D	TRANSPORTATION ENGINEERING	PCC	3	0	0	0	3	2023

i) COURSE OVERVIEW

The goal of this course is to introduce students to the fundamental concepts of Highway, Railway, Airway, Harbour, and Tunnel Engineering. It covers the geometric design of highways, railways and airport runway, and the design of flexible and rigid pavements. An introduction to the features of docks and harbours and to the concepts of tunnelling is included in the course.

ii) COURSE OUTCOMES

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

CO1	Apply Indian standard specifications and guidelines to design geometric elements of highways and railway tracks.	Apply
CO2	Apply appropriate techniques for axle load analysis and material characterization for the design of pavements.	Apply
CO3	Design flexible and rigid pavements in accordance with Indian guidelines.	Apply
CO4	Explain the key features of docks and harbours, and the fundamental concepts of tunnelling.	Understand
CO5	Apply standard specifications to carry out the geometric design of an airport runway.	Apply

iii) SYLLABUS

Introduction to Transportation Engineering, Geometric design of highways – Design controls and criteria, Design of highway cross-section elements, Sight distance, Design of horizontal and vertical alignment and integration of the design elements.

Introduction to flexible and rigid pavement – Analysis of axle load data and volume count for pavement design, Material characterization for pavement design, Design of flexible pavement by IRC:37-2018 and rigid pavement by IRC:58-2015, Use of relevant software for pavement design.

Railway Engineering – Component parts of a railway track and their functions, Geometric design of railway track.

Tunnel Engineering – Tunnel sections, surveying and alignment, Harbours – Break waters and Docks, Airways - Design of basic runway length and corrections required.

iv) a) TEXTBOOKS

1. S. K. Khanna, C. E. G. Justo and A. Veeraragavan, Highway Engineering, 10th edition, Nem Chand and Bros., 2018, ISBN: 13 – 978-8185240930.

2. S. C. Saxena and S. P. Arora, A Text Book of Railway Engineering, 7th edition, Dhanpat Rai Publications, 2015, ISBN: 13 – 978-9383182923.
3. Srinivasan R., Harbour, Dock & Tunnel Engineering, 28th edition, Charotor Publishing House Pvt. Ltd., 2016, ISBN: 13 – 978-9385039195.
4. S. K. Khanna, M. G. Arora and S. S. Jain, Airport Planning and Design, 6th edition, Nem Chand and Bros, 2012, ISBN: 13 – 978-8185240688.
5. Fred L. Mannering and Scott S Washburn, Principles of Highway Engineering and Traffic Analysis, 7th edition, Wiley, 2020, ISBN: 13 – 978-1119493969.

b) CODES OF PRACTICE

1. IS: 73 - 2013 (2013), Indian Standard Paving Bitumen – Specification, 4th revision, Bureau of Indian Standards, New Delhi.
2. IRC: 37 - 2018 (2018), Guidelines for the Design of Flexible Pavements, Indian Roads Congress, New Delhi. (Permitted in the examination hall).
3. IRC: 58-2015, Guidelines for the Design of Plain Jointed Rigid Pavements for Highways, Fourth revision, Indian Roads Congress, New Delhi, 2015. (Permitted in the examination hall).

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Transportation Engineering, Classification of roads, Typical cross sections of roads in urban and rural area, Requirements and factors controlling alignment of roads. **Geometric design of highways** – Design controls and criteria, Design of highway cross section elements, Sight distance – stopping sight distance, overtaking sight distance and intersection sight distance, Design of horizontal alignment and vertical alignment, Integration of design elements.	**9**
II	**Axle load analysis for pavement design –** Axle configuration, Discussion of IRC:3, Conduct and analysis of axle load survey, Concepts of equivalent single wheel load and equivalent wheel load factors, Directional distribution and lane distribution, Computation of load equivalency factors, vehicle damage factors, and equivalent standard axle load for design. **Material characterization for pavement design –** granular materials, bituminous mixture and paving quality concrete – measurement of CBR, modulus of subgrade reaction, resilient modulus, dynamic modulus and modulus of rupture.	**12**
III	**Stress analysis of flexible and rigid pavements.** **Pavement design –** Flexible pavement design using IRC37-2018 and rigid pavement design using IRC58-2015, Use of relevant software.	**12**

IV	**Railway engineering –** Components and their functions, Concept of gauges, Coning of wheels, Geometric design of railway track – Horizontal curves, radius, superelevation, cant deficiency. **Harbours** – Classification, features and requirements, Break waters – necessity, functions, and classification, Docks – Functions, Dry docks and wet docks.	**6**
V	**Airport Engineering** – Components of airport, Selection of site for airport, Runway orientation – wind rose diagram, Basic runway length and corrections required. **Tunnel Engineering** – Tunnel sections, Tunnel surveying and alignment, Transferring centre grade into tunnel.	**6**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEJ30E	QUANTITY SURVEYING AND VALUATION	PCC	3	0	0	2	5	2023

i) PRE-REQUISITE: 23ESP10C Design Studio I

ii) COURSE OVERVIEW

This course integrates project-based learning with essential knowledge of quantity surveying and valuation. It aims to provide students with practical exposure to the preparation of detailed estimates, rate analysis, and valuation through real/simulated construction projects. Students will engage in hands-on activities such as preparing BoQ, detailed estimates, and valuation reports while aligning with standard practices such as CPWD DSR and DAR.

iii) COURSE OUTCOMES

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

CO 1	Explain fundamental concepts of quantity surveying, estimation, and valuation including related terminologies and contract documents.	Understand
CO 2	Interpret drawings and specifications for quantity estimation and rate analysis.	Understand
CO 3	Apply CPWD DSR and DAR to analyze rates of various construction activities.	Apply
CO 4	Prepare detailed estimates, bar bending schedules (BBS), and bill of quantities (BoQ) for building and infrastructure projects.	Apply
CO 5	Explain concepts and processes involved in valuation, depreciation, and obsolescence.	Understand
CO 6	Apply different valuation methods to assess property value and prepare valuation reports.	Apply

iv) SYLLABUS

Introduction to Quantity Surveying, Types of Estimates, Contingencies, Work-charged Establishment, Introduction to CPWD Schedule of Rates (DSR) and Analysis of Rates (DAR) as per latest specifications, Detailed Estimation using Centre Line Method and Long wall–Short wall Method.

Preparation of Bill of Quantities (BoQ), Material Quantity Calculation for various construction works, Bar Bending Schedule (BBS), General and Detailed Specifications, Rate Analysis of key construction items.

Basics of Valuation, Depreciation, Obsolescence, and different methods of property valuation, integrated with project-based learning for hands-on experience in preparing estimates, rate analysis, and valuation reports for real or simulated construction projects.

v) a) TEXTBOOKS

1) Dutta, B. N., Estimation and Costing in Civil Engineering, UBS Publishers and Distributors Pvt. Ltd., 28th Edition, 2020.
2) Rangwala, Estimation Costing and Valuation, Charotar Publishing House Pvt. Ltd., 17th Edition, 2017.
3) Seetharaman, S. and Chinna Swami, M., Estimation and Quantity Surveying, Anuradha Publications, 2015.

b) REFERENCES

1) Patil, B. S., Civil Engineering Contracts and Estimates, Orient Blackswan Pvt. Ltd., 4th Edition, 2015.
2) Vazirani, V. N. and Chandola, S. P., Civil Engineering Estimation, Costing, and Valuation, Khanna Publishers, 6th Edition.
3) IS 1200: 1968, Methods of Measurement of Building and Civil Engineering Works, Bureau of India Standards, New Delhi, 1968.
4) CPWD, Analysis of Rates for Delhi - 2021, Central Public Works Department, New Delhi,2021.
5) CPWD, Delhi Schedule of Rates - 2021, Central Public Works Department, New Delhi, 2021.
6) CPWD, Specifications – Volumes 1 & 2, Central Public Works Department, New Delhi, 2019.

V) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Quantity survey, basic principle, Role/responsibility of Quantity surveyor, Estimate-List the types, Details required. Types of estimates, simple problems of approximate estimate, purpose. Contingencies, Work-charge establishment, Tools and Plant, centage charge, Day work, Prime cost, Provisional sum & provisional Quantity (Brief description only). Bill of Quantity (BoQ) -Typical format-use. Units of measurement of various materials and works. General rule & method of measurement with reference to Indian Standard Specifications IS1200. Introduction to the use of CPWD schedule of rates as per DSR (2023, Volume I & II) and Analysis of rate as per DAR (2023, Volume I & II), Overhead charges, Cost index. Project Task 1: Prepare approximate estimates for a given residential building project (in Excel). CPWD Schedule of Rates	**16**

	(DSR), Analysis of Rates (DAR), overheads, profit margin and cost index.	
II	Specifications-General specification of various items of building work. Detailed specification of major item of work like Earth work excavation in foundation, masonry, Reinforced cement concrete, finishing of building work with reference to CPWD specifications (2019, Volume I & II). Analysis of rates for Earth work in excavation for foundation, mortars, reinforced cement concrete. Works, finishing work, masonry work, stone works, flooring with reference to DSR and DAR (All data (Material, labour & machine) and rate will be given in the question paper). Project Task 2: Prepare rate analysis report of a specific work.	**16**
III	Preparation of detailed measurement and abstract of estimate using Centre line method & Short wall long wall (separate wall) method. Explain with a single room building example. Preparation of detailed measurement for RCC single storey buildings with stair cabin. Excavation for foundation, Foundation and basement, DPC, Masonry in superstructure, RCC, Plastering, Painting, flooring, Woodwork, Staircase. Preparation of BoQ of single storied RCC building. Material quantity calculation of the Rubble, Brick work, Concrete work, plastering in detailed estimate of RCC building (Data for unit quantity should be provided from DAR). Bar Bending Schedule (BBS) of RCC beams, slabs, Column footings, Retaining wall. Road estimation-Estimation of earthwork from longitudinal section. Estimation of sanitary and water supply work -Water tank, Septic tank, Manhole (Concept only). Introduction to Software tools: Application of software tools like Revit, CostX, Primavera, MS Project or Tally Prime in quantity estimation. Project Task 3: Prepare detailed estimate using any software tool, quantity take-off from a 2-D Autocad drawing/ Prepare detailed BBS from a structural drawing.	**28**
IV	Valuation –Purpose, factor affecting- Introduction to terms-Value, Cost, Price, Income- Gross income, net income, outgoings, annuity, sinking fund (Simple Examples), Year's purchase, Depreciation, obsolescence -Free hold and leasehold properties. Depreciation – methods of calculating depreciation– straight line method, constant percentage method, sinking fund method, and quantity survey method-numerical examples. Methods of valuation of land with building – rental method, direct comparison of capital cost, valuation based on profit, depreciation method. Various method of valuation of land (Brief description only)	**15**

	Project Task 4: Prepare a valuation report for a given property including depreciation calculation. Valuation methods: Rental, Direct comparison, Profit, and Depreciation method.	
	Total hours	**75**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 60: 40

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Project Work	:	20 marks
Total Continuous Assessment	:	**60 marks**
End Semester Examination	:	**40 marks**
TOTAL	:	**100 marks**

VII) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

VIII) END SEMESTER EXAMINATION

Maximum Marks	:	40
Exam Duration	:	2 hours

Course Code	Course Name	Category	L	T	P	J	Credit
23CEP30A	Material Testing Lab II	PCC	0	0	3	0	2

i) COURSE OVERVIEW

The course aims to familiarize the students with experimental evaluation of properties of the materials, their suitability for preparing a concrete mix and to evaluate the strength of concrete by destructive and non-destructive methods.

ii) COURSE OUTCOMES

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

CO 1	Interpret the quality of various construction materials as per IS codal provisions.	Apply
CO 2	Assess the mechanical properties of concrete and its constituent materials through experimental methods to determine their suitability for mix design and preparation.	Apply
CO 3	Utilize non-destructive testing methods to assess the hardened properties and quality of concrete.	Apply

iii) SYLLABUS

Testing of Cement, Tests on Coarse and Fine Aggregate, Tests on tiles, Tests on bricks, Concrete mix design by IS code method, Workability Tests on Concrete, Tests on hardened properties of concrete, Study on Non-destructive tests on hardened concrete.

IV) a) TEXTBOOKS

1) M.S. Shetty, Concrete Technology, Theory and Practice, S. Chand & Company, 2021.

2) A.M. Neville and J.J Brooks, Concrete Technology, Second edition, Pearson, 2019.

b) CODES OF PRACTICE

1) IS 1489 (Part 1): 2015, Specification for Portland Pozzolana Cement – Fly Ash Based (Fourth Revision), Reaffirmed in 2020.

2) IS 1489 (Part 2): 2015, Specification for Portland Pozzolana Cement – Calcined Clay Based (Fourth Revision), Reaffirmed in 2020

3) IS 269: 2015, Specification for Ordinary Portland Cement, 33 Grade (Sixth Revision), Reaffirmed in 2020.

4) IS 8112: 2013, Specification for Ordinary Portland Cement, 43 Grade, Reaffirmed in 2020.

5) IS 12269: 2013, Specification for Ordinary Portland Cement, 53 Grade, Reaffirmed in

2020.

6) IS 4031: 1988, Methods of Physical Tests for Hydraulic Cement, Reaffirmed in 2024.

7) IS 2386 (Part 1): 1963, Methods of Test for Aggregates for Concrete – Part 1: Particle Size and Shape.

8) IS 2386 (Part 3): 1963, Methods of Test for Aggregates for Concrete – Part 3: Specific Gravity, Density, Voids, Absorption, and Bulking.

9) IS 383: 2016, Specification for Coarse and Fine Aggregate from Natural Sources for Concrete (Third Revision). Reaffirmed in 2020.

10) IS 1199: 1959, Methods of Sampling and Analysis of Concrete.

11) IS 10262: 2019, Concrete Mix Proportioning – Guidelines.

12) IS 516 (Part 1): 2018, Methods of Tests for Strength of Concrete.

13) IS 13311 (Part 1): 2021, Non-Destructive Testing of Concrete – Rebound Hammer.

13) IS 13311 (Part 2): 2021, Non-Destructive Testing of Concrete – Ultrasonic Pulse velocity.

iv) COURSE PLAN

Experiment No.	Contents	No. of hours
1	Tests on cement: (a) Normal consistency (b) Setting time	**3**
2	Tests on Coarse and Fine Aggregates- (a) Grain size distribution (b) Specific gravity (c) Bulk Density (d) Void ratio and porosity	**6**
3	Tests on aggregate for concrete- Bulking of sand	**3**
4	Tests on tiles – dimension, transverse strength, water absorption.	**3**
5	Tests on bricks – crushing strength, water absorption and efflorescence.	**3**
6	Tests on cement: Compressive strength.	**3**
7	Concrete mix design by IS code method and casting of cubes, beams and cylinders with designed concrete mixes.	**6**
8	Tests on fresh concrete: Workability tests - (a) Slump test (b) Compaction factor test	**3**
9	Tests on fresh concrete: Study on Vee-bee Consistometer test and Flow table test.	**3**
10	Tests on hardened concrete: (a) Compressive strength of concrete cubes and cylinders (b) Modulus of Elasticity of concrete cylinders .	**3**
11	Tests on hardened concrete: (a)Split tensile strength test on concrete cylinders (b) flexure test on concrete beams.	**3**
12	Demonstrations/Virtual Lab: Demonstration/study of Non- Destructive Testing Equipment - Rebound hammer, ultrasonic pulse velocity and Rebar locator, Concrete core cutter, concrete penetrometer and crack detection microscope.	**3**
13	Internal Lab Test	**3**
	Total hours	**45**

v) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN:

Attendance	: 5 marks
Class work/ Assessment /Viva-voce	: 55 marks
Final Assessment	: 40 marks
Total	**: 100 marks**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEP30B	TRANSPORTATION ENGINEERING LABORATORY	PCC	0	0	3	0	2	2023

i) PRE-REQUISITE: 23CEL30D, Transportation Engineering

ii) COURSE OVERVIEW

This course aims to familiarize students with standard laboratory testing methods used to evaluate the properties of bitumen, determine its grading, and assess its suitability for pavement applications. It also covers the fundamentals of bituminous mix design, including the determination of optimal mixing and compaction temperatures. In addition, students will gain an introduction to techniques for evaluating the functional performance of pavements.

iii) COURSE OUTCOMES

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

CO 1	Apply standard test procedures to determine the grade of bitumen and its suitability for pavement construction.	Apply
CO 2	Estimate the mixing and compaction temperatures of bituminous mixes through material characterization.	Apply
CO 3	Apply Marshall method to design bituminous mixes.	Apply
CO 4	Apply appropriate evaluation techniques to assess the functional condition of pavements.	Apply

iv) SYLLABUS

Grade of bitumen – Specific gravity, Viscosity, Penetration, Softening point, Ductility.

Mixing and compaction temperature using viscosity-temperature relationship, measured using rotational viscometer.

Design of aggregate gradation for bituminous mixtures, Determination of bulk specific gravity of blended aggregates and compacted bituminous mixtures, Theoretical maximum specific gravity of loose bituminous mixtures, Determination of optimum binder content using Marshall method.

Evaluation of functional condition of pavements using Merlin.

v) a) CODES OF PRACTICES

1. IS: 1201 - 1978 to IS: 1220 - 1978 (2007), Edition 2.1 (1996-11), Indian Standard Methods for Testing Tar and Bituminous Materials, 1st Revision, Bureau of Indian Standards, New Delhi.
2. IS: 73 - 2013 (Reaffirmed 2018), Paving Bitumen Specification, 4th revision, Bureau of Indian Standards, New Delhi.

3. ASTM D4402/D4402-M-15 (2015), Standard Test Method for Viscosity Determination of Asphalt at Elevated Temperatures using a Rotational Viscometer, ASTM International, West Conshohocken, PA.
4. ASTM D6857 / D6857M – 18, Standard Test Method for Maximum Specific Gravity and Density of Asphalt Mixtures Using Automatic Vacuum Sealing Method, ASTM International, West Conshohocken, PA.
5. MS-2 Manual (2015), Asphalt Mix Design Methods, 7th edition, Asphalt Institute, USA.
6. IRC: SP:16-2004 (2004), Guidelines for Surface Evenness of Highway Pavements, 1st revision, Indian Roads Congress, New Delhi.
7. MoRTH (2013), Specification for Road and Bridge Works, 5th revision, Indian Roads Congress, New Delhi.

b) REFERENCES

1. S. K. Khanna, C.E.G. Justo, and A. Veeraragavan, Highway Materials and Pavement Testing, 5th edition, Nem Chand and Bros, 2013, ISBN: 9788185240589.

vi) COURSE PLAN

Exp. No.	List of Experiments	No. of hours
(a) Bitumen Type and its Use		
1	Penetration test	3
2	Softening point test	
3	Specific gravity test	3
4	Ductility test	
(b) Mixing and Compaction Temperature		
5	Determination of viscosity using rotational viscometer	3
6	Estimation of mixing and compaction temperatures of bitumen	3
(c) Tests on Aggregates		
7	Shape test	3
8	Crushing test	
9	Abrasion test	3
10	Impact test	
(d) Specific Gravity of Bituminous Mixes		
11	Determination of theoretical specific gravity of loose bituminous mix	6
12	Estimation of bulk specific gravity of compacted bituminous mixture	
(e) Bituminous Mix Design		
13	Stripping value test	3

14	Bituminous mix design using Marshall method	12
(f) Functional Condition of Pavements		
15	Pavement roughness evaluation using MERLIN	3
	Internal Lab Test	3
	Total hours	**45**

vii) ASSESSMENT PATTERN

Continuous Assessment : Final Lab Assessment – 100 : 0

Continuous Assessment		
Attendance	:	5 marks
Continuous Assessment in Lab (Lab work + Record + Viva-voce) 35 marks	:	55 marks
Internal Lab Test 20 marks	:	
Final Lab Examination	:	40 marks
TOTAL	**:**	**100 marks**

Final Lab Examination

Maximum Marks	:	40
Exam Duration	:	2 ½ hours

PROGRAM ELECTIVE I

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL31A	ADVANCED CONCRETE TECHNOLOGY	PEC	3	0	0	0	3	2023

i) PRE-REQUISITE: 23ESL10R BUILDING MATERIALS AND CONSTRUCTION MANAGEMENT

ii) COURSE OVERVIEW

This course is aimed at exposing the students to the fundamentals of properties of concrete materials, its testing procedures, various types of concretes, NDT of concrete and mix design. After this course, students will be able to determine the properties of concrete materials, testing of concrete and do a mix design based on requirement.

iii) COURSE OUTCOMES

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

CO 1	Explain the properties and testing procedure of concrete materials as per IS code and describe the rheology of concrete.	Understand
CO 2	Design concrete mix using IS Code.	Apply
CO 3	Identify durability related issues in concrete and suggest preventive measures.	Apply
CO 4	Make use of destructive and non-destructive testing methods to assess and determine the properties of concrete.	Apply
CO 5	Design and develop the self-compacting and high-performance concrete.	Apply

iv) SYLLABUS

Cement, Aggregate, Chemical Admixtures, Mineral admixtures, Rheology, Bingham model. Mix design, design of concrete mix as per IS 10262-2019, Statistical quality control of concrete. Properties of fresh concrete, Properties of hardened concrete, Creep, Shrinkage. Durability of concrete, Non-destructive testing of concrete surface hardness test. Special concretes, Special processes and technology.

v) a) TEXTBOOKS

1) A. M. Neville and J. J. Brooks, Concrete Technology, 2nd edition, Pearson Education, 2019. ISBN: 978-9332577460.
2) A. R. Santhakumar, Concrete Technology, 1st edition, Oxford University Press, 2018. ISBN: 978-0198061956.
3) M. S. Shetty and A. K. Jain, Concrete Technology, 3rd edition, S. Chand & Co., 2019. ISBN: 978-8121907375.

b) CODES OF PRACTICE

1) IS 1489 (Part 1): 2015, Portland Pozzolana Cement – Specification, Part 1 Fly Ash Based (Fourth Revision), Reaffirmed in 2020.

2) IS 1489 (Part 2): 2015, Portland Pozzolana Cement – Specification, Part2- Calcined Clay Based (Fourth Revision), Reaffirmed in 2020.
3) IS 269: 2015, Ordinary Portland Cement- Specification (Sixth Revision), Reaffirmed in 2020.
4) IS 8112: 2013, Ordinary Portland Cement, 43 Grade- Specification (Second Revision).
5) IS 12269: 2013, Ordinary Portland Cement, 53 Grade- Specification (First Revision).
6) IS 4031 (Part 1): 1996, Methods of Physical Tests for Hydraulic Cement (Second Revision), Reaffirmed in 2005.
7) IS 2386 (Part 1): 1963, Methods of Test for Aggregates for Concrete – Part 1: Particle Size and Shape, Reaffirmed in 2021.
8) IS 2386 (Part 3): 1963, Methods of Test for Aggregates for Concrete – Part 3: Specific Gravity, Density, Voids, Absorption, and Bulking, Reaffirmed in 2021.
9) IS 383: 2016, Specification for Coarse and Fine Aggregate from Natural Sources for Concrete (Third Revision).
10) IS 1199 (Part 1): 2018, Methods of Sampling, Testing and Analysis, Part 1- Sampling of Concrete (First Revision).
11) IS 1199 (Part 2): 2018, Methods of Sampling, Testing and Analysis, Part 2- Determination of Consistency of Concrete (First Revision).
12) IS 1199 (Part 5): 2018, Methods of Sampling, Testing and Analysis, Part 5- Making and Curing of Test Specimens, (First Revision).
13) IS 10262: 2019, Concrete Mix Proportioning – Guidelines (Second Revision).
14) IS 516 (Part 1) Section 1: 2021 Hardened Concrete- Methods of Tests (First Revision).
15) IS 516 (Part 5) Section 1: 2018 Hardened Concrete- Methods of Tests Part 5- Ultrasonic Pulse Velocity Testing (First Revision).
16) IS 516 (Part 5) Section 4: 2021 Hardened Concrete- Methods of Tests Part 5- Rebound Hammer Test (First Revision).

c) REFERENCES

1) A. M. Neville, Properties of Concrete, 5th edition, Trans-Atlantic Publications Inc., 2016. ISBN: 978-0131195662.
2) P. Kumar Mehta and Paulo J. M. Monteiro, Concrete: Microstructure, Properties, and Materials, 4thedition, McGraw-Hill Education, 2017. ISBN: 978-1259085811.
3) Peter C. Hewlett, Lea's Chemistry of Cement and Concrete, 5th edition, Butterworth-Heinemann Ltd., 2017. ISBN: 978-0081002047.

V) COURSE PLAN

Module	Contents	No. of hours
I	Cement– Manufacturing, Types of cement, Properties of Cement, Testing of Cement, Fine aggregates and coarse aggregates- Properties and testing, process of hydration, Chemical Admixtures- types, uses, mechanism of action, effects on properties of concrete, Mineral admixtures-types, chemical composition, physical characteristics, effects on properties of concrete, Rheology – basic concepts, Bingham model.	**9**
II	Mix design - nominal mix, design mix, concept of mix design, variables of proportioning, general considerations, factors considered in the design of concrete mix, various methods of mix design, design of concrete mix as per IS 10262-2019, Statistical quality control of concrete – mean strength, standard deviation, coefficient of variation, sampling, testing, acceptance criteria.	**9**
III	Properties of fresh concrete- workability, factors affecting workability, measurement of workability, Properties of hardened concrete - modulus of elasticity, compressive strength, split tensile strength, flexural strength, effect of water cement ratio, maturity concept, Creep - factors affecting creep, effect of creep. Shrinkage- factors affecting shrinkage, plastic shrinkage, drying shrinkage, autogenous shrinkage, carbonation shrinkage.	**9**
IV	Durability of concrete- Factors affecting durability, permeability, cracking, reinforcement corrosion, carbonation, chloride penetration, sulphate attack, acid attack, fire resistance, frost damage, alkali silica reaction, concrete in sea water, non- destructive testing of concrete - surface hardness test, ultrasonic pulse velocity method, penetration resistance, pull-out test core cutting, measuring reinforcement cover.	**9**
V	Special concretes - lightweight concrete, heavy weight concrete, high strength concrete, high performance concrete, self- compacting concrete, roller compacted concrete, fiber reinforced concrete, polymer concrete, pumped concrete, ready mix concrete - green concrete. Special processes and technology - sprayed concrete, underwater concrete, mass concrete. Types of failure - Diagnosis of distress in concrete, Crack control, leak proofing, Shotcrete, Guniting and jacketing techniques.	**9**
	Total hours	**45**

VI) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

VII) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

VIII) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL31B	STRUCTURAL HEALTH MONITORING AND RETROFITTING	PEC	3	0	0	0	3	2023

PRE-REQUISITE: 23ESL10R Building Materials and Construction Technology

i) COURSE OVERVIEW

Goal of this course is to understand structural monitoring for structures and to understand the conditional assessments and techniques for strengthening and retrofitting of structures.

ii) COURSE OUTCOMES

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

CO 1	Explain suitable Sensors & Instruments required in SHM for in-service performance of structures	Understand
CO 2	Identify the health of structures using different techniques of Structural health monitoring	Apply
CO 3	Identify suitable technique for structural condition assessment	Apply
CO 4	Examine the damage to structures using various techniques	Apply
CO 5	Choose the appropriate strengthening and retrofitting techniques to regain the structural health	Apply

iii) SYLLABUS

Introduction to SHM: Need, definition and concept of SHM, biometric comparison of SHM with NDT, procedure, objective and operational evaluation of SHM and its advantages. basics of Instrumentation and measurements, Various Types of Electromechanical, Electronics & Digital Instruments for SHM, Basics of Sensors, Transducers & Actuators, Classification of Sensors, Characteristics & Working Principles of Various Types of Sensors Concept of Smart Materials & Smart Structures with SHM, methodologies and monitoring principles for SHM, dynamic field testing, short- and long-term monitoring, Vibration Based SHM Techniques IoT Application in SHM, Artificial Intelligence & Machine Learning in SHM damage diagnosis assessment- aspects, procedure, visual inspection, and various methods of NDT structural Assessment & Retrofitting of Structures: introduction, principles, classification and levels of assessment, current scenario through case study. Concepts of repair and retrofitting of structures.

iv) a) TEXTBOOKS

1) Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring ISTE Ltd and John Wiley & Sons 2006. ISBN- 978-1-905209-01-9

2) Fu-Kuo Chang, Structural Health Monitoring, echnomic Publishing Company, 1st Edition, 1999.ISBN-13: 978-1566768818
3) Harish Chandra Arora, Hashem Jahangir, Damage Detection and Structural Health Monitoring of Concrete Structures, 1st Edition, 2023. ISBN 978-9819789740
4) Suresh Bhalla, Smart Materials in Structural Health Monitoring, Control and Biomechanics, 1st Edition, 2012. ISBN 978-3642244629

a) REFERENCES

1) Vistasp M. Karbhari, Durability of Composites for Civil Structural Applications, Woodhead Publishing, 1st Edition,2007. ISBN 978-1845690359
2) Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring, 1st Edition, 2006. ISBN 978-1905209019
3) Jiannong Cao, Wireless Sensor Networks for Structural Health Monitoring, 1st Edition 2011.ISBN: 978-3319290324
4) Feld, J. and Carper, K. L., *Construction Failures*, Wiley Europe (2008) ISBN: 978-0471574774

V) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to structural health monitoring (SHM): need of SHM, definition and concepts of SHM, SHM and Biometric comparison of SHM with non-destructive test, types, and components of SHM, procedure of SHM, objectives and operational evaluations of SHM, advantages of SHM. Instrumentations & Sensors for SHM Basics of Instrumentations & Measurements, Classifications, Various Types of Electromechanical, Electronics & Digital Instruments for SHM.	**9**
II	Basics of Sensors, Transducers & Actuators, Classification of Sensors, Characteristics & Working Principles of Various Types of Sensors like Strain Gauges, LVDT, Accelerometers etc. Concept of Smart Materials & Smart Structures with SHM, Basics of Smart Materials like Piezoelectric and Shape Memory Alloys. Methods of SHM Methodologies and Monitoring Principles, Local & Global Techniques for SHM, Static & Dynamic Field Testing, Short & Long-Term Monitoring, Active & Passive Monitoring.	**9**
III	Vibration Based SHM Techniques - Use & Demonstration of Dynamic Properties of Structures for Damage Detection & SHM, Ambient Vibration Test, Acoustic Emission Technique, Electromechanical Impedance Technique, Wave Propagation Based Techniques, Fibre	**9**

	Optics Based Techniques, Remote & Wireless SHM Techniques, IoT Application in SHM, Artificial Intelligence & Machine Learning in SHM. Damage Diagnosis assessment – various aspects of inspection, assessment procedure for evaluating a damaged structure, visual inspection, Non-destructive testing using rebound hammer, ultra sonic pulse velocity, Semi destructive testing, Probe test, Pull out test, Chloride penetration test, Carbonation, Carbonation depth testing; practical demonstration of damage diagnosis assessment tests.	
IV	Modern techniques of repair, rehabilitation and retrofitting of RCC and steel structures, use of chemicals in repair-application of polymers. Ferrocement and fibre concrete as rehabilitation materials. Structural Assessment & Retrofitting of Structures Structural Assessment & Need for retrofitting: Introduction to health assessment of structures, structural damages & failures, Principles of structural assessment, Classification & levels of assessment, Current scenario of infrastructure through case studies	**9**
V	Concept of repair & retrofitting of structures: Case studies of structural & foundation failure, performance problems, responsibility & accountability, causes of distress in structural members, design and material deficiencies, factors causing extensive Deterioration. Retrofitting of structures: Fundamental of retrofitting, Flow of retrofitting process, Methods of retrofitting, Materials for retrofitting (conventional and smart materials), selection of retrofitting methods	**9**
	Total hours	**45**

VII) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

VIII) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

IX) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL31C	GEOTECHNICAL INVESTIGATION	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

Goal of this course is to impart to the students a clear idea about how a geotechnical investigation program is to be planned and executed. After the completion of the course, students will be familiar with the principles of exploration, geophysical methods, modern methods of drilling, sampling and instrumentation.

ii) COURSE OUTCOMES

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

CO1	Explain the planning and execution of a geotechnical investigation programme.	Understand
CO2	Explain different sampling methods used in geotechnical investigation.	Understand
CO3	Interpret soil profile data to make decisions on geotechnical investigations, prepare bore logs and soil investigation reports.	Apply
CO4	Discuss the various methods of geotechnical investigation and the field tests to be conducted in different situations.	Understand
CO5	Discuss the geotechnical instrumentation to assess field behaviour of soil.	Understand

iii) SYLLABUS

Objectives of soil exploration – planning of a subsurface exploration programme – I.S. and other guidelines – Methods of exploration.

Disturbed and undisturbed soil sampling, representative samples – Sampling techniques – Bore log – Soil profile – Sub-soil investigation report.

Sounding methods – Procedure, Instrument, uses, limitations – Pressure meter test – Procedure, uses, limitations – setting up procedures.

Standard Penetration Test – Procedure, Numerical examples – Static Cone Penetration Test –Dynamic Cone Penetration Test –– Critical comparison of SPT, static CPT and dynamic CPT.

Static pile load test – Cyclic pile load test – Procedure, Instrumentation – Anchor pile load test Strain gauges – Earth pressure cell, Settlement gauges, Piezometers etc.

iv) a) TEXTBOOKS

1. Venkataramaiah, C. Geotechnical Engineering, Universities Press (India) Limited, Hyderabad, 6th edition, ISBN: 9788173719879, 2018.
2. Ranjan, G and Rao, A.S.R., Basic and Applied Soil Mechanics, New Age International (P) Limited, New Delhi, 3rd edition, ISBN: 9788122438755, 2016.

3. Dunnicliff, J. and Green, G. E., Geotechnical Instrumentation for Monitoring Field Performance, John Wiley & Sons, ISBN: 9781119223272, 2016.

b) REFERENCES

1. Look, B. G., Handbook of Geotechnical Investigation and Design Tables, Taylor & Francis Group, 2nd edition, ISBN: 9780415468503, 2014.
2. Purushothamaraj, P., Soil Mechanics and Foundation Engineering, Dorling Kindersley (India) Pvt. Ltd., ISBN: 9788131760437, 2013.
3. Das, B. M., Principles of Geotechnical Engineering, Cengage Learning Inc, 7th Edition, ISBN: 9780495668107, 2010.
4. Arora K.R., "Geotechnical Engineering", Standard Publishers Distributors, New Delhi, ISBN: 9788180141125, 2006.
5. Joseph E. Bowles, Foundation Analysis and Design, Mc. Graw Hill Inc., New York, ISBN: 9780070066102, 1988.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction and practical importance - Objectives of soil exploration – Planning of a subsurface exploration programme –Collection of existing information, reconnaissance, preliminary and detailed investigation - I.S. and other guidelines for deciding the number, size, spacing and depth of boreholes. Methods of exploration - Open pits – Auger boring- -Wash boring, percussion drilling, rotary drilling –Stabilization of bore holes.	**7**
II	Disturbed and undisturbed soil sampling, representative samples, Methods to minimize sample disturbance. Importance of area ratio, inside clearance, outside clearance, recovery ratio. Types of samplers – split spoon sampler, piston sampler, thin-walled sampler etc. Preservation and handling of samples. Rock core sampling, Rock Quality Designation, Core Recovery Ratio – Bore log – Soil profile – Sub-soil investigation report.	**8**
III	Geophysical methods – Seismic refraction method – Procedure, uses, limitations – Geode Seismograph - Solution of numerical problems to estimate the velocity of seismic waves and the thickness of upper layer of a two-layered soil system-Electrical resistivity method – Electrical profiling and electrical sounding – Procedure, uses, limitations – ABEM Terrameter LS 2, Pressure meter test - Procedure –Uses – limitations- Menard Pressure meter: Standard test device, pre-bored hole- setting up procedures.	**10**

IV	Standard Penetration Test – Procedure – corrections to be applied to observed N values – Procedure for estimation of representative average N value – Numerical examples. Static Cone Penetration Test – Procedure, Merits/drawbacks – Correlation of static CPT results with soil properties - Dynamic Cone Penetration Test – Procedure, Merits/drawbacks – Critical comparison of SPT, static CPT and dynamic CPT.	**8**
V	Static pile load test – procedure for estimation of safe load, Cyclic pile load test –Procedure for separation of end bearing and skin friction resistance-solution of numerical problems using static and cyclic pile load test data Instrumentation- Anchor pile load test- procedure for estimation of load-carrying capacity and performance of anchor piles under tensile or lateral loads, Strain gauges – resistance and inductive type, Earth pressure cell, Settlement gauges, Piezometers - Determination of vertical and horizontal displacements, Slope indicators, Inclinometers.	**12**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL31D	MECHANICS OF FLUID FLOW	PEC	3	0	0	0	3	2023

i) PRE-REQUISITE 23CEL20B FLUID MECHANICS AND HYDRAULICS

ii) COURSE OVERVIEW

This course introduces the fundamental principles and concepts of fluid flow in flow through pipes and open channels for solving Civil engineering problems. This course delves into the fundamental concepts and advanced analyses of boundary layers in fluid mechanics.

iii) COURSE OUTCOMES

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

CO 1	Explain the principles of potential flow and viscous flow	Understand
CO 2	Solve the problems of viscous flow and turbulent flow through pipes and pipe bends	Apply
CO 3	Make use of the principles and laws governing fluid flow to analyse flow in open channels	Apply
CO 4	Identify conditions leading to boundary layer separation and apply methods to control separation and reduce drag.	Apply

iv) SYLLABUS

Fluid flow: Types of fluid flow –Potential flow, Viscous flow – Shear stress – Laminar flow Turbulent flow , Moody's diagram, Hazen William's formula. Flow through pipe bends.
Open channel flow –spillway crest –Specific energy for channel transitions.
Rapidly varied steady flow –hydraulic jumps – Surges – water hammer.
Boundary Layer – Von- Karman momentum integral equations – calculation of drag separation of boundary .

v) a) TEXTBOOKS

1) V. L. Streeter, and E. B Wylie, Fluid Mechanics, McGraw Hill, 9th edition, ISBN-13: 978-0070622326 , 2017.
2) P.N. Modi and S.M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, 22nd edition, New Delhi, ISBN-13: 978-8189401269, 2020.
3) K Subramanya , Flow in Open Channels, Tata McGraw Hill, 5th edition, ISBN-13: 978-9353166342, 2019.
4) K. R. Arora Fluid Mechanics, Hydraulics and Hydraulic Machines, Standard Publishers, ISBN-13: 978-8180140709, 2020.

b) REFERENCES

1) Frank M. White and Henry Xue, Fluid Mechanics, McGraw Hill, 9th edition, ISBN-13: 978-1260258318, 2022.
2) James. A Fay. Introduction to Fluid Mechanics. Cambridge, MA: MIT Press. ISBN-13: 9780262061650,1994
3) Bruce R Munson, Donald F Young. Fundamentals of Fluid Mechanics, John Wiley & Sons, ISBN-13: 978-0471675822, 2011.
4) A.K Mohanty. Fluid Mechanics, Prentice Hall, New Delhi, ISBN-13: 978-8120308947, 2011.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Fluid flow: Types of fluid flow (Review) Potential flow-velocity potential, stream function, streamlines and equipotential lines, flow net-uses and limitations. Viscous flow – Reynold's experiment; Shear stress – pressure gradient relationship – Laminar flow through pipes (Hagen-Poiseuille Equations), laminar flow between stationary parallel plates.	**9**
II	Turbulent flow – Computation, velocity distribution, Head loss due to friction in pipes – Nikuradse experiment with artificially roughened pipe. Friction coefficient for laminar and turbulent flows, Moody's diagram, reduction of carrying capacity of pipes with age. Hazen William's formula. Flow through pipe bends – application of linear momentum principle.	**9**
III	Open channel flow – Hydraulic exponents and section factor for uniform and critical flow, Pressure distribution in curvilinear flows – spillway crest and spillway bucket. Comparison of discharge through compound channels. Application of Specific energy for channel transitions – hump and reduction in channel width.	**9**
IV	Rapidly varied steady flow – hydraulic jumps – types based on tail water conditions; Uses of hydraulic jumps for energy dissipation below spillways – jump height curve; tail water curve. Unsteady flow through open channels – Surges – positive surges and concept of negative surges; Transients in pipes – water hammer.	**10**

V	Boundary Layer : Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, Von- Karman momentum integral equations for the boundary layers, calculation of drag, separation of boundary and methods of control.	**8**
	Total hours	**45**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

ix) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL31E	AIR QUALITY MANAGEMENT	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

The goal of this course is to introduce students to the fundamental aspects of air pollution, air quality monitoring and air pollution control strategies. It motivates the students in maintaining and improving the air quality of the environment and empowers learners to take appropriate actions to reduce the air pollution for the benefit of the society.

ii) COURSE OUTCOMES

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

CO 1	Explain the sources, types and effects of indoor and outdoor air pollutants	Understand
CO 2	Identify the meteorological aspects of air pollutant dispersion and behaviour of plume	Apply
CO 3	Explain the different methods of ambient air quality monitoring system which supports an air quality management program	Understand
CO 4	Identify the various air pollution control strategies that can be undertaken to meet the air quality standards.	Apply

iii) SYLLABUS

Introduction- Air Pollutants, History of air pollution episodes, Sources, Types of air pollutants, Effects of air pollutants, Indoor air pollution

Meteorological aspects of Air Pollutant Dispersion, Inversions- Types, Atmospheric stability, Dispersion of air pollutants, Plume behaviour, Guassian Plume model

Air Quality Monitoring - Ambient air sampling - Ambient Air Quality standards- Air pollution indices, Emission Inventory

Control of Air Pollutants- Particulate emission control methods, Gaseous emission control methods, Case studies

iv) a) TEXTBOOKS

1) C.S. Rao, Environmental Pollution Control Engineering, New Age International (P) Ltd., Publishers, 4th edition, ISBN: 978-8122472288, 2021
2) M.N. Rao and H.V.N. Rao, Air Pollution, Tata McGraw Hill Education, 1st edition, ISBN: 978-0074518717, 2017

3) Roger D. Griffin, Principles of Air Quality Management, CRC Press, 2nd edition, ISBN: 978-0367577803, 2020

b) CODES OF PRACTICE

1. National Ambient Air Quality Standards, Central Pollution Control Board (CPCB), Government of India, 2009

c) REFERENCES

1) Zhang,Y.,Hopke,P.K., Mandin,C., Handbook of Indoor Air Quality, Springer Nature Singapore, ISBN: 978-9811676796, 2022

2) Mudakavi, J.R., Principles and Practices of Air Pollution Control and Analysis, IK International Publishing House Pvt. Ltd., ISBN: 978-9380026381, 2013

3) Bhatia, S.C., Textbook of Air Pollution and Its Control, Atlantic publishers, ISBN: 978-8126908257, 2021

4) Mahajan, S.P., Air Pollution Control, The Energy Resources Institute, TERI, ISBN:978-8179931868, 2009

V) COURSE PLAN

Module	Contents	No. of hours
I	Introduction- Definition of Air Pollution, History of air pollution episodes. Sources of Air pollution, Industrial Processes causing Air Pollution, Air Pollutants- Types of Air Pollutants- Criteria Pollutants- Hazardous air pollutants.	**9**
II	Effect of air pollutants on health, vegetation, animals, materials and atmosphere. Indoor Air Pollution- Sources of indoor air pollutants- Effects of indoor air pollution, Sick Building Syndrome, Control of Indoor air pollution.	**9**
III	Meteorological aspects of Air Pollutant Dispersion - Temperature and Pressure relationships. Atmospheric Stability- Temperature Lapse Rate, Inversions- Types Plume behaviour, Dispersion of Air pollutants-Plume dispersion theory- Gaussian plume model - Assumptions- Advantages and Disadvantages, Pasquill's stability curves. Box Model for Indoor Air Pollution.	**9**
IV	Air quality monitoring - Ambient air sampling methods- Collection of gaseous air pollutants-Collection of particulate pollutants. Instrumentation for air quality monitoring- gas analyzers, PM monitors. Air pollution indices, Emission inventory, Ambient Air Quality	**9**

	standards.	
V	Control of Air Pollutants- Particulate emission control methods, Scrubbing - Cyclones - Filtration- Electrostatic Precipitation Gaseous emission control methods - adsorption, absorption, thermal methods. Air pollution control towers. Case studies on air pollution control technologies.	**9**
	Total hours	**45**

VI) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

VII) CONTINUOUS ASSESSMENT TEST

No. of Test	:	2
Maximum Marks	:	30 marks
Test Duration	:	1.5 hours
Topic	:	2.5 modules

VIII) END SEMESTER EXAMINATION

Maximum Marks	:	**60 marks**
Exam Duration	:	3 Hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL31F	URBAN AND REGIONAL TRANSPORTATION PLANNING	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

Goal of this course is to cover the fundamentals of transportation planning, focusing on its relationship with urban structure, land use, and travel demand. It explores the four-stage planning process—trip generation, distribution, mode choice, and assignment—along with data collection, land-use models, sustainable strategies, and GIS applications.

ii) COURSE OUTCOMES

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

CO1	Explain transportation planning principles to address issues related to urban structure, land use, and travel demand.	Understand
CO2	Apply the four-stage transportation planning process, including trip generation, trip distribution, mode split, and traffic assignment.	Apply
CO3	Apply appropriate data collection, zoning, and sampling techniques for effective transportation planning.	Apply
CO4	Apply land-use transport models for transportation planning.	Apply
CO5	Describe sustainable approaches in transportation planning and development of comprehensive mobility plans.	Understand

iii) SYLLABUS

Transportation Planning and Urban Structure: Key aspects of urban travel, transportation challenges, environmental impacts, and urban structure types (centripetal, grid, linear, directional) with a focus on accessibility and movement.

Demand Analysis and Planning Process: Principles of travel demand, consumer behavior models, and stages of transportation planning, including data collection, zoning, sampling, and survey methods.

Trip Generation, Distribution, and Modal Split: Forecasting trip generation, growth factor and gravity models for trip distribution, and modal split models (trip-end, interchange, and logit).

Traffic Assignment and Land Use: Traffic assignment techniques for network optimization and the interaction between transportation and land use using the Lowry model.

Sustainable Transportation and Mobility Plans: Transit-oriented development, demand management, non-transport solutions, and GIS-based tools in comprehensive mobility planning.

iv) a) TEXTBOOKS

1. M. J. Bruton, Introduction to Transportation Planning, 3rd edition, Routledge, 2023. ISBN-13: 978-0367726577
2. Partha Chakroborty and Animesh Das, Principles of Transportation Engineering, 2nd edition, PHI Learning, 2017. ISBN-13: 978-8120353459
3. Dr. L.R. Kadiyali, Traffic Engineering and Transport Planning, 9th edition, Khanna Publishers, 2024. ISBN-13: 978-81-7409-220-5

b) REFERENCES

1. Hutchinson, B. G., Principles of Urban Transport Planning, Tata McGrawHill, 1990. ISBN-13: 978-0070315396
2. John W. Dickey, Metropolitan Transportation Planning, 2nd edition, Routledge (imprint of Taylor and Francis), 2017 (e-book). ISBN-13: 978-0203747346
3. Michael D. Meyer, and Eric J. Miller, Urban Transportation Planning a Decision Oriented Approach, Tata McGrawHill, 2nd edition, 2001 (e-book). ISBN-13: 978-0072423327
4. C. S. Papacostas and P. D. Prevedouros, Transportation Engineering and Planning, Prentice Hall of India Pvt. Ltd., 3rd edition, 2012. ISBN-13: 978-8120321540

v) COURSE PLAN

Module	Contents	No. of hours
I	**Need for transportation planning** - Characteristics of urban travel, Transportation issues and challenges, Detrimental effects of traffic on environment. **Urban Structure** - types and properties - centripetal, grid, linear, directional, Movement and Accessibility - Hierarchy of transportation facilities. **Demand analysis in transportation planning**, Modelling based on consumer behavior of travel choices, Basic principles of travel demand analysis and assumptions	8
II	**Transportation planning process** - Systems approach, Elements/stages of transportation planning process - Goal, objectives and constraints, Trip-based and Activity-based approaches for transportation planning. **Data collection** - Definition of study area, zoning- selection of cordon, Sampling techniques and sample size, Sources of data and types of surveys for planning. **Trip Generation**- Factors influencing grip generation, methods of forecasting trip generation rates- expansion factor, linear regression, category analysis.	10
III	**Trip Distribution** - Growth factor methods, Synthetic methods- Gravity models, opportunity model. **Modal Split**- Factors influencing modal split, Types of mode split models - trip end, trip interchange, logit model. **Traffic assignment** - Purpose, Elements of transportation networks- Nodes and links, Methods for traffic assignment	9

IV	**Transportation and land use** - Role of urban activity analysis in transportation planning, Transportation impacts on activity system, Land use transportation interaction. **Land use models**- Selection of land use model, Lowry model - Structure, features, Model equation system.	9
V	**Sustainable transportation** - features, facilities, Transit oriented development, Non-transport solutions to transport problems, Transportation demand management, Quick response techniques for demand estimation. **Comprehensive Mobility Plan** - objectives and activities involved.	9
	Total	**45 hours**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

IX) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL31G	ADVANCED MATERIALS AND SUSTAINABLE CONSTRUCTION PRACTICES	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

The course aims to provide a comprehensive understanding of advanced construction materials with a focus on sustainability. It covers fundamental aspects of cement and concrete technology, special concretes, sustainable construction products, and green building practices. Students will gain insight into emerging trends, practical testing methods, and modern construction solutions aligned with environmental and regulatory standards.

ii) COURSE OUTCOMES

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

CO1	Identify the properties, standards, and sustainable practices associated with cement and its applications.	Understand
CO2	Design concrete mixes using conventional and advanced materials, including special concretes.	Apply
CO3	Apply sustainable construction methods using advanced materials and water-resistant solutions and modern concrete technologies like ready-mix and value-added concretes	Apply
CO4	Explain green building practices, including energy and water efficiency strategies.	Understand

iii) SYLLABUS

Introduction to cement – Properties, manufacturing, testing, applications, sustainable practices
Concrete mix design – Admixtures, field and lab testing, quality control, special concretes
Special concretes – Ready-mix, decorative, structural solutions, durability-enhanced mixes
Sustainable building materials – Waterproofing, AAC blocks, adhesives, repair products
Green building practices – Solar energy, water conservation, IGBC certification, future trends

iv) a) TEXTBOOKS

1) M. S. Mamlouk and J. P. Zaniewski, Materials for Civil and Construction Engineers, 4th ed. Pearson Education, 2016. ISBN: 9780134320533.
2) A. M. Neville, Properties of Concrete, 5th ed. Pearson Education, 2011. ISBN: 9780273755807.
3) P. K. Mehta and P. J. M. Monteiro, Concrete: Microstructure, Properties, and Materials, 4th ed. McGraw-Hill Education, 2014. ISBN: 9780071797870.
4) S. Kumar, Building Materials and Construction, S.K. Kataria & Sons, 2015. ISBN: 9789350142818.

b) REFERENCES

1) M. V. Rao, Sustainable Construction and Building Materials, New Age International, 2011. ISBN: 9788122433312.
2) Bureau of Energy Efficiency (BEE), Manuals on Energy Efficient Buildings, Government of India, 2005.
3) V. K. Raina, Concrete Bridges: Design and Construction, 2nd ed. Tata McGraw-Hill, 2007. ISBN: 9780070620971.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Cement and Sustainability in Cement Industry** – Introduction to cement, Types and grades of cement, Physical and chemical properties. Manufacturing process of cement, Testing of cement – Field and laboratory, Overview of relevant IS codes, Applications of cement in construction. Sustainable practices in the cement industry, Innovations and future trends in cement technology. Case study: Sustainable cement manufacturing at UltraTech's plants, Use of low-clinker cement for large infrastructure project and its environmental impact.	9
II	Concrete Technology and Innovations – Concrete, Fresh and hardened properties of concrete, Concrete mix design principles - IS method, performance-based approach), Role and types of admixtures. Field and laboratory testing of concrete, Quality control and quality assurance in concrete works. Design and applications of special concretes (e.g., High Performance, Self-Compacting, Fiber-Reinforced), Recent advances in concrete technology Case Study: Self-Compacting Concrete in Metro Projects, Concrete in Marine Environments.	9
III	**Value-Added Concrete Products and Structural Solutions** - introduction to Ready Mix Concrete (RMC), Value-added concrete products (e.g., pervious concrete, precast elements), Advanced structural solutions using concrete, Durability multiplier concepts,	9

	Decorative and architectural concrete, Flooring and slab solutions, Smart repair solutions for concrete structures. Case Study: Ready Mix Concrete in high-rise construction – time, cost, and quality analysis, Use of smart slab systems in industrial warehouses.	
IV	**Sustainable Construction Materials and Practices** – Sustainability in construction: concepts and applications, Waterproofing solutions and technologies, Modern plasters and floor screeds. Masonry solutions – AAC blocks and alternatives, Tile adhesives and their applications, Industrial grouts and precision applications, Advanced repair materials and sustainable retrofitting techniques. Case study: AAC block adoption in affordable housing projects, Performance review of tile adhesives and plaster systems in coastal climates.	**9**
V	**Green Building Concepts and Certification Systems** – Fundamentals of green building design, Sustainable architectural and structural design principles, Energy efficiency in buildings, Solar energy integration in building systems, Water conservation and management strategies – Rainwater harvesting, Sustainable materials selection for green buildings. Green building rating systems (IGBC, GRIHA), Policies and regulations in green construction, Emerging trends in green and net-zero buildings. Case study: IGBC-Certified commercial office building with integrated sustainable construction materials, Design and execution of a green campus with net-zero energy and water goals.	**9**
	Total hours	**45**

v) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

HONOURS COURSES

Semester	Basket I				Basket II				Basket III			
	Course Code	Course	L-T-P-J	Credits	Course Code	Course	L-T-P-J	Credits	Course Code	Course	L-T-P-J	Credits
S4	23CEL2HB	Advanced Mechanics of Solids	3-0-0-0	3	23CEL2HD	Environmental Pollution Control Techniques	3-0-0-0	3	23CEL2HF	Geographical Information System	2-0-2-0	3
S5	23CEL3HA	Modern Construction Materials	3-0-0-0	3	23CEL3HC	Groundwater Hydrology	3-0-0-0	3	23CEL3HE	Pavement Construction and Management	3-0-0-0	3
S6	23CEL3HB	Finite Element Method	3-0-0-0	3	23CEL3HD	Environmental Pollution Modelling	3-0-0-0	3	23CEL3HF	Transportation System Management	3-0-0-0	3
S7	23CEL4HA	Structural Dynamics	3-0-0-0	3	23CEL4HC	Earth Dams and Earth Retaining Structure	3-0-0-0	3	23CEL4HE	Soil Dynamics and Machine Foundation	3-0-0-0	3
S8	23CEJ4HB	Mini Project	0-0-6–0	3	23CEJ4HD	Mini Project	0-0-6–0	3	23CEJ4HF	Mini Project	0-0-6–0	3

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL3HA	Modern Construction Materials	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course aims to develop a comprehensive understanding of advanced and emerging construction materials, their behaviour, applications, and sustainability performance in modern civil engineering infrastructure.

ii) COURSE OUTCOMES

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

CO1	Explain the classification, manufacturing techniques, and properties of composite, smart, and advanced metallic materials used in modern construction.	Understand
CO2	Explain the functional behaviour and integration of smart and responsive materials in civil engineering structures.	Understand
CO3	Apply appropriate modern materials in the design or rehabilitation of construction elements considering functional requirements.	Apply
CO4	Apply appropriate high-performance and sustainable construction materials to achieve desired structural behaviour and environmental performance in civil engineering projects.	Apply
CO5	Utilize emerging construction technologies and their associated materials in planning and executing advanced infrastructure systems.	Apply

iii) SYLLABUS

Composites in Construction- Classification, Manufacturing methods**,** Mechanical behaviour, durability, and failure modes- Applications in bridge decks, facades, retrofitting, and modular systems.

Smart and Responsive Materials- Concept and need for smart materials, types, working mechanisms and integration in civil structures, Case studies.

Light Gauge Steel and Advanced Metals- Design aspects and codal provisions, Aluminium alloys in construction, Hybrid steel- aluminium systems and innovations in modular steel.

High-Performance & Sustainable Materials- Life-cycle cost analysis (LCCA) of modern vs. conventional materials, Environmental performance of new materials.

Emerging Trends & Applications- 3D-printing and printed concrete, Materials and challenges- Transparent concrete and light-transmitting materials, Integration with Building Information Modelling (BIM) and sensors for performance monitoring.

iv) a) TEXT BOOKS

1) William D. Callister JR and David G. Rethwisch, Materials Science and Engineering: An Introduction, 10th edition, Wiley, 2018. ISBN: 978-1119405498
2) P. Kumar Mehta and Paulo J. M. Monteiro, *Concrete:* Microstructure, Properties, and Materials, 4th edition, McGraw-Hill Education, 2014. ISBN: 978-0071797870
3) Sidney Mindess, J. Francis Young, and David Darwin, Concrete, 2nd edition, Prentice Hall, 2002. ISBN: 978-0130646323
4) J.M. Illston and P.L.J. Domone**,** Construction Materials*: Their* Nature and Behaviour, 3rd Edition, CRC Press, 2001. ISBN: 978-041925860

b) REFERENCES

1) B. Bhattacharjee, Admixtures and Sustainability of Concrete, CRC Press (India), 2022. ISBN: 978-1032116334
2) Dr. S.K. Sharma**,** Civil Engineering Construction Materials, 1st Edition, Khanna Publishing House, 2019. ISBN: 978-9382609841
3) M.S. Shetty and A.K. Jain, Concrete Technology: Theory and Practice, 8th Edition, S. Chand Publishing, 2019. ISBN: 978-9352533800
4) A.M. Neville, Properties of Concrete, 5th edition, Pearson India, 2012. ISBN: 978-9332586142.

v) COURSE PLAN

Module	Contents	No. of hours
I	Composites in Construction- Classification- Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Natural Fibre Composites**,** Functionally Graded Composites- Manufacturing methods- Hand layup, Pultrusion, Filament winding, Spray-up, Autoclave- Mechanical behaviour, durability, and failure modes- Applications in bridge decks, facades, retrofitting, and modular systems	**9**
II	Smart and Responsive Materials - Concept and need for smart materials-Types- Piezoelectric, Electrochromic, Thermo-chromic, Shape Memory Alloys, Self-healing materials-Working mechanisms and integration in civil structures-Case studies- Smart pavements, adaptive facades, vibration damping in bridges.	**9**
III	Light Gauge Steel and Advanced Metals - Introduction to cold-formed steel systems- Design aspects and codal provisions- Aluminium alloys in construction- Corrosion resistance, welding, architectural use- Hybrid steel-aluminium systems and innovations in modular steel.	**9**
IV	High-Performance and Sustainable Materials- Geopolymers and alkali-activated materials- Ultra High-Performance Concrete, Self-Compacting Concrete, Engineered Cementitious Composites- Aerogels, Nano-materials in construction- Carbon capture materials, bio-based composites, Life-cycle cost analysis (LCCA) of modern materials compared to conventional materials, Environmental performance of new materials..	**9**
V	Emerging Trends & Applications- 3D-printing and printed concrete- Materials and challenges- Transparent concrete and light-transmitting materials- Aerated concrete and foamed concretes- Innovations in non-structural materials- Advanced claddings, coatings, fire-resistant materials- Integration with Building Information Modelling (BIM).	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL3HC	GROUNDWATER HYDROLOGY	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental concepts of groundwater hydrology and its engineering applications. The course aims to impart knowledge on the hydraulics of subsurface fluid flow, characteristics of porous media, well flow near aquifer boundaries, surface investigation of groundwater, quality of groundwater, artificial recharge and groundwater flow modeling.

ii) COURSE OUTCOMES

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

CO 1	Explain the occurrence and movement of groundwater through porous media	Understand
CO 2	Identify the aquifer parameters using different methods	Apply
CO 3	Solve drawdown in wells due to the effect of aquifer boundaries and thickness of aquifers	Apply
CO 4	Compute sea water intrusion length and fresh water discharge into the sea	Apply
CO 5	Solve problems of groundwater systems using numerical modelling methods	Apply

iii) SYLLABUS

Vertical distribution of groundwater, Darcy's law, Steady unidirectional flow Partial differential equation governing unsteady groundwater flow.
Unsteady radial flow towards well. Well flow near aquifer boundaries.
Practical cases Surface investigation of groundwater- different methods, determination of aquifer thickness of horizontal aquifers.
Quality of groundwater- Pollution of groundwater- Sea water intrusion Artificial recharge of groundwater.
Modeling of groundwater flow, governing equations of groundwater flow and boundary conditions.

iv) a) TEXTBOOKS

1) Todd, David K., and Larry W. Mays. Groundwater Hydrology. (3rd ed., Indian adaptation), Wiley, 2021. ISBN: 9788194726333
2) Raghunath, H. M. Groundwater Hydrology. 4th ed., New Age International Publishers, 2021.ISBN-13: 9788185790908
3) Tang, Y., Zhou, J., Yang, P., Yan, J., & Zhou, N.. Groundwater engineering 2nd ed.. Springer.2018. ISBN: 9789811092244.
4) Rastogi, A.K. Numerical Groundwater Hydrology. Penram International Publishers, 2007.ISBN-13: 9788187972273

b) REFERENCES

1) Bouwer, Herman. Groundwater Hydrology. 2nd ed., McGraw-Hill, 2000. ISBN-13: 9780070067158
2) United States Bureau of Reclamation. Groundwater Manual: A Water Resources Technical Publication. U.S. Department of the Interior, Bureau of Reclamation, 1995.
3) Kresic, Neven. Hydrogeology and Groundwater Modeling. 2nd edition, CRC Press, 2006.ISBN-13: 9780849333484

V) COURSE PLAN

	Contents	No. of hours
I	Vertical distribution of groundwater-Types of geologic formations, Properties of aquifer related to storage and transmissivity of water, Darcy's law, Steady unidirectional flow, Steady flow in a homogeneous aquifer, Unidirectional flow, Aquifer with recharge, Flow into infiltration galleries	**9**
II	Partial differential equation governing unsteady groundwater flow, Unsteady radial flow towards well, Evaluation of aquifer parameters- Theis method, Jacob's method, Chow's method	**9**
III	Well flow near aquifer boundaries, Image well system, Method of images, Surface investigation of groundwater, Electrical resistivity method, Refraction method, Determination of aquifer thickness of horizontal aquifers, Resistivity method, Seismic refraction	**9**
IV	Quality of groundwater – Graphical representations, Pollution of groundwater-sources, Distribution and evaluation of groundwater pollution, Sea Water intrusion-Ghyben Herzberg equation, Length of intrusion, Upconing, Preventive measures Artificial recharge of groundwater- different techniques	**9**
V	Modeling of groundwater flow - Governing equations of groundwater flow and boundary conditions, Solution groundwater flow for 1D steady state groundwater flow in homogeneous aquifer using finite difference method. Groundwater flow modeling using MODFLOW Software	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL3HE	PAVEMENT CONSTRUCTION AND MANAGEMENT	VAC	3	0	0	0	3	2023

i) PRE-REQUISITE: 23CEL30D – Transportation Engineering

ii) COURSE OVERVIEW

This course covers the construction and performance evaluation of flexible and rigid pavements, including embankment and subgrade preparation, granular and bituminous layer construction. It also deals with equipment operations, quality assurance, pavement condition assessment and introduces pavement management systems.

iii) COURSE OUTCOMES

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

CO1	Explain construction methods and quality control of bituminous pavements, including mix design.	Understand
CO2	Explain mix design and construction principles of stabilized pavement layers.	Understand
CO3	Explain construction methods, joint design, and rehabilitation of cement concrete pavements.	Understand
CO4	Utilize alternative materials and recycling methods, including mix design, in sustainable pavement construction.	Apply
CO5	Apply pavement management principles to support decision-making in maintenance planning and management.	Apply

iv) SYLLABUS

Bituminous Pavement Construction – Earthwork grading, Embankment construction, Quality control, Material specifications, Bituminous mix design, Statistical quality control.

Stabilized Pavement Layers – Soil-aggregate gradation, Mix design for soil-cement, Soil-bitumen, Soil-lime stabilization, Cement-treated bases and sub-bases.

Cement Concrete Pavement Layers – Construction methods, Interlocking block pavements, Joint design, Quality control, Rehabilitation of distressed pavements.

Sustainable Pavement Construction: Recycling methods, Mix design with RAP, Full-depth reclamation, Use of geosynthetics and alternative materials.

Pavement Management: Evaluation of pavement conditions, Performance prediction, Rehabilitation strategies, Life cycle cost analysis, Pavement management systems.

v) a) TEXTBOOKS

1. Prithvi Singh Kandhal, Bituminous Road Construction in India, 1st edition (revised), PHI Learning Pvt. Ltd, 2016, ISBN-13: 978-8120352582.
2. S. K. Khanna, C. E. G. Justo, and A. Veeraragavan, Highway Engineering, 10th edition, Nem Chand and Sons, 2018, ISBN-13: 978-8185240930.
3. Rajib B. Mallick and Tahar El-Korchi, Pavement Engineering, 4th edition, CRC press, 2022, ISBN: 13-978-0367758073.
4. Ralph Haas, W. Ronald Hudson with Lynne Cowe Falls, Pavement Asset Management, 1st edition, Scrivener Publishing (Wiley), 2015, ISBN: 978-1-119-03870-2.

b) CODES OF PRACTICE

1. IRC 015: 2017 (2017), Code of Practice for Construction of Jointed Plain Concrete Pavements, 5th revision, Indian Roads Congress, New Delhi.
2. IRC: 115 – 2014 (2014), Guidelines for Structural Evaluation and Strengthening of Flexible Road Pavements Using Falling Weight Deflectometer (FWD) Technique, 1st edition, Indian Roads Congress, New Delhi.
3. IRC: 117 – 2014 (2014), Guidelines for the Structural Evaluation of Rigid Pavement by Falling Weight Deflectometer, 1st edition, Indian Roads Congress, New Delhi.
4. IRC: SP:83-2018 (2018), Guidelines for Maintenance, Repair and Rehabilitation of Cement Concrete Pavements, 1st revision, Indian Roads Congress, New Delhi.
5. IRC: 82-2015 (2015), Code of Practice for Maintenance of Bituminous Road Surfaces, 1st revision, Indian Roads Congress, New Delhi.
6. IRC: 120-2015 (2015), Recommended Practice for Recycling of Bituminous Pavements, 1st edition, Indian Roads Congress, New Delhi.
7. IRC: 121-2017 (2017), Guidelines for Use of Construction and Demolition Waste in Road Sector, 1st edition, Indian Roads Congress, New Delhi.

c) REFERENCES

1. E. Ray, Prithvi S. Kandhal, Freddy L. Roberts, Y. Richard Kim, Dah-Yinn Lee and Thomas W. Kennedy Brown, Hot Mix Asphalt Materials, Mixture Design, and Construction, 3rd edition, NAPA Research and Education Foundation, 2009, ISBN-13 : 978-0914313021.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Bituminous Pavement Construction –** Earthwork grading, compaction and construction of embankments and cuts for roads, problems in embankment construction on weak and compressible foundation, quality control tests as per MoRTH specifications. Specifications of materials, construction methods and field control checks for pavement materials in sub-base, base, binder and surface course layers and their choice. Numerical problems on bituminous mix volumetric design, statistical	9

	applications in quality control and quality assurance.	
II	**Stabilized Pavement Layers –** Principles of gradation/proportioning of soil-aggregate mixes and compaction, Design factors, mix design for mechanical, soil-cement, soil-bitumen, and soil-lime 2stabilization methods. Cement Treated Bases and Sub-bases, Numerical problems on mix design and applications.	9
III	**Cement Concrete Pavement Layers –** Specifications and method of cement concrete pavement construction, Construction of interlocking block pavements, paneled concrete pavements. White topping, design of joints, Quality control tests. Distresses and rehabilitation of distressed concrete pavements.	10
IV	**Sustainable Pavement Construction –** Need for recycling, methods of recycling, mix design - hot and cold recycling, Full Depth Reclamation. Use of Geosynthetics in highway construction, Utilization of waste products like fly ash, slag, marginal materials, problems in mix design with RAP.	10
V	**Pavement management –** Concepts, different levels of pavement management and functions, applications of Pavement Management System. Data Requirements, evaluation of structural capacity, evaluation of functional condition. Performance prediction, Generating alternate strategies of design and rehabilitation, Application of Highway Development and Management Tools in pavement management. Problems in pavement evaluation and rehabilitation design considering life cycle cost analysis.	9
	Total	**45**

vii) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

MINOR COURSES

Semester	Basket I				Basket II				Basket III			
	Infrastructure Development and Management				Environmental and Water Resource Engineering				Transportation Engineering			
	Course Code	Course	L-T-P-J	Credits	Course Code	Course	L-T-P-J	Credits	Course Code	Course	L-T-P-J	Credits
S3	23CEL2MA	Building Information Modelling	3-0-0-0	3	23CEL2MC	Climate Change and Disaster Mitigation	3-0-0-0	3	23CEL2ME	Traffic Engineering	3-0-0-0	3
S4	23CEL2MB	Infrastructure Health Monitoring	3-0-0-0	3	23CEL2MD	Watershed Management	3-0-0-0	3	23CEL2MF	Urban Transportation Planning	3-0-0-0	3
S5	23CEL3MA	Infrastructure Project Management	3-0-0-0	3	23CEL3MC	Air Pollution and Control Techniques	3-0-0-0	3	23CEL3ME	Traffic Flow Theory and Modelling	3-0-0-0	3
S6	23CEL3MB	Performance and Risk Assessment of Infrastructure Systems	3-0-0-0	3	23CEL3MD	Integrated Waste Management for Smart Cities	3-0-0-0	3	23CEL3MF	Transportation and logistics management	3-0-0-0	3
S7/ S8	23CEJ4MA	Mini Project	0-0-6–0	3	23CEJ4MC	Mini Project	0-0-6–0	3	23CEJ4ME	Mini Project	0-0-6–0	3

Semester	Basket IV				Basket V			
	Virtual Reality and Automation Technologies in Construction				Engineering Project Management			
	Course Code	Course	L-T-P-J	Credits	Couse Code	Course	L-T-P-J	Credits
S3	23CEL2MG	Infrastructure Management with Informatics	3-0-0-0	3	23CEL2MI	Advanced Project Management	3-0-0-0	3
S4	23CEL2MH	Construction Automation and Robotics	3-0-0-0	3	23CEL2MJ	Building Information Modelling in Management	3-0-0-0	3
S5	23CEL3MG	Machine Learning for Construction Automation	3-0-0-0	3	23CEL3MI	Contract Management	3-0-0-0	3
S6	23CEL3MH	Virtual Reality in Construction	3-0-0-0	3	23CEL3MJ	Quality, Risk and Safety Management	3-0-0-0	3
S7/ S8	23CEJ4MG	Mini Project	0-0-6-0	3	23CEJ4MI	Mini Project	0-0-6-0	3

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL3MA	INFRASTRUCTURE PROJECT MANAGEMENT	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This Course deals with the processes and policies of infrastructure development and gives an understanding of the mechanism of delivering infrastructure projects and related services. It broadly includes all the aspects related to infrastructure life cycle from planning, financing, development, implementation mechanism, execution and evaluation. The course imparts the skill to recognise the issue and evaluate the performance of infrastructure project.

ii) COURSE OUTCOMES

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

CO 1	Explain the importance of infrastructure sector in economic development and growth of a region and country.	Understand
CO2	Explain the different infrastructure financing policies.	Understand
CO 3	Explain the different processes in the development of infrastructure project.	Understand
CO 4	Describe the current status, demand trends, and challenges in major infrastructure sectors in India, including transport, energy, water, and social infrastructure.	Apply
CO 5	Apply different infrastructure protocols for sustainable projects.	Apply

iii) SYLLABUS

Introduction to Infrastructure: India's Infrastructure Development Policies and programmes.
Infrastructure Development Process and financing.
Infrastructure Sectors: Transport Sector- Energy sector-Water sector
Environmental concerns and sustainability of infrastructure projects: Infrastructure protocols for environmental sustainability.

iv) a) TEXTBOOKS

1) Alwin S Goodman Makarand Hastak, Infrastructure Planning, Engineering, and Economics. Second Edition, Mc Graw- Hill Professional, 2015, ISBN 13- 978-0071850131
2) Hendrickson, C and Mathews H S, Civil Infrastructure Planning, Investment and Pricing, Pittsburgh, P A: Carnegie- Mellon University, ISSN -13- 0193-9750
3) Graham M. Winch, Managing Infrastructure Projects, Wiley-Blackwell, 2019, ISBN-13-978-1-405-18457-1

b) REFERENCES

1) Barbara Webber, Mirjam Staub- Bisang and Hans Wilhelm Alfen, Infrastructure As An Asset Class - Investment Strategy, Sustainability, Project Finance and PPP, Wiley Publication, 2016, ISBN-13- 978-1-119-22654-3

2) Waheed Uddin, W. Hudson, Ralph Haas, Public Infrastructure Asset Management,2nd edition, 2013, Newyork, McGraw Hill, ISBN-13- 9780071820110

V) COURSE PLAN

Module	Contents	No. of hours
I	Infrastructure definition and classification. Principles and objectives of urban planning. Infrastructure gap and need of investment. Relationship between infrastructure development and economic development. India's Infrastructure Development Policies and programmes. The different infrastructure projects in India.	**9**
II	Idea generation and project Conceptualisation, need of the project, Preliminary Decision Making, data requirement and analysis, Project planning, Viability assessment, phasing and DPR. Infrastructure regulations, Due diligence, Institutional mechanism and goverence. PPP mechanism for project delivery, PPP Agreement, Procurements for infrastructure projects, Stakeholders management, Infrastructure risk assessment. Construction of Infrastructure Projects, Infrastructure Durability.	**10**
III	Overview of infrastructure financing: models and relevance; public corporates and private financing. Fiscal and market financing of infrastructure projects, External commercial borrowings, financing institutions, fund Managers, Projects and infrastructure bonds etc. Infrastructure pricing.	**8**
IV	Status, Challenges, demand, current proposals, regulations and guidelines, performance appraisal mechanism in different sectors of infrastructure development. Concepts and significance of TOD (Transit-Oriented Development)- National Road Transport, National rail-based transport, ports and shipping, multi modal connectivity. Energy sector- oil and gas, renewable energy, thermal and hydroelectric power, nuclear power. Water sector- policy, irrigation and dams, rural infrastructure and urban infrastructure.	**10**
V	Environmental concerns and sustainability of infrastructure projects, Infrastructure protocols for environmental sustainability, Infrastructure for resilient development, Carbon Pricing and Credits, Impact assessment.	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL3MC	AIR POLLUTION AND CONTROL TECHNIQUES	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

The goal of this course is to introduce students to the fundamental aspects of air pollution, air quality monitoring and air pollution control strategies. It motivates the students in maintaining and improving the air quality of the environment and empowers learners to take appropriate actions to reduce the air pollution for the benefit of the society.

ii) COURSE OUTCOMES

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

CO 1	Explain the sources, types and effects of indoor and outdoor air pollutants	Understand
CO 2	Identify the meteorological aspects of air pollutant dispersion and behaviour of plume	Apply
CO 3	Explain the different methods of ambient air quality monitoring system which supports an air quality management program	Understand
CO 4	Identify the various air pollution control strategies that can be undertaken to meet the air quality standards.	Apply

iii) SYLLABUS

Introduction- Air Pollutants, History of air pollution episodes, Sources, Types of air pollutants, Effects of air pollutants, Indoor air pollution

Meteorological aspects of Air Pollutant Dispersion, Inversions- Types, Atmospheric stability, Dispersion of air pollutants, Plume behaviour, Guassian Plume model

Air Quality Monitoring - Ambient air sampling - Ambient Air Quality standards- Air pollution indices, Emission Inventory

Control of Air Pollutants- Particulate emission control methods, Gaseous emission control methods, Case studies

iv) a) TEXTBOOKS

1) C.S. Rao, Environmental Pollution Control Engineering, New Age International (P) Ltd., Publishers, 4th edition, ISBN: 978-8122472288, 2021
2) M.N. Rao and H.V.N. Rao, Air Pollution, Tata McGraw Hill Education, 1st edition, ISBN: 978-0074518717, 2017

3) Roger D. Griffin, Principles of Air Quality Management, CRC Press, 2nd edition, ISBN: 978-0367577803, 2020

b) CODES OF PRACTICE

1. National Ambient Air Quality Standards, Central Pollution Control Board (CPCB), Government of India, 2009

c) REFERENCES

1) Zhang,Y.,Hopke,P.K., Mandin,C., Handbook of Indoor Air Quality, Springer Nature Singapore, ISBN: 978-9811676796, 2022

2) Mudakavi, J.R., Principles and Practices of Air Pollution Control and Analysis, IK International Publishing House Pvt. Ltd., ISBN: 978-9380026381, 2013

3) Bhatia, S.C., Textbook of Air Pollution and Its Control, Atlantic publishers, ISBN: 978-8126908257, 2021

4) Mahajan, S.P., Air Pollution Control, The Energy Resources Institute, TERI, ISBN:978-8179931868, 2009

V) COURSE PLAN

Module	Contents	No. of hours
I	Introduction- Definition of Air Pollution, History of air pollution episodes. Sources of Air pollution, Industrial Processes causing Air Pollution, Air Pollutants- Types of Air Pollutants- Criteria Pollutants- Hazardous air pollutants.	**9**
II	Effect of air pollutants on health, vegetation, animals, materials and atmosphere. Indoor Air Pollution- Sources of indoor air pollutants- Effects of indoor air pollution, Sick Building Syndrome, Control of Indoor air pollution.	**9**
III	Meteorological aspects of Air Pollutant Dispersion - Temperature and Pressure relationships. Atmospheric Stability- Temperature Lapse Rate, Inversions- Types Plume behaviour, Dispersion of Air pollutants-Plume dispersion theory- Gaussian plume model - Assumptions- Advantages and Disadvantages, Pasquill's stability curves. Box Model for Indoor Air Pollution.	**9**
IV	Air Quality monitoring - Ambient air sampling methods- Collection of gaseous air pollutants-Collection of particulate Pollutants. Instrumentation for air quality monitoring- gas analyzers, PM monitors. Air pollution indices, Emission inventory, Ambient Air Quality	**9**

	standards.	
V	Control of Air Pollutants- Particulate emission control methods, Scrubbing - Cyclones - Filtration- Electrostatic Precipitation Gaseous emission control methods - adsorption, absorption, thermal methods. Air pollution control towers. Case studies on air pollution control technologies.	**9**
	Total hours	**45**

VI) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

VII) CONTINUOUS ASSESSMENT TEST

No. of Test	:	2
Maximum Marks	:	30 marks
Test Duration	:	1.5 hours
Topic	:	2.5 modules

VIII) END SEMESTER EXAMINATION

Maximum Marks	:	**60 marks**
Exam Duration	:	3 Hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL3ME	TRAFFIC FLOW THEORY AND MODELLING	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental concepts of traffic flow, traffic stream models, traffic flow modelling analogies, queuing theory and simulation modelling. The course equips students with essential analytical and computational skills for modelling and evaluating traffic operations in mixed traffic conditions.

ii) COURSE OUTCOMES

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

CO 1	Explain the traffic stream characteristics and their relationship.	Understand
CO 2	Apply various traffic stream models to evaluate real-world traffic conditions.	Apply
CO 3	Apply shock wave theory and queuing models to assess traffic congestion and bottleneck effects.	Apply
CO 4	Identify key challenges of heterogeneous traffic conditions in traffic management.	Apply

iii) SYLLABUS

Traffic stream characteristics- Fundamental traffic flow and derived characteristics, Time-space diagrams, Fundamental relations of traffic flow, Fundamental diagrams of traffic flow.

Traffic stream models – Greenshield's model, Greenberg's logarithmic model, Underwood's exponential model, Pipe's generalized model, Multi-regime models.

Traffic flow modelling analogies – Fluid flow analogy, Lighthill-Whitham theory, Shock wave theory, Platoon diffusion, Car-following models.

Fundamentals of queuing theory – Demand service characteristics, Vehicle arrival and headway modelling, Gap acceptance, Lane-changing models, Deterministic and stochastic queuing models

Mixed traffic flow – Flow models under heterogeneous conditions, Challenges and case studies, Introduction to simulation modelling – Need, Applications, Classification, Steps, Advantages, Simulation packages

iv) a) TEXTBOOKS

1) Fred L. Mannering, Scott S. Washburn, & Walter P. Kilareski, Principles of Highway Engineering and Traffic Analysis, 6th edition, Wiley, 2020, ISBN 978-1119305026
2) Roger P. Roess, Elena S. Prassas, & William R. McShane, Traffic Engineering, 5th edition, Pearson, 2019, ISBN 978-9353434854
3) L. R. Kadiyali, Traffic Engineering and Transport Planning, 8th edition, Khanna Publishers, 2017, 978-8174092205

b) REFERENCES

1) Papacostas, C. S., & Prevedouros, P. D., Transportation Engineering and Planning, 3rd edition, Pearson, 2015, 978-9332555150
2) Papageorgiou, M., Applications of Automatic Control Concepts to Traffic Flow Modelling and Control, 1st edition, Springer, 1983, ISBN 9783540122371
3) C. Jotin Khisty & B. Kent Lall, Transportation Engineering: An Introduction, 4th edition, Pearson, 2018, 978-9332569706
4) Nicholas J. Garber & Lester A. Hoel, Traffic and Highway Engineering, 5th edition, Cengage Learning, 2014, 978-1133605157
5) Adolf D. May, Traffic Flow Fundamentals, 1st edition, Prentice Hall, 1990, ISBN 978-0139260728

V) COURSE PLAN

Module	Contents	No. of hours
I	**Traffic stream characteristics:** Microscopic and Macroscopic study, Fundamental traffic flow characteristics and derived characteristics, Time-space diagram for single vehicle and multiple vehicles, Fundamental relations of traffic flow, Fundamental diagrams of traffic flow	9
II	**Traffic stream models:** Greenshield's model, Greenberg's logarithmic model, Underwood's exponential model, Pipe's generalized model, multi-regime models	7
III	**Traffic flow modelling analogies:** Fluid flow analogy assumptions and model formulation, Light hill- Withams theory, shock Wave Theory, Flow concepts including shock waves and bottleneck, Platoon Diffusion, Car following model	11
IV	**Queuing Theory:** Fundamentals of Queuing Theory, Demand Service Characteristics, Probabilistic aspects of traffic flow – Vehicle arrival modelling, Headway modelling, Gap Acceptance, Lane changing models, Deterministic Queuing Models and Stochastic Queuing Models, Analysis of Different Highway Facilities	9
V	**Simulation modelling:** Flow models under mixed traffic, Problems in mixed traffic flow – Case studies on mixed traffic from India (minimum 3 case studies), Introduction to simulation modelling- Need for simulation, Application, Classification, Steps in simulation, Advantages of simulation	9

	techniques, Simulation packages	
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL3MG	MACHINE LEARNING FOR CONSTRUCTION AUTOMATION	VAC	3	0	0	0	3	2023

i) PRE-REQUISITE: 23MAL20C: Probability, Statistics and Numerical Methods, 23MAL10A: Linear Algebra & Calculus

ii) COURSE OVERVIEW

This course introduces the fundamentals of machine learning techniques and their applications in automating construction processes. Students will learn to select and implement appropriate machine learning algorithms to address challenges in construction automation, enhancing efficiency, safety and decision-making in construction projects.

iii) COURSE OUTCOMES

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

CO 1	Explain the fundamental concepts of machine learning and its role in automating construction processes using data from BIM, IoT, sensors, and project records.	Understand
CO 2	Apply supervised learning algorithms to solve problems related to cost estimation and project scheduling in construction.	Apply
CO 3	Analyze construction data using unsupervised learning techniques like clustering and dimensionality reduction for pattern recognition and anomaly detection	Analyze
CO 4	Apply deep learning architectures and reinforcement learning models for construction monitoring, robotics, and equipment automation	Apply
CO5	Apply Big data tools for managing and analyzing large-scale construction datasets.	Apply

iv) SYLLABUS

Machine learning (ML) concepts and their applications in construction automation. Supervised and unsupervised learning techniques, including regression, classification, clustering, and dimensionality reduction. Advanced topics such as deep learning (CNNs, LSTMs) and reinforcement learning are explored with applications in construction robotics and monitoring. The course also introduces big data analytics using tools like Hadoop and MapReduce for handling large-scale construction data. Real-world case studies and data from BIM, IoT, and sensors are integrated to provide practical insights.

v) a) TEXTBOOKS

1) Mohri M., Rostamizadeh A. and A. Talwalkar, 2018, *Foundations of Machine Learning*, 2nd Edition, MIT Press. ISBN-13: 978-0262039406

2) Raphael B. and I.F.C. Smith, 2013, Engineering Informatics: Fundamentals of computer aided engineering, 2nd Edition, John Wiley. ISBN-13: 978-1119953418
3) Kevin Murphy, Machine Learning: A probablistic perspective, MIT Press, 2012. ISBN-13: 978-0262018029
4) Trevorhastie, Robert Tibshirani, Jerome Ffriedman, The Elements of Statistical Learning, Springer 2009. ISBN-13: 978-0387848570
5) Han J., Kamber M. and J. Pei, 2011, *Data Mining: Concepts and Techniques*, 3rd Edition, Morgan Kaufmann. ISBN-13: 978-0123814791

b) REFERENCES

1) Strang G., Introduction to linear algebra, 6th edition, Wellesley-Cambridge Press, Wellesley 2023. ISBN-13: 978-1733146678
2) Murad, Yasmin, Husam, Abu Hajar and Iftikhar Azim, eds. Machine learning applications in Civil Engineering, Vol 16648714.Frontiers Media SA, 2022.
3) Rubinstein R.Y., and Kroese, D.P., Simulation and the Monte Carlo method, 3rd edition, John Wiley & Sons, Inc., New Jersey, 2017. ISBN-13: 978-1118632161
4) Bishop C.M., Pattern recognition and machine learning, Springer, New York, 2006. ISBN-13: 978-0387310732

V) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Machine Learning in Construction:** Overview of Machine Learning (ML) Concepts, Types of ML: Supervised, Unsupervised, and Reinforcement Learning, Role of ML in Construction Automation, Construction Data Sources: BIM, IoT, Sensors, and Project Records, Data Collection and Preprocessing-Data Cleaning, Normalization, and Transformation-Handling Missing Data and Outliers, Case Studies of ML Applications in Construction.	9
II	**Supervised for Construction:** Supervised Learning-Regression Models: Linear and Logistic Regression-Decision Trees and Random Forests-Support Vector Machines (SVM)- Introduction to Artificial Neural Networks (ANN) Applications in Cost Estimation and Scheduling.	9
III	**Unsupervised Learning for Construction** – Similarity measures, Clustering Techniques-K-Means, K-medoids Hierarchical Clustering. Principal Component Analysis (PCA), Singular Value Decomposition -Anomaly Detection in Construction Processes.	9

IV	**Deep Learning and Reinforcement Learning:** Deep Learning Architectures and Their Applications, Convolutional Neural Networks (CNN) for Construction Monitoring, Long Short-Term Memory Networks (LSTMs) Reinforcement Learning (RL)-Basics of RL and Q-Learning-Applications in Construction Robotics and Equipment Automation.	**9**
V	**Introduction to Big Data**- Characteristics of big data (Volume, Variety, Velocity, Veracity, Value), State of the practice in analytics, Example Applications - Credit Risk Modeling, Business Process Analytics. Big Data Analytics using Map Reduce and Apache Hadoop, Developing and Executing a Hadoop MapReduce Program.	**9**
	Total hours	**45**

VI) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

VII) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

VIII) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL3MI	CONTRACT MANAGEMENT	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course provides an understanding of contract formulation, execution, administration, and dispute resolution in various industries. It covers legal frameworks, negotiation techniques, risk management strategies, and modern technological interventions in contract management.

ii) COURSE OUTCOMES

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

CO 1	Explain the fundamentals of contract management, including legal principles and key contract components.	Understand
CO 2	Summarize various types of contracts and their practical applications in different industries.	Understand
CO 3	Make use of contract administration techniques for effective execution and compliance.	Apply
CO 4	Identify dispute resolution mechanisms and emerging trends in contract management.	Apply

iii) SYLLABUS

Contract Management - Definition, scope, Importance, Key stakeholders, Phases. Legal framework and principles of contract law, Common terminologies, Ethical considerations. Types of Contracts and Contract Formulation, Risk assessment and allocation in contracts, Role of insurance and guarantees in contracts, International contract management practices. Contract Administration and Execution, Roles and responsibilities of contract managers, Performance monitoring and compliance checks, Variations, amendments, and contract modifications, Contract payment structures and invoicing procedures, Subcontracting and supplier management, Challenges and strategies. Dispute Resolution and Legal Aspects of Contracts, Case laws and real-world examples of contract disputes, Role of technology in contract enforcement. Advanced Topics and Future Trends in Contract Management, Role of contract lifecycle management (CLM) software, Sustainable and ethical contract practices, Emerging legal trends in contract law, Future challenges and evolving best practices in contract administration.

iv) a) TEXTBOOKS

1) Ali D. Haidar, Handbook of Contract Management in Construction, 1st Edition, Springer, 2021, ISBN: 978-3030722647
2) Joseph J. Corey Jr., Contract Management and Administration for Contract and Project Management Professionals, 1st Edition, Self-published, 2015, ISBN: 9781508751083
3) Gregory A Garrett, World-Class Contracting, 6th edition, Cch Inc, 2015, ISBN: 978-0808042402
4) Alan Turner, Building Procurement, 2nd Edition, Red Globe Press, 1997 ISBN: 978-0333688090

b) REFERENCES

1) Contract Management Body of Knowledge (CMBOK), 7th Edition, National Contract Management Association (NCMA), 2023, ISBN: 978-0982838518
2) Conditions of Contract for Construction (Red Book), 2nd Edition, International Federation of Consulting Engineers, 2017, ISBN: 978-2884320849
3) Peter Sammons, Contract Management: Core Business Competence, 1st Edition, Kogan Page, 2017, ISBN: 978-0749480646

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Contract Management: Basics of Contract Management, Definition and importance of contracts, Role of contract management in business and construction, Contract lifecycle: pre-award, award, post-award phases, Legal Aspects of Contracts, Basic principles of contract law, Essential elements of a valid contract (Offer, Acceptance, Consideration, Legality, Capacity), Legal obligations and enforceability of contracts, Key Stakeholders and Their Roles, Clients, contractors, suppliers, legal teams, and regulatory authorities, Ethical Considerations in Contract Management.	**8**
II	Types of Contracts and Contract Formulation: Classification of Contracts - Fixed-price contracts (Lump Sum, Firm-Fixed-Price), Cost-reimbursable contracts (Cost-Plus, Incentive-Based Contracts), Time and materials contracts, Unit price contracts; Standard Contract Forms - FIDIC (International Federation of Consulting Engineers) contracts, NEC (New Engineering Contract) contracts, AIA (American Institute of Architects) contracts; Contract Formulation Process, Drafting contract documents, Key contract clauses (Scope, Price, Payment Terms, Termination, Dispute Resolution), Indemnities and warranties; Role of insurance and guarantees in contracts, Risk Allocation in Contracts, Identifying risks and assigning responsibilities, Use of risk mitigation strategies in contracts.	**9**
III	Contract Administration and Execution: Contract Administration Principles, Importance of contract administration in project success, Roles and responsibilities of contract administrators, Contract Documentation and Compliance, Maintaining accurate records and documentation, Performance tracking and compliance monitoring, Legal and regulatory compliance in contract execution, Managing Variations and Change Orders, Procedures for contract modifications and amendments, Cost and schedule implications of contract variations, Payment Structures and Invoicing, Milestone payments vs. progress payments, Retention clauses and final settlements, Subcontracting and Supplier Management, Managing subcontractor agreements, Supplier selection and performance	**10**

	evaluation, Challenges in Contract Execution, Common pitfalls and risk factors, Strategies for overcoming execution challenges, Real world Contract Scenarios.	
IV	Dispute Resolution and Legal Aspects of Contracts: Common Causes of Contract Disputes, Breach of contract and non-performance, Ambiguities and misinterpretations in contracts, Delays and cost overruns, Dispute Resolution Mechanisms, Negotiation, Mediation, Arbitration, Litigation, Legal Remedies for Contract Breach, Damages and compensations, Specific performance and contract termination, Force Majeure and Contract Termination, Definition and impact of force majeure clauses, Termination clauses and legal consequences, Bill of Quantities (BoQ) coordination with contract clauses, Case Studies on Contract Disputes, Real-world examples of contract disputes and resolutions.	**9**
V	Emerging Trends and Future Developments in Contract Management: Digital Transformation in Contract Management, AI-driven contract analytics, Smart contract technology using blockchain, Role of contract lifecycle management (CLM) software, Sustainability and Ethical Contracting, Green procurement and sustainable contract practices, Ethical sourcing and social responsibility in contracts, International Contract Management, Managing cross-border contracts, Legal and cultural challenges in international contracting, Regulatory Changes and Future Trends, Evolution of contract laws and global compliance requirements, Future challenges and best practices in contract administration.	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	**:**	**5 marks**
Assignments	**:**	**15 marks**
Assessment through Tests	**:**	**20 marks**
Total Continuous Assessment	**:**	**40 marks**
End Semester Examination	**:**	**60 marks**
TOTAL	**:**	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	**:**	**02**
Maximum Marks	**:**	**30**
Test Duration	**:**	**1 ½ hours**
Topics	**:**	**2 ½ modules**

viii) END SEMESTER EXAMINATION

Maximum Marks	**:**	**60**
Exam Duration	**:**	**3 hours**

SEMESTER 6

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL30F	Design of Steel Structures	PCC	3	1	0	0	4	2023

PRE-REQUISITE: 23CEL20D Structural Analysis

i) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental design concepts of steel structures. The course will cover the analysis and design of different connections; Tension members; Compression members- column bases; Design of Beams-Plate girders; Design of roof trusses; Moment resistant/Eccentric connections (in plane and out of plane). Fire resistant design of steel structures are also included.

ii) COURSE OUTCOMES

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

CO 1	Explain the properties of structural steel to resist various structural forces and the design approaches.	Understand
CO 2	Apply the codal provisions to compute the design strength and requirements of in plane and eccentric joints in structural steel connections.	Apply
CO 3	Design of structural steel members subjected to tensile, compressive and flexural forces.	Analyse
CO 4	Analyse the truss members subjected to wind loads.	Analyse
CO 5	Explain the standard methods and approaches adopted for the fire resistant design of steel structures.	Understand

iii) SYLLABUS

Introduction to steel and steel structures- Connections- Moment resistant/Eccentric

connections Design of Tension members

Design of Compression members and column bases

Design of beams- Plate girders (concept only).

Design of roof trusses- Fire resistant design-

iv) a) TEXTBOOKS

1) Duggal S K, Limit State Design of Steel Structures, Tata McGraw Hill Education Private Limited, 2015, ISBN-13- 978-9353164874
2) S S Bavikati., Design and Drawing of Steel Structures, Dreamtech Press, 10th edition 2019. ISBN-13- 978-9389520460
3) Ramamrutham S., Design of Steel Structures, Dhanpath Rai Publishing company, 6th edition, 2016. ISBN-13- 978-9389535960
4) N Subramanian N, Design of Steel Structures-Limit States Method, 2nd Edition, Oxford University Press, New Delhi, 2017. ISBN-13- 978-0199460915

b) CODES OF PRACTICE

1) IS 800 –2007, General Construction in Steel - Code of Practice, (Third Revision), Bureau of Indian Standards, New
2) IS 875 (Part 3) : 2015, Code of practice for design loads (Other than earthquake) for Buildings and Structures, Part:3 Wind loads, Bureau of Indian Standards, New Delhi, 2015.
3) EN 1993-1-1 , Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings , 2005

c) REFERENCES

1) Jayagopal L S and Tensing D , Design of Steel Structures, Vikas Publishing House Pvt Ltd., 2016.ISBN-13-978-9325984288
2) Krishna Raju N, Structural Design and Drawing (Reinforced Concrete and Steel), University Press, Hyderabad,2008. ISBN-13- 978-8173714894

V) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to steel and steel structures-Properties of structural steel and types of Structural steel sections- design philosophies- Design loads and load combinations. Connections: Bolted and Welded - Problems in lap joint, butt joint - eccentric loaded connections.	**14**
II	Introduction to Tension members - Types of tension members-Modes of failure-Factors affecting strength of tension members-Design of tension members-Concept of shear lag- Application of lug angle connections in tension members	**10**
III	Compression members- Classification-Behaviour, Design of struts Solid and built-up columns for axial loads, Design of lacing and battening system Column base plate- Simple slab base plate and gusseted base plate under axial load.	**12**
IV	Beams- design of Laterally restrained beams and unrestrained beams. Design of simple and compound beams. Plate girder- design for welded connection. Design of stiffeners- end bearing and intermediate stiffeners Gantry girders and beam-column joint (concept)	**12**
V	Type of roof truss- design loads and load combinations- Calculation of wind loads Design of purlins. Fire resistance criterion- Fire resistance assessment of steel structure material property at elevated temperature- design approaches and tools-different models-methods-procedures. Passive protection-fire performance assessment.	**12**
	Total hours	**60**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL30G	FOUNDATION ENGINEERING	PCC	3	0	0	0	3	2023

i) PRE-REQUISITE: 23CEL30C SOIL MECHANICS

ii) COURSE OVERVIEW

To provide students with fundamental knowledge of site investigation, foundation types and selection, bearing capacity analysis, stress distribution in soils, pile foundation design, and an introduction to lateral earth pressure and slope stability.

iii) COURSE OUTCOMES

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

CO 1	Explain the principles of site investigation, foundation types and selection, shear failure mechanisms in shallow foundations, lateral earth pressure and types of slope failure.	Understand
CO 2	Apply the concepts of soil mechanics to determine the soil properties obtained from site investigation and prepare a preliminary geotechnical investigation report.	Apply
CO 3	Apply the concept of Terzaghi's Bearing capacity theory and field method, to determine the bearing capacity of shallow foundation and to design combined footing, to assess the stress distribution in soils subjected to various loads.	Apply
CO 4	Apply the concept of static analysis, dynamic analysis and field method, to determine the pile load carrying capacity.	Apply
CO 5	Apply the concept of Rankine's method to determine the lateral earth pressure of soil and to determine the stability of finite slopes at failure.	Apply

iv) SYLLABUS

Site investigation, sampling of soil, geophysical methods

Introduction to foundations, determination of bearing capacity of shallow foundations

Design of combined footings, raft foundation and settlement analysis of footings, stress distribution in soils subjected to different loads

Introduction to earth pressure theories – Rankines and Coulombs theory

Introduction to pile foundations, determination of pile capacity (single and group), stability of finite slopes

a) TEXTBOOKS

1) Braja, M. Das, "Principles of Geotechnical Engineering", 10th Edition, Cengage India Private Limited; 2022. ISBN-13: 978-0357420478
2) Gopal Ranjan and Rao A.S.R., "Basic and Applied Soil Mechanics", 3rd Edition, New Age International (P) Ltd., New Delhi, 2016. ISBN-13: 978-8122440393

3) K.R. Arora, "Soil Mechanics & Foundation Engineering", 7th Edition, Standard Publishers, Distribution, 2009 (Reprint 2017). ISBN-13: 978-8180141126

4) B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, "Soil Mechanics and Foundation Engg.", 17th Edition, Laxmi Publications Co., New Delhi, 2017. ISBN-13: 978-8170087915

b) CODES OF PRACTICE

1) IS: 1904 - 2021 (Reaffirmed 2021), General Requirements for Design and Construction of Foundations in Soils - Code of practice, 4th Revision, Bureau of Indian Standards, New Delhi.

2) IS: 6403 - 1981 (Reaffirmed 2021), Code of practice for determination of bearing capacity of shallow foundations - 2nd Revision, Bureau of Indian Standards, New Delhi.

3) IS: 2911 – 2010 (Part 1 - Sec 1 to 4) (Reaffirmed 2020), Code of practice for design and construction of pile foundations: Part 1 Concrete piles, 1st Revision, Bureau of Indian Standards, New Delhi.

c) REFERENCES

1) VNS Murthy, "Textbook of Soil Mechanics and Foundation Engineering: Geotechnical Engineering series", CBS publishers, 2017. ISBN-13: 978-8123913629

2) J.E Bowles, "Foundation Analysis and Design", 5th Edition, McGraw Hill Pub. Co. New York. (2001). ISBN-13: 978-0071188449

3) D.F. McCarthy, "Essentials of Soil Mechanics and Foundations". Prentice-Hall, 2006. ISBN-13: 978-0131145603

V) COURSE PLAN

Module	Contents	No. of hours
I	Site investigation and soil exploration: objectives - planning - reconnaissance - Guidelines for choosing spacing and depth of borings [I.S. guidelines only] - Methods of subsurface exploration - test pits - Auger borings - Wash Boring - Rotary drilling - Standard Penetration Test - procedure and correlations - Corrections for SPT value - Numerical Problems. Sampling - disturbed samples, undisturbed samples and chunk samples - types of samplers - Sampler parameters - Boring log -Soil profile - Location of Water table. Geophysical methods: Seismic Refraction method and Electrical Resistivity method [in brief].	7
II	Foundation - General Considerations: Functions of foundations - definition of shallow and deep foundation - Selection of type of foundation - Different types of shallow foundations -advantages and limitations of various types of shallow foundations - floating foundations – well foundations – raft foundation [brief discussion only] Bearing capacity of shallow foundations: Gross and Net	9

	bearing pressure - Ultimate and Safe bearing capacity - Failure mechanism - Allowable soil pressure - Terzaghi's bearing capacity theory for strip footing [no derivation required] -Assumptions - Bearing capacity factors - Numerical problems - Terzaghi's formulae for circular and square footings - Numerical problems - Factors affecting bearing capacity - Effect of water table on bearing capacity - Numerical problems – Types of shear failure in shallow foundation - General, local and punching shear failure -Numerical problems	
III	Footings: Principles of design of footings -strip/continuous and individual footings -Numerical Problems - Combined footings - Rectangular and Trapezoidal combined footings - Numerical problems - Footings subjected to eccentric loading [Numerical not needed] Stress distribution in homogeneous and isotropic medium – Boussinesqs' theory – (Point load, Line load and uniformly distributed load) - Use of New marks influence chart Settlement analysis: Introduction - causes of settlement -estimation of immediate settlement - Numerical problems - Allowable Settlement - Maximum and differential settlements as per Indian standard - Field test - Plate load test - Procedure, uses and limitations	**10**
IV	Pile foundations - uses of piles - classification of piles - determination of type and length of piles - Bearing capacity of single pile in clay and sand [I.S. Static formulae] - Numerical problems - Negative skin friction - Numerical problems Group action - Group efficiency - Capacity of Pile groups -Numerical problems Dynamic formulae [Modified Hiley formulae only] - Numerical Problems - I.S. Pile load test [conventional]	**9**
V	Earth pressure: Earth pressure - At rest, active and passive earth pressures - Practical examples Rankine's theory - Earth pressure and point of application for cohesionless and cohesive soils - Influence of surcharge and water table on earth pressure - Numerical problems - Earth pressure with layered backfill - Numerical problems Stability of finite slopes - Toe failure, base failure, slip failure. Swedish Circle Method - Factor of safety with respect to cohesion and angle of internal friction - Stability number - Stability charts.	**10**
	Total hours	**45**

VI) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

VII) CONTINUOUS ASSESSMENT TEST

No. of Test	:	2
Maximum Marks	:	30 marks
Test Duration	:	1.5 hours
Topic	:	2.5 module

VIII) END SEMESTER EXAMINATION

Maximum Marks	:	**60 marks**
Exam Duration	:	3 Hours

Course Code	Course Name	Category	L	T	P	J	Credit
23HSL30A	Business Economics and Accountancy	HSC	3	0	0	0	3

i) COURSE OVERVIEW: To familiarize the prospective engineers with elementary Principles of Business Economics and Accountancy to analyse various business structures by using Economics principles and Accounting tools at an elementary level.

ii) COURSE OUTCOMES

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

CO 1	Explain the problem of scarcity of resources and consumer behaviour	Understand
CO 2	Examine the production efficiency and profitability with the help of quantitative and qualitative methods	Analyse
CO3	Interpret the macro-economic policies, trends and issues of the economy	Understand
CO4	Analyse business viability with the help of business models and financial planning.	Analyse
CO5	Develop an accurate and compliant balance sheet by classifying and recording financial transactions systematically	Apply

iii) SYLLABUS

Introductory Micro-Economics

Scarcity and choice - Basic economic problems- PPC – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.

Microeconomic Foundations: Production, Cost, Market Structures & Pricing Strategies

Production function – law of variable proportion – economies of scale – internal and external economies – Cobb-Douglas production function - Cost concepts - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point. Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopolyNon-price competition – Product pricing strategies

Introductory Macro-Economics

Circular flow of income-two sector and multi-sector models- National Income Concepts-Measurement Methods-Problems-Inflation, deflation - Fiscal Policy

(Government spending & taxation) - Monetary Policy (Interest rates & money supply) - Wage Rigidity & Unemployment - Demand-Pull vs. Cost-Push Inflation

Business Models and Financial Planning

Innovation and creativity in entrepreneurship - Business idea generation and feasibility analysis - Business planning (Lean Canvas, SWOT, PESTEL analysis) - Types of business structures (sole proprietorship, partnership, corporation) - Legal aspects and regulatory requirements - Sources of funding: Bootstrapping and personal savings, Venture capital and angel investors, Bank loans and government grants (Startup India, MSME financing), Crowdfunding and alternative finance - Financial planning and forecasting - Challenges in entrepreneurial finance (liquidity, risk management) - Exit strategies (IPO, mergers, acquisitions)

Introduction to Accounting

Book-Keeping and Accountancy- Elements of Double Entry- Book –Keeping-rules for journalizing-Ledger Accounts-Cash book- Banking transactions- Trial Balance- Method of Balancing accounts-the journal proper.

Final accounts: Preparation of trading and profit and loss Account- Balance sheet preparation and interpretation - Introduction to accounting packages. Modern methods in book keeping accounting.

iv) Text Books

1. Gregory N Mankiw, Principles of Micro Economics, Cengage Publications 2023
2. Gregory N Mankiw, Principles of Macro Economics, Cengage Publications 2023
3. Steven Rogers, Entrepreneurial Finance, McGraw-Hill, Fourth Edition, 2020
4. Agrawal R and Sriniwasan R, Accounting Made Easy, Tata McGraw-Hill 2010

REFERENCES

1. Dominick Salvatore, Theory and Problems of Micro Economic Theory. Tata Mac Graw- Hill, New Delhi.2017
2. Dwivedi D.N., Macroeconomics: Theory And Policy, Tata McGraw Hill, New Delhi 2018
3. Dornbusch, Fischer and Startz, Macroeconomics, McGraw Hill, 12th edition, 2018.
4. Janet Kiholm Smith and Richard L Smith, Entrepreneurial Finance: Venture Capital, Deal Structure & Valuation, Stanford Business Books US, 2019
5. M.Kasi Reddy and S.Saraswathi, Managerial Economics and Financial Accounting. Prentice Hall of India. New Delhi. 2008

v) COURSE PLAN

Module	Contents	No. of hours
I	Scarcity and choice - Basic economic problems - PPC – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes	9

	in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.	
II	Production function – law of variable proportion – economies of scale – internal and external economies – Cobb-Douglas production function - Cost concepts - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point. Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly - Non-price competition – Product pricing strategies	**8**
III	Circular flow of income - two sector and multi-sector models - National Income Concepts - Measurement Methods – Problems - Inflation, deflation - Fiscal Policy (Government spending & taxation) - Monetary Policy (Interest rates & money supply) - Wage Rigidity & Unemployment - Demand-Pull vs. Cost-Push Inflation	**9**
IV	Innovation and creativity in entrepreneurship - Business idea generation and feasibility analysis - Business planning (Lean Canvas, SWOT, PESTEL analysis) - Types of business structures (sole proprietorship, partnership, corporation) - Legal aspects and regulatory requirements - Sources of funding: Bootstrapping and personal savings, Venture capital and angel investors, Bank loans and government grants (Startup India, MSME financing), Crowdfunding and alternative finance - Financial planning and forecasting - Challenges in entrepreneurial finance (liquidity, risk management) - Exit strategies (IPO, mergers, acquisitions)	**9**
V	Book-Keeping and Accountancy - Elements of Double Entry - Book – Keeping - rules for journalizing - Ledger accounts - Cash book- Banking transactions - Trial Balance - Method of Balancing accounts - the journal proper. Final accounts: Preparation of trading and profit and loss Account - Balance sheet preparation and interpretation - Introduction to accounting packages. Modern methods in book keeping accounting	**10**
	Total	**45**

vi) Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	**:**	**40 Marks**

vii) End Semester Examination

There will be an end semester examination for 60 marks with a duration of 3 hours.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEP30C	Geotechnical Engineering Laboratory	PCC	0	0	3	0	2	2023

PRE-REQUISITE: 23CEL30C Soil Mechanics

i) COURSE OVERVIEW

Goal of this course is to determine the index and engineering properties of soil through lab and field tests. The course focuses on assessing soil behaviour, including California Bearing Ratio (CBR), to determine its suitability for construction applications.

ii) COURSE OUTCOMES

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

CO 1	Determine the index, and engineering properties of soil.	Apply
CO 2	Determine the sub grade strength of soil.	Apply
CO 3	Create detailed reports interpreting soil behaviour for engineering decision-making.	Create

ii) SYLLABUS

Index Properties of soil - Determination of water content and specific gravity, Grain size distribution, Atterberg limits.

Engineering Properties of soil - In-situ density, optimum moisture content (OMC) and maximum dry density (MDD), Permeability, Shear parameters, compressibility characteristics, California Bearing Ratio (CBR)

iii) a) TEXT BOOKS

1) Terzaghi, K., Theoretical Soil Mechanics, John Wiley & Sons, 1943. ISBN: 9780471853053.
2) Holtz, R. D. & Kovacs, W. D., An Introduction to Geotechnical Engineering, Prentice Hall India, 2nd edition, 2011. ISBN: 9780132496346
3) Mitchel, J. K., Fundamentals of Soil behaviour, John Wiley & Sons, 3rd edition, 2005. ISBN: 9780471463023.

b) REFERENCES

1) Murthy V.N.S., A Textbook of Soil Mechanics and Foundation Engineering, 2nd edition, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2011,ISBN: 9789810860899.
2) Ramamurthy T.N. & Sitharam T.G., Geotechnical Engineering (Soil Mechanics), 3rd edition, S Chand and Company Ltd., New Delhi, 2010, ISBN: 9788121924573.
3) Raj P. Purushothama, Soil Mechanics and Foundation Engineering, 2nd edition, Pearson India, New Delhi, 2008, ISBN: 9788131711774.

c) CODES OF PRACTICE

1) IS: 2720 (Part 1 to 41) - Methods of Tests for Soil, Bureau of Indian Standards, New Delhi. (Only relevant codes).

iv) COURSE PLAN

Experiment No.	Experiment	No. of hours
I	Determination of water content and specific gravity	**3**
II	Determination of Grain Size Distribution a) Sieve analysis b) Sedimentation analysis	**6**
III	Determination of Optimum Moisture Content	**3**
IV	Determination of Permeability test of soils a) Falling head permeability test b) Constant head permeability test	**3**
V	Determination of Shear parameters of soil a) Direct shear test b) Unconfined compression test	**6**
VI	Determination of compressibility characteristics of soil	**3**
VII	Determination of Atterberg Limits of Soil	**6**
VIII	Determination of CBR of a soil specimen	**3**
IX	Determination of In-situ density a) Sand replacement method b) Core cutter method	**6**
X	Soil Report Preparation – Compilation of geotechnical investigation results.	**3**
	Internal Lab test	**3**
	Total hours	**45**

v) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Continuous Assessment: Final Lab Assessment – 100: 0

Continuous Assessment		
Attendance	:	5 marks
Assessment of Lab Work Continuous Assessment in Lab (Lab work + Record + Viva - voce) -35 marks and Internal Lab test -20 marks	:	55 marks
Final Lab Assessment	:	40 marks
TOTAL	**:**	**100 marks**

Final Lab Assessment

Maximum Marks: 40
Exam Duration: 2.5 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEP30D	DESIGN STUDIO II	PCC	0	0	3	0	3	2023

i) PRE-REQUISITE: 23ESP10C Design Studio I, 23CEL20D Structural Analysis, 23CEL30A Design of Reinforced concrete structures

ii) COURSE OVERVIEW

The course aims to train the students to use different software tools needed for professional practice in civil engineering. Also the preparation of necessary engineering and project management documentation are included in this laboratory course

iii) COURSE OUTCOMES

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

CO 1	Analysis and design of structural components and multi-storeyed framed structure.	Analyse
CO 2	Prepare design details of different structural components	Apply
CO 3	Prepare architectural designs and generate floor plans, sections, elevations, and 3D visualizations using BIM tools	Apply
CO 4	Apply computer-aided techniques for civil engineering applications such as surveying, road network planning, foundation modelling, and pipe network simulations	Apply

iv) SYLLABUS

Analysis and design of steel and RCC elements and multi-storey frame, Preparation of structural drawings, Building Information Modelling tools, Modelling of water distribution network, isolated footing and road network, Terrain mapping using QGIS.

v) a) TEXTBOOKS

1. N. K. Raju, Structural Design and Drawing, 2nd ed. Hyderabad, India: Universities Press (India) Pvt. Ltd., 2009, ISBN: 978-81-7371-654-6.
2. 2) Autodesk, AutoCAD Essentials. Hoboken, NJ, USA: John Wiley & Sons, 2015, ISBN: 978-1-118-90485-3.
3. 3) C. Eastman, P. Teicholz, R. Sacks, and K. Liston, BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, 3rd ed. Hoboken, NJ, USA: Wiley, 2018, ISBN: 978-1-118-91787-7.

b) CODES OF PRACTICE

1. IS 456: 2000, Indian Standard Plain and Reinforced Concrete - Code of practice, 4th
2. revision, Bureau of Indian Standards, New Delhi

3. SP 34: 1987, Handbook on Concrete Reinforcement and Detailing Bureau of Indian

c) REFERENCES

1. Reference Manual of the Relevant Softwares

vi) COURSE PLAN

Cycle No. or Exp. No.	Experiment	No. of hours
I	Develop the 3D model of a residential building	**3**
II	Load Calculation and Structural System Identification of the building model	**3**
III	Analysis and design of cantilever/simply supported beams	**3**
IV	Analysis and design of continuous beams	**3**
V	Analysis and design of steel frames	**3**
VI	Analysis and design of multi-storied RCC framed structure	**3**
VII	Detailed structural drawing of continuous / flanged beams	**3**
VIII	Detailed structural drawing of continuous one way/two way slabs	**3**
IX	Detailed structural drawing of isolated footing	**3**
X	Use of Building Information Modelling tools: introduction to BIM Software	**3**
XI	Modelling of water distribution system using EPANET	**3**
XII	Terrain mapping, computation of areas using QGIS.	**3**
XIII	To set up a basic road network and understand traffic flow dynamics	**3**
XIV	Analyze a shallow foundation for its settlement under various load conditions.	**3**
	Internal Lab test	**3**
	Total hours	**45**

vii) ASSESSMENT PATTERN

Continuous Assessment : Final Lab Assessment – 100 : 0

Continuous Assessment		
Attendance	:	5 marks
Assessment of Lab Work	:	55 marks
Continuous Assessment in Lab (Lab work + Record + Viva - voce) -35		

marks and
Internal Lab test -20 marks

Final Lab Assessment	:	40 marks
TOTAL	**:**	**100 marks**

Final Lab Assessment

Maximum Marks: 40
Exam Duration: 2.5 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CES38A	SEMINAR	PWS	0	0	4	0	2	2023

i) COURSE OVERVIEW

The course involves exploring academic literature to select a relevant document in the student's area of interest and, under a seminar guide's supervision, develop skills in presenting and preparing technical reports. The course aims to enhance students ability to engage critically with scholarly work and communicate technical information effectively.

ii) COURSE OUTCOMES

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

CO 1	Investigate and synthesize information from diverse sources to gain a comprehensive understanding of a chosen technical topic.	Apply
CO 2	Interpret technical content to explore the practical implications and applications of emerging technologies in the field of engineering.	Apply
CO3	Utilize communication skills to articulate complex technical information through oral presentations and written report.	Apply
CO 4	Engage in constructive discussions and respond to questions and feedback.	Apply

iii) GENERAL GUIDELINES

- An Internal Evaluation Committee (IEC) shall be constituted by the department, comprising the program's HoD / Senior Faculty as Chairperson, along with the seminar coordinator and the student's seminar guide as members. All IEC members must be present during each student's seminar presentation.
- Formation of IEC and guide allotment shall be completed within a week after the End Semester Examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- The seminar topic should be current and broad-based/narrowly focused on specific research. Ideally, it should be closely related to the student's final year project area. Team members may select or be assigned seminar topics that cover different aspects of their common project theme.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.
- The IEC shall approve the selected topic/paper by the second week of the semester.

- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

iv. EVALUATION PATTERN

Total Marks	CIE Marks
100	100

CONTINUOUS ASSESSMENT EVALUATION PATTERN

Seminar Guide (20 Marks):

Background Knowledge – 10 marks (based on the student's understanding of the selected topic).

Relevance of Topic – 10 marks (based on the suitability and significance of the s elected paper/topic).

Seminar Coordinator (15 Marks):

Seminar Diary – 10 marks (weekly progress tracked and approved by the guide).

Attendance – 5 marks.

Evaluation of Presentation by IEC (45 Marks):

Clarity of Presentation – 10 marks.

Interaction – 10 marks (ability to answer questions).

Overall Participation – 10 marks (engagement during others' presentations).

Quality of the content – 15 marks.

Marks awarded by IEC for report (20 Marks)

PROGRAM ELECTIVE II

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL32A	ADVANCED STRUCTURAL ANALYSIS	PEC	3	0	0	0	3	2023

i) PRE-REQUISITE: 23CEL20D STRUCTURAL ANALYSIS

ii) COURSE OVERVIEW

This course introduces students to advanced methods and concepts in structural analysis, focusing on three-hinged arches and the matrix analysis of structures, particularly the direct stiffness method. It also provides a foundation in finite element methods, which form the basis of many structural analysis software, and offers a brief introduction to structural dynamics and plastic analysis.

iii) COURSE OUTCOMES

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

CO 1	Analyse multi-storeyed frames by substitute frame method.	Analyse
CO 2	Apply the displacement methods to determine internal forces in framed structures.	Apply
CO 3	Apply the basic principles of structural dynamics to simple structures to determine their structural response	Apply
CO 4	Apply fundamental concepts of the finite element method to solve the governing equations.	Apply
CO 5	Apply suitable methods of analysis for indeterminate arches, cables and suspension bridges.	Apply

iv) SYLLABUS

Approximate Methods- substitute frames, Matrix Analysis of Structures- Direct stiffness method, Analysis of two hinged arches- Support reactions normal thrust and radial shear, influence line for horizontal thrust, bending moment, normal thrust, and radial shear, Structural dynamics- degrees of freedom, free response of damped and undamped systems, Finite Element Methods- Basic Concepts, Introduction to Elasticity, approximate numerical solutions, Formulation techniques.

v) a) TEXTBOOKS

1) M. G. James and W. Weaver, Matrix Analysis of Framed Structures, CBS Publishers, 2nd edition, 2018.
2) C. S. Krishnamoorthy, Finite Element Analysis: Theory and Programming, Tata McGraw Hill, 2nd edition, 2019.
3) Madhujit Mukhopadhyay, M. and Sheikh Abdul Hamid, Matrix and Finite Element Analyses of Structures, Ane Books, 1st edition, 2015
4) R. Vaidyanathan and P. Perumal, Comprehensive Structural Analysis Volume I & II, Laxmi Publications (P) Ltd, 4th edition, 2024
5) C. K. Wang, Intermediate Structural Analysis, McGraw Hill Education, 1st edition, 2017

b) REFERENCES

1) M. G. James and W. Weaver, Matrix Analysis of Framed Structures, CBS Publishers, 2nd edition, 2018.

2) R.C. Hibbeler, Structural Analysis, Pearson, 10th edition, 2022

3) Anil K. Chopra, Dynamics of Structures- Theory and application to Earthquake Engineering, Prentice Hall of India, 3rd edition, 2008.

4) K. J. Bathe, Finite Element Procedures in Engineering Analysis, Prentice Hall of India, 2006.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Review of Fundamental Concepts: Analysis of statically determinate beams, frames, trusses: Indeterminate structures: Slope deflection method, consistent deformation method, moment distribution method Approximate Methods of Analysis of Multi-storeyed Frames: Analysis for vertical loads-substitute frames-loading condition for maximum hogging and sagging moments in beams and maximum bending moment in columns. Cables: Analysis of forces in cables under concentrated and uniformly distributed loads - Anchor Cable supports. Suspension Bridges: Un-stiffened suspension bridges, maximum tension in the suspension cable and backstays, pressure on towers.	**8**
II	Matrix Analysis of Structures: Reviewing the definition of flexibility and stiffness influence coefficients, and concepts of physical approach Direct stiffness method: Introduction to direct stiffness method- Rotation of axes in two dimensions, stiffness matrix of elements in global co- ordinates from element co-ordinates- assembly of load vector and stiffness matrix, solution of two span continuous beam- single bay single storey portal frame.	**9**
III	Two hinged Arches: Analysis of two hinged arches - Support reactions normal thrust and radial shear at any section of a parabolic arch due to simple cases of loading, influence line for horizontal thrust, bending moment, normal thrust, and radial shear. Plastic Theory: Introduction – plastic hinge concepts – plastic modulus – shape factor – redistribution of moments – collapse mechanisms – Plastic analysis of beams and portal frames by equilibrium and mechanism methods. (single storey and single bay frames only)	**10**

IV	Structural dynamics: Introduction - degrees of freedom - equation of motion, D'Alembert's principle-damping- free response of damped and undamped systems- logarithmic decrement-- single degree of freedom systems subjected to harmonic load - transient and steady state responses, simple portal frame problems.	**9**
V	Finite Element Methods: Basic Concepts of Finite Element Analysis, Introduction to Elasticity, Steps in Finite Element Analysis, Types of 1D, 2D and 3D elements- element properties- polynomial form shape function form- equilibrium and compatibility in the solution- convergence requirements, boundary conditions.	**9**
	Total hours	**45**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

ix) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL32B	PRESTRESSED CONCRETE	PEC	3	0	0	0	3	2023

PRE-REQUISITE: 23CEL20A Mechanics of Structures, 23CEL20D Structural Analysis and 23CEL30A Design of Reinforced Concrete Structures

i) COURSE OVERVIEW

course provides a comprehensive understanding of the principles, analysis, and design of prestressed concrete structures. It covers topics such as prestressing methods, losses in prestress, design of beams for flexure and shear, and stress distribution in anchorage zones. Students will also learn about slabs and apply IS 1343 code provisions for practical design and analysis.

ii) COURSE OUTCOMES

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

CO 1	Explain the general mechanism of prestressed concrete members	Understand
CO 2	Analyse the behaviour of prestressed concrete beams	Analyse
CO 3	Apply codal provisions to design prestressed concrete beams under flexure and shear	Apply
CO 4	Analyse prestressed slabs	Analyse
CO 5	Analyse and design anchorage zones in prestressed beams	Analyse

iii) SYLLABUS

General Principles - Introduction, methods (pre-tensioning, post-tensioning), IS 1343 code.

Analysis and Losses - Beam analysis (flexure, stresses), losses

Design of beams for Flexure and Shear - Elastic and limit state design, flexural strength, shear resistance, reinforcement design.

Slabs - Design of One way slab - Two way slab

Anchorage Zone Stresses - Stress distribution in end blocks, bursting forces, reinforcement design.

iv) a) TEXTBOOKS

1) N. Krishna Raju, Prestressed Concrete, 6th edition, Tata McGraw-Hill Education, 2020, ISBN-13: 978-9387886209.
2) S. Ramamrutham, Design of Prestressed Concrete Structures, 4th edition, Dhanpat Rai Publishing, 2022, ISBN-13: 978-9352161324.
3) P. Dayaratnam, Prestressed Concrete Structures, 6th edition, Oxford & IBH Publishing, 2021, ISBN-13: 978-8120417915.

4) Praveen Nagarajan, Prestressed Concrete Design, 1st edition, Pearson Education, 2021, ISBN-13: 978-9332513754.
5) Arthur H. Nilson, Design of Prestressed Concrete, 6th edition, John Wiley & Sons, 2023, ISBN-13: 978-0471830726.

b) CODES OF PRACTICE

1) IS: 1343 - 2012 (Reaffirmed in 2018), Indian Standard Code of Practice for Prestressed Concrete, 1st revision, Bureau of Indian Standards, New Delhi.
2) IS: 1786 - 2008 (2018), Indian Standard High Strength Deformed Steel Bars and Wires for Concrete Reinforcement – Specification, 4th revision, Bureau of Indian Standards, New Delhi.

c) REFERENCES

1) Lin, T. Y. and Burns, N. H., Design of Prestressed Concrete Structures, 3rd edition, John Wiley & Sons, 2021.
2) Nawy, E. G., Prestressed Concrete: A Fundamental Approach, 6th edition, Pearson Education, 2020.
3) Collins, M. P. and Mitchell, D., Prestressed Concrete Structures, 2nd edition, Prentice Hall, 2019.
4) Naaman, A. E., Prestressed Concrete Analysis and Design: Fundamentals, 4th edition, Techno Press, 2022.
5) Rajagopalan, N., Prestressed Concrete, 5th edition, PHI Learning, 2021.

v) COURSE PLAN

Module	Contents	No. of hours
I	**General Principles of Pre Stressed Concrete:** Introduction: Basic concepts Materials –Need for High strength materials. Advantages and Applications of prestressed concrete. Different methods of Pre stressing. Pre-tensioning and post-tensioning. Hoyer System, Freyssinet system, Magnel-Blaton system, Lee Mecal system. Use of IS 1343 code, concepts of pre tensioned and post tensioned elements.	7
II	**Analysis and Losses of PSC beams:** Analysis of sections for pre stress and flexure for Straight Concentric, Eccentric, Bent and Parabolic Tendons. Pressure Line Cable, concept of cracking moment of resistance. Load balancing concept. Short term and Long term losses in P.S.C.	10
III	**Design of Section for Flexure and Shear:** Elastic Design and Limit state method -Design of Rectangular and I Section beams for Flexure. Check for ultimate flexural strength as per I S 1343	10

	Codal Provisions. Design of Section for Shear- Shear and principal stresses. Factors affecting shear resistance, Cracked and uncracked sections Codal provisions - ultimate shear resistance. Design of shear reinforcement in beams.	
IV	**Slabs:** Design of One way slab - Two way slab	**9**
V	**Anchorage Zone stress in Post tensioned members:** Stress distribution in End Block- Analysis by Magnel and Guyon's methods – IS 1343 Code Provisions – Bursting Tensile Force Design of anchorage zone reinforcement.	**9**
	Total hours	**45**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

IX) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL32C	GROUND IMPROVEMENT TECHNIQUES	PEC	3	0	0	0	3	2023

i) PRE-REQUISITE: 23CEL30C Soil Mechanics

ii) COURSE OVERVIEW

Goal of this course is to introduce students to various types of ground improvement techniques that can be adopted in different conditions.It enables the students to choose the suitable ground improvement techniques to be adopted depending on the site conditions and requirements.

iii) COURSE OUTCOMES

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

CO 1	Classify different ground improvement methods and its construction procedures based on soil suitability and sustainability	Understand
CO 2	Choose different applications of drainage and drains in ground improvement	Apply
CO 3	Summarize different applications of reinforced materials and geosynthetics in ground improvement	Understand
CO 4	Explain the principles of soil stabilization, nanotechnology and grouting for ground improvement	Understand

iv) SYLLABUS

Role of ground improvement in foundation engineering- Sustainable development and energy geotechnology- Microbial methods- In Situ densification process- dynamic methods- vibration methods-Drainage and dewatering- Earth reinforcement- Soil nailing and micropile- Use of Geosynthetics- Grouting techniques- Thermal method- Soil stabilization-Brief introduction to nanotechnology and soil fracturing techniques- Case histories

v) a) TEXTBOOKS

1) Bikash Chandra Chattopadhyay & Joyanta Maity, Ground Improvement Techniques,1st Edition, PHI Learning, ISBN-13:978-8120353206, 2017.
2) Nihar Ranjan Patra, Ground Improvement Techniques,1st Edition, Vikas Publishing Home, ISBN-13:978-9325960015, 2012.

b) REFERENCES

1) Abdeltif Amrane, Dinesh Mohan, Aymen Anine Assadi, Ghulam Yasin and Tuan Anh Nguyen, Nanomaterials for Soil remediation, 1st Edition, Elsevier, ISBN: 9780128228913, 2020.
2) Alessio Ferrari, Lyesse Laloai, Energy Geotechnics,1st Edition, Springer series in Geomechanics and Geoengineering, ISBN 13:978-3319996691, 2018.
3) K. Krisvch and F. Krisch, Ground Improvement by Deep Vibratory Methods, 2nd Edition, Spon Press, Taylor and Francis, ISBN 13: 978-1-4822-5756-4, 2017.
4) Donald P Coduto, Foundation Design Principles and Practices, 3rd Edition, Pearson, Indian edition, ISBN: 978-0-13-341189-8, 2015.
5) Buddhima Indraratna and Jian Chu, Ground Improvement: Case Histories,1st Edition, Elsevier, ISBN: 978-0-08-100191-2, 2014.
6) Manfred R, Hausmann, Engineering Principles of Ground Modification, Mc. Graw Hill, ISBN 13:978-9351341871, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Role of ground Improvement in foundation engineering- Classification of ground improvement methods- different problematic soil- selection of suitable ground improvement based on the soil condition; Sustainable development and energy geotechnology- objectives, energy geotechnology, geothermal energy, use of underground space for energy storage; Microbial Geotechnology- objectives, bioclogging, biocementation,limitations, Case histories on microbial geotechnology.	**9**
II	In-Situ densification- deep compaction and shallow compaction, properties of compacted soil and compaction control; Dynamic Compaction- procedure, design considerations, soil suitability, merits and demerits; Vibration Methods- vibro compaction techniques- blasting, vibrating compactors; Vibro displacement methods-vibroflotation sand pile, stone column, lime-sand column, lime-pile- principle, installation procedure, basic design considerations, soil suitability, merits and demerits, Case histories on vibration techniques.	**9**

III	Drainage Methods- methods of dewatering systems-open sump, well points, vacuum dewatering and electro-osmotic methods; Drains- drainage facility after construction-foundation drain, blanket drain and interceptor drains; Precompression and vertical drains- preloading, vertical drain-general principle, soil suitability, sand drain, PVD installation procedure, Case histories on Drainage Methods	**9**
IV	Earth reinforcement- reinforcement materials, reinforced earth wall, design considerations, construction procedure; Soil nailing and Micropile- basic concept, construction sequence, areas of application, design considerations, merits and demerits, Case histories on earth reinforcement; Geosynthetics- use, types, functions- filtration, drainage, separation- Applications of geotextile in different works; Case histories on application of geosynthetics; Brief introduction on soil fracturing techniques for terminating settlements and restoring levels of buildings, Case histories on Soil Fracturing technique.	**9**
V	Grouting techniques- grouting material- groutability-stabilization with cement, lime and chemicals, Classification of grouting techniques- compaction grouting, penetration grouting, jet grouting, displacement grouting- procedure- soil suitability- merits and demerits- Case histories; Thermal methods- stabilization by heating and cooling- Case histories; Soil stabilization- fundamental concept of soil- cement stabilization, mechanism of lime stabilization, Case histories on lime stabilization; Nanotechnologies in ground improvement and site remediation- evolution of technology, applications in geotechnical engineering, implementation in India, limitations- Case histories on nano technology.	**9**
	Total hours	**45**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks

Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

ix) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL32D	Applied Soil Engineering	PEC	3	0	0	0	3	2023

PRE-REQUISITE: 23CEL30C Soil Mechanics

i) COURSE OVERVIEW

This course focuses on designing stable retaining walls, deep excavations, tunnels, slopes, and underwater foundations using geotechnical principles and advanced stabilization techniques.

ii) COURSE OUTCOMES

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

CO 1	Describe various geotechnical design principles and construction practices for ensuring stability in soil-structure interaction	Understand
CO 2	Apply earth pressure theories to design stable retaining walls and select appropriate design principles and construction techniques of deep excavations and diaphragm walls under various soil conditions.	Apply
CO 3	Examine stress redistribution concepts in soil arching to design tunnels and conduits .	Apply
CO 4	Choose suitable methods to stabilize slopes using geosynthetics and drainage control techniques.	Understand
CO 5	Examine construction techniques for cofferdams and underwater foundations in challenging environments.	Apply

iii) SYLLABUS

Earth Pressure Theories and Design of Retaining Walls -Open Cuts & Deep Excavations, Diaphragm Walls -Theory of Arching in Soils and its Applications in Design of Tunnels & Conduits - Slope Stability-Cofferdams and Foundation below water - Earth Dams and Embankments - Choice of Material, Filters and Drains - Selection of suitable materials, Design of core and shell, Filter and drainage design, Seepage control measures, Stability analysis.

iv) a) TEXTBOOKS

1) H. Y. Fang, Foundation Engineering Handbook, 2nd edition, CBS Publishers and Distributors, New Delhi, 2004. ISBN: 9780824750277
2) Budhu, M., Soil Mechanics and Foundations, 1st edition, John Wiley & Sons Inc., New York, N.Y., 2000. ISBN: 9780471431176

3) Ranjan, G. and Rao, A. S. R., Basic and Applied Soil Mechanics, 2nd edition, New Age International (P) Ltd., New Delhi, 2000. ISBN: 9788122423196

b) REFERENCES

1) R. D. Holtz and W. D. Kovacs, An Introduction to Geotechnical Engineering, 2nd edition, Prentice Hall India, 2011. ISBN: 9780132496346
2) B. M. Das, Principles of Foundation Engineering, 7th edition, PWS Publishing, Pacific Grove, California, 2011. ISBN: 9780495668107

v) COURSE PLAN

Module	Contents	No. of hours
I	Design of Retaining Walls – Concepts of earth pressure, Rankine's and Coulomb's earth pressure theories, Active and passive earth pressures, Design principles of retaining walls. Types of retaining walls – Gravity, Cantilever, Counterfort, Mechanically Stabilized Earth(MSE) walls, Stability analysis – Overturning, Sliding, Bearing capacity failure, Drainage and backfill considerations.	**9**
II	Introduction to Open Cuts and Deep Excavations, Diaphragm Walls – Stability of deep excavations, Braced and strutted excavations, Design principles of diaphragm walls, Construction methods, Applications in deep excavations and underground structures.	**9**
III	Theory of Arching in Soils and its Applications in Design of Tunnels & Conduits – Concept of arching effect in soils, Load transfer mechanism, Stress redistribution, Factors affecting arching, Application in tunnel and conduit design, Practical implications in geotechnical structures.	**9**
IV	Introduction to Slope Stability, Slope Protection and Stabilization – Different methods of analysis – Limit equilibrium method, Infinite slope analysis, Bishop's and Fellenius methods, Factors affecting slope stability, Landslide mitigation techniques, Slope reinforcement methods, Use of geosynthetics for slope stabilization, Drainage control measures. Introduction to Geostudio software for slope stability analysis.	**9**
V	Introduction to Cofferdams and Foundation Construction Below Water – Types of cofferdams, Design and construction methods, Dewatering techniques, Underwater concreting	**9**

	methods, Stability considerations, Applications in bridge and marine construction. Introduction to Earth Dams and Embankments – Choice of material, Selection of suitable materials- core and shell, Filter and drainage design, Seepage control measures, Stability analysis, Erosion protection methods, Construction and maintenance practices.	
	Total hours	**45**

vi) ASSESSMENT EVALUATION PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of Test : 2
Maximum Marks : 30 marks
Test Duration : 1.5 hours
Topic : 2.5 module

viii) END SEMESTER EXAMINATION

Maximum Marks : **60 marks**
Exam Duration : 3 Hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL32E	APPLIED HYDROLOGY	PEC	3	0	0	0	3	2023

i) PRE-REQUISITE: 23CEL20E HYDROLOGY AND WATER RESOURCES ENGINEERING

ii) COURSE OVERVIEW

This course covers fundamental and complex principles of surface and groundwater hydrology, including rainfall analysis, infiltration, evapotranspiration, runoff, flood estimation, routing and environmental flow. It emphasizes analytical methods and practical applications in water resources management with a focus on advanced hydrological modelling.

iii) COURSE OUTCOMES

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

CO 1	Describe the concepts and fundamentals of the various components of hydrologic cycle.	Understand
CO 2	Make use of rainfall data and concept of hydrographs for the estimation of infiltration , evapotranspiration and runoff.	Apply
CO 3	Identify the behaviour and response of the catchments by developing the stage discharge curves.	Apply
CO 4	Utilize hydrological and statistical principles for the estimation of flood discharge.	Apply
CO 5	Identify the planning and operational strategies of reservoirs and dams in the context of maintaining or restoring environmental flows.	Apply

iv) SYLLABUS

Hydrology and Hydrologic cycle, Catchment characteristics, Runoff - Computation of runoff– Hydrograph analysis, Application of linear regression in hydrologic modelling, Design flood and their Estimation, Flood Routing, Flood control methods - Flood forecasting and warning, Fundamental concept of environmental flow - reservoir and dam planning

v) a) TEXTBOOKS

1) K. Subramanya and Priyank J Sharma, Engineering Hydrology, 6th edition, Tata McGraw Hill, ISBN-13: 978-9355327949, 2024.
2) Ven Te Chow, Hand book of Applied Hydrology, Tata McGraw Hill, 2nd edition, ISBN-13**:** 978-0071835091, 2017

3) Angela H. Arthington, Environmental Flows: Saving Rivers in the Third Millennium, ISBN-13: 978-0520273696 Univ of California Press, 2012

b) REFERENCES

1) Sharad K Jain and Vijay P Singh, Engineering Hydrology, 1st edition, McGraw Hill, ISBN-13: 978-1259641978, 2019.
2) P.Jaya Rami Reddy, A Textbook of hydrology, Laxmi publications, 3rd edition, ISBN-13: 978-9380856049, 2019.
3) C. S. P Ojha, R. Berndtsson, P. Bhunya, Engineering Hydrology, Oxford University Press Learning, 9th edition, ISBN-13: 978-0195694611, 2016.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Hydrology and Hydrologic cycles, Test for consistency of rainfall data – Double Mass Curve, Analysis of rainfall data intensity, duration, frequency (IDF) curves, Depth area duration (DAD) curve. Frequency analysis-probable maximum precipitation, Hydrologic abstractions- Infiltration- Green Ampt method, Evapotranspiration- methods of estimation-Blaney Criddle method Penman method, Penmann-Montieth method.	**9**
II	Catchment Characteristics, Classification of streams – Stream pattern and stream order, Stream gauging- different methods, Selection of site for stream gauging stations. Stage Discharge Curve, Extension of stage discharge curve. Adjustment of stage discharge curve.	**9**
III	Runoff - Computation of runoff -Rational and SCS curve number method, Hydrograph analysis and S- Hydrograph, Unit hydrograph from complex storm, Synthetic unit hydrograph, Instantaneous unit hydrograph, Linear reservoir model, Application of linear regression in hydrologic model.	**9**
IV	Design flood - Estimation - Different methods. Flood frequency studies -Gumbel's method, Flood Routing-Hydrologic and Hydraulic routing, Flood routing through reservoirs – concept and approaches, Flood routing through channels - Muskingum method. Flood control methods, Flood forecasting and warning. Flood modeling using HECRAS	**9**

V	Fundamental concept of environmental flow – catchment drainage network and resource regimes – river ecology, the natural flow regime paradigm and hydro ecological principles – reservoir and dam Planning – institutionalizing environmental flow through adaptive reservoir operations – defining environmental water status - effects of catchment change and river corridor engineering	**9**
	Total hours	**45**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

ix) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL32F	MUNICIPAL SOLID WASTE MANAGEMENT	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

The goal of this course is to create an awareness of different types of solid waste generated in our environment and their ill effects. The course also gives the details of various municipal solid waste management methods like generation of solid waste, storage, collection, processing and disposal technologies.

ii) COURSE OUTCOMES

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

CO 1	Explain the classification and characteristics of solid wastes based on their source.	Understand
CO 2	Identify the composition and methods of quantifying municipal solid waste.	Apply
CO 3	Analyse efficient storage and collection systems and processing techniques for municipal solid waste.	Analyse
CO 4	Explain the disposal of municipal solid wastes by sanitary landfill and incineration technologies.	Understand
CO 5	Identify appropriate biological processing techniques such as composting and anaerobic digestion to manage municipal solid waste effectively.	Apply

iii) SYLLABUS

Solid wastes- Categories, Sources, Characteristics. Solid waste management rules. Generation of solid wastes, Collection of solid Wastes, Processing techniques, Disposal technologies- Physical, Thermal, Biological methods. Energy from solid wastes. Case studies on smart and sustainable municipal solid waste management systems.

iv) a) TEXTBOOKS

1) Peavy, H. S., Rowe, D. R. and Tchobanoglous, G., Environmental Engineering, McGraw Hill Education, 2nd edition, ISBN-13: 978-9351340263, 2017.
2) CPHEEO, Manual on Municipal Solid Waste Management, Ministry of Urban Development, Government of India, 2000.
3) Worrell, W. A., Vesilind, P. A. and Ludwig, C., Solid Waste Engineering: A Global Perspective, Cengage learning, 3rd edition, ISBN-13: 978-1305635203, 2016.
4) Tchobanoglous, G. and Kreith, F., Handbook of Solid Waste Management, McGraw hill publications, New York, ISBN-13: 978-0071356237, 2002.

b) REFERENCES

1) Pichtel, J., Waste Management Practices, Taylor and Francis publishers, 2nd edition, ISBN-13: 978-1466585188, 2014.
2) Cornwell, D. A. and Davis, M. L., Introduction to Environmental Engineering, McGraw Hill International Edition, 5th edition, ISBN-13: 978-0073401140, 2012.
3) Botkin, D. B. and Keller, E. A., Environmental Science (Earth as a living plant), John Wiley and Sons Inc, 4th edition, ISBN-13: 978-0471389149, 2005.

v) COURSE PLAN

Module	Contents	No. of hours
I	Wastes-Terms and definitions, Sources, Characteristics and Management. Categories of wastes- Municipal, Industrial, Medical, Universal, Construction and demolition debris, Radioactive, Mining, E wastes, Agricultural waste. Solid waste management rules.	**9**
II	Municipal solid waste generation- Methods of estimation of generation rate, Measure of quantities, Sampling procedure, Composition- Physical and chemical. Storage of solid waste.	**9**
III	Collection – Collection services, Collection systems, Collection routes, Need for transfer operation. Processing techniques- Mechanical volume and size reduction, Chemical volume reduction, Component separation, Drying.	**9**
IV	Disposal of solid waste- Sanitary landfill- Area method, Trench method- Advantages and disadvantages. Incineration- Types of incinerators, Parts of an incinerator, Incinerator effluent gas composition.	**9**
V	Composting- Types of composting- Indore process, Bangalore process-Advantages and disadvantages. Anaerobic digestion of wastes, Biogas digesters. Case studies on smart and sustainable municipal solid waste management systems, Black Soldier Fly Composting, Compact Composting Systems for Apartments.	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL32G	Traffic Flow Modelling	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

The goal of this course is to introduce the foundational and advanced principles of traffic flow theory and its applications. It covers mathematical modeling of traffic streams, traffic flow parameters, macroscopic and microscopic traffic models, queuing theory, and network traffic modeling. The course integrates theoretical approaches with practical applications, emphasizing problem-solving and software tools for traffic simulation.

ii) COURSE OUTCOMES

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

CO 1	Explain the fundamental concepts and parameters of traffic flow theory	Understand
CO 2	Apply mathematical models to simulate and analyze traffic stream behavior under varying conditions	Apply
CO 3	Explain macroscopic and microscopic traffic flow models and their applications	Understand
CO 4	Make use of queuing theory and network analysis techniques to determine traffic flow	Apply
CO 5	Apply techniques of traffic flow modelling and simulation through the use of software tools	Apply

iii) SYLLABUS

Traffic flow parameters: Speed, flow, and density relationships; Fundamental diagrams of traffic flow, Measurement techniques, and data collection

Continuum models and flow-density relationships; Lighthill-Whitham-Richards (LWR) model; Shockwave analysis and applications

Car-following theories and models; Lane-changing models; Cellular automata for traffic flow

Basic queuing theory principles; Applications in traffic intersections and toll plazas; Delay models and analysis

Network Traffic Modelling and Simulation; Traffic assignment and route choice models; Dynamic traffic assignment; Introduction to traffic simulation software (e.g., VISSIM or SUMO)

iv) a) TEXTBOOKS

1. L. R. Kadiyali, Traffic Engineering and Transport Planning, 8th edition, Khanna Publishers, 2017, 978-8174092205
2. Fred L. Mannering, Scott S. Washburn, & Walter P. Kilareski, Principles of Highway Engineering and Traffic Analysis, 6th edition, Wiley, 2020, ISBN 978-1119305026
3. Roger P. Roess, Elena S. Prassas, & William R. McShane, Traffic Engineering, 5th edition,

Pearson, 2019, ISBN 978-9353434854

b) REFERENCES

1. Carlos F. Daganzo, Fundamentals of Transportation and Traffic Operations, 1st edition, Elsevier, 1997. ISBN 978-0080427850
2. Adolf D. May, Traffic Flow Fundamentals, 1st edition, Prentice Hall, 1990, ISBN 978-0139260728
3. Martin Treiber & Arne Kesting, Traffic Flow Dynamics: Data, Models and Simulation, 1st edition, Springer, 2013, 978-3642324598
4. Markos Papageorgiou, Applications of Automatic Control Concepts to Traffic Flow Modelling and Control, 1st edition, Springer, 1983, ISBN 9783540122371
5. Nicholas J. Garber & Lester A. Hoel, Traffic and Highway Engineering, 5th edition, Cengage Learning, 2014, 978-1133605157
6. C. Jotin Khisty & B. Kent Lall, Transportation Engineering: An Introduction, 4th edition, Pearson, 2018, 978-9332569706
7. C. S. Papacostas & P. D. Prevedouros, Transportation Engineering and Planning, 3rd edition, Pearson, 2015, 978-9332555150

c) CODES OF PRACTICE

1. Highway Capacity Manual, 7th edition, Transportation Research Board, 2022.
2. Indian Highway Capacity Manual (Indo-HCM), 1st edition, CSIR-Central Road Research Institute (CRRI), 2017.

V) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Traffic Flow Modelling**: Overview of traffic flow theory and its importance in transportation systems; Traffic flow parameters: Speed, flow, density, headway, and their interrelationships; Fundamental diagrams of traffic flow: Flow-density, speed-density, and speed-flow relationships; Traffic data collection techniques: Manual surveys, loop detectors, ANPR cameras, and GPS-based methods; Real-world applications of traffic flow theory	**9**
II	**Macroscopic Traffic Flow Models**: Overview of macroscopic modeling: Traffic as a continuous flow; Fundamental models of traffic flow: Greenshields, Greenberg, Underwood models; Continuum modeling: Lighthill-Whitham-Richards (LWR) model; Shockwaves: Formation, propagation, and dissipation; Applications of shockwave analysis: Bottlenecks, traffic incidents, and congestion management	**9**

III	**Microscopic Traffic Flow Models:** Introduction to microscopic models: Vehicle behavior and interactions; Car-following models: Basic principles and examples (Gipps, Newell, and IDM models); Lane-changing models: Decision-making process, critical gaps, and driver behavior; Cellular Automata Models for traffic flow: Basic rules and simulation; Calibration and validation of microscopic models	**9**
IV	**Queuing Theory in Traffic Flow:** Basics of queuing theory: Terminology and classifications (FIFO, LIFO, and priority queues); Application of queuing theory in traffic intersections and toll plazas; Delay models and their impact on traffic system performance; Traffic signal analysis: Webster's method for signal design; Real-world examples: Queue dynamics in transportation	**9**
V	**Network Traffic Modelling and Simulation:** Introduction to network modeling: Traffic assignment and route choice models; Static vs. Dynamic Traffic Assignment (DTA): Concepts and differences; Tools and techniques for traffic simulation: Introduction to software like VISSIM and SUMO; Case studies: Traffic flow simulation for urban areas and highways; Limitations and future developments in traffic flow modeling and simulation	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

INSTITUTE ELECTIVE I

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23IEL31A	GREEN BUILDING AND ENERGY MANAGEMENT	IEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

Goal of this course is to expose the students to the principles and practices of green building design, construction and operation, with a focus on energy management and sustainability.

ii) COURSE OUTCOMES

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

CO1	Explain the principles, benefits, and key certifications of green buildings and sustainable design.	Understand	
CO2	Describe sustainable construction materials, waste management, and energy-efficient building systems.	Understand	
CO3	Apply energy management strategies, renewable energy technologies, and smart building techniques.	Apply	
CO4	Discuss building performance assessment methods, energy audits, BIM, and sustainability policies.	Understand	

iii) SYLLABUS

Introduction to Green building - benefits, and history, sustainability and major certifications like LEED, IGBC, and GRIHA.

Eco-friendly materials - water-saving methods, effective waste management in sustainable construction.

Energy-efficient MEP systems - smart technologies, and renewable energy sources like solar, wind, and geothermal.

Passive/active design - water and energy conservation, indoor quality, site planning, and energy audits.

Building performance tools - BIM, LCA - policies, incentives, and real-world green building case studies and trends.

iv) a) TEXTBOOKS

1. Kibert, C. J., Sustainable Construction: Green Building Design and Delivery, 5th edition, Wiley, ISBN: 9781119706455, 2022.
2. Ching, F. D. K., & Shapiro, I. M., Green Building Illustrated, 2nd edition, Wiley, ISBN: 9781119584459, 2020.

3. Capehart, B. L., Turner, W. C., & Kennedy, W. J., Guide to Energy Management, 8th edition, CRC Press, ISBN: 9780367333427, 2020.

b) REFERENCES

1. Yang, P., Renewable Energy: Challenges and Solutions, Springer, ISBN: 9783031421034, 2024.
2. Uherova Hasbani, K., Sustainable Energy Management: Policies and Technologies, Springer, ISBN: 9783030613782, 2021.
3. Kubba, S., Handbook of Green Building Design and Construction: LEED, BREEAM, and Green Globes, 2nd edition, Butterworth-Heinemann, ISBN: 9780128104439, 2016.
4. Sayigh, A., Sustainability, Energy, and Architecture: Case Studies in Realizing Green Buildings, Elsevier, ISBN: 9780123972705, 2016.
5. Lechner, N., Heating, Cooling, Lighting: Sustainable Design Methods for Architects, 4th Ed., Wiley, ISBN: 9781118582425, 2014.
6. Wilson, A., The Building Green Guide to Insulation Products and Practices, Building Green, Inc., ISBN: 9781934429257, 2013.
7. Balcomb, J. D., Passive Solar Buildings, MIT Press, ISBN: 9780262518844, 2013.
8. Yudelson, J., The Green Building Revolution, Island Press, ISBN: 9781597261791, 2008.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Green Building and Sustainable Design - Definition and principles of green buildings, history and evolution, benefits (environmental, economic, health), key certifications (LEED, BREEAM, WELL, IGBC, GRIHA). Introduction to sustainability concepts - climate-responsive design, green building rating systems - their application in real-world projects.	**9**
II	Sustainable Construction Materials and Waste Management - Low-impact and eco-friendly materials - Recycled and locally sourced materials, Green insulation solutions, Green certifications for materials (Cradle to Cradle, FSC), Rainwater harvesting, greywater recycling, and smart water sensors, Wastewater treatment & solid waste management in green buildings.	**9**
III	Building Systems for Energy Efficiency and Renewable Energy - Overview of mechanical, electrical, and plumbing (MEP) systems in buildings, advanced Heating, Ventilation, and Air Conditioning (HVAC) technologies, energy-efficient lighting and control systems, smart building technologies and automation. Renewable energy systems for buildings - solar photovoltaic (PV) and thermal systems, wind energy integration, geothermal heat pumps, biomass energy systems, energy storage solutions, and smart grid integration.	**9**

IV	Sustainable Design Principles and Energy Management - Energy efficiency principles and strategies - passive and active design techniques, water conservation methods, indoor environmental quality improvement strategies. Site selection and planning considerations for optimizing energy use and sustainability - importance of energy management- energy consumption patterns in buildings - energy audits.	**9**
V	Building Performance Assessment, Policies, and Case Studies - Energy auditing techniques and tools, Building Information Modelling (BIM) for sustainable building design and operation, Life Cycle Assessment (LCA) to measure environmental impact, financial incentives and government regulations for sustainable buildings, case studies of successful green buildings, emerging trends and innovations in green building technology.	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23IEL31B	ENGINEERING PROJECT MANAGEMENT	IEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course is designed to equip professionals with the skills and insights necessary to excel in complex project environments. The course introduces students to importance of project management as it affects strategy and business success. It introduces the concept of slack and of crashing and acquaints the complexities of scheduling multi-project programs.

ii) COURSE OUTCOMES

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

CO 1	Explain the fundamental concepts of project management, project life cycle, scope, and the role of the project manager.	Understand
CO 2	Develop project networks using various techniques, perform scheduling using forward and backward pass methods to identify critical paths and slack times.	Apply
CO3	Identify the role of Project Management in instructional technology and project development using appraisal techniques, cost estimation, and social cost-benefit analysis.	Apply
CO 4	Apply network flow concepts to project scheduling and optimize resource allocation in complex project scheduling scenarios	Apply

iii) SYLLABUS

Foundations and Environment of Project Management, Project Life Cycle & Selection Methods, Project Proposal & Scope Definition, Work Breakdown Structure (WBS), PMBOK Framework

Project Network Development, Forward and Backward Pass Computations, Critical Path Algorithm, Total & Free Slack, Three Time Estimates (PERT), Mean, Variance of Activity Times, Event-Oriented Critical Path Algorithm, Schedule Date Probability (PERT Analysis)

Generation and Screening of Project Ideas, Project Rating Index, Cost Estimation, Social Cost-Benefit Analysis (UNIDO Method), Economic Pricing, Income Distribution Impact, Merit/Demerit Goods, Little-Mirrlees Approach

Flow Network for Critical Path, Time-Cost Trade Off, Chance-Constrained Linear Programming in PERT

Resource Allocation & Levelling Techniques, Complexity with Limited Resources, Demand Levelling for Key Resources, Heuristic Programs for Resource Allocation, Project Crashing (Time-Cost Optimization)

iv) a) TEXTBOOKS

1. J. R. Meredith and S. J. Mantel, *Project Management: A Managerial Approach*, 8th ed. Hoboken, NJ, USA: John Wiley & Sons Inc., 2012, ISBN: 978-1-118-09473-8.
2. P. I. Parameshwar, *Engineering Project Management with Case Studies*. New Delhi, India: Vikas Publishing, 2005, ISBN: 978-81-259-1874-5.
3. P. Chandra, *Projects: Planning, Implementation and Control,* 8th ed. New Delhi, India: Tata McGraw Hill, 2017, ISBN: 978-93-5260-724-0.

b) REFERENCES

1. Project Management Institute (PMI), *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, 5th ed. Newtown Square, PA, USA: Project Management Institute, 1996, ISBN: 978-1-93389-051-7.
2. C. F. Gray and E. W. Larson, *Project Management: The Managerial Process*, 8th ed. New York, NY, USA: McGraw-Hill Education, 2020, ISBN: 978-1-260-23886-0.
3. L. S. Srinath, *PERT & CPM: Principles and Applications*. New Delhi, India: East-West Press, 2001, ISBN: 978-81-7678-136-7.

v) COURSE PLAN

Module	Contents	No. of hours
	Foundations of Project Management, Project Life Cycle, Project Environment, Project Selection, Project Proposal, Project Scope, Work Breakdown Structure. Project Management Body of Knowledge (PMBOK), Role of Project manager, SWOT Analysis in Project Management, Project Organisation and Structure	**8**
II	Development of project network, dummy activities, activity on node networks, cyclic network, forward pass and backward pass computations, algorithm for critical path, total slacks, free slacks and their interpretations. Three time estimates for activities, estimation of mean and variance of activity times, event oriented algorithm for critical path, probability of meeting a schedule date.	**10**
III	Analysis and appraisal generation of project ideas, scouting for project ideas, preliminary screening, project rating index, and cost of project. Social cost-benefit analysis, UNIDO approach, the net benefit in terms of economic prices, measurement of impact on distribution, savings impact and its value, income distribution impact, adjustment for merit and demerit, goods little Mirrless approach.	**9**

IV	A flow network interpretation for determination of critical paths, Time-Cost Trade off, Chance constrained linear programming for probabilistic durations of activities in PERT network	**9**
V	Resource allocation and levelling, Complexity of project scheduling with limited resources, levelling the demands on key resources, a simple heuristic program for resource allocation, project crashing	**9**
	Total	**45 hours**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL31C	DISASTER MITIGATION AND MANAGEMENT	IEC	3	0	0	0	3	2023

PRE-REQUISITE: Nil

i) COURSE OVERVIEW

The goal of this course is to expose the students to the fundamental concepts of disaster mitigation and management. The course details the various phases of disaster management cycle and the measures to mitigate disaster risks.

ii) COURSE OUTCOMES

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

CO 1	Explain the fundamental concepts and terminology related to disaster management.	Understand
CO 2	Explain hazard and vulnerability types and methodologies for disaster risk assessment	Understand
CO 3	Identify the core elements and phases of disaster management cycle and the various measures to mitigate disaster risks	Apply
CO 4	Explain the legislations and best practices for disaster mitigation and management at national and international level	Understand

iii) SYLLABUS

Interaction between various Earth Systems and their role in disasters, climate change and its impact on disasters, Key concepts and Terminology related to disaster management

Types of hazards and vulnerability assessments, Disaster risk assessment

Phases of disaster management cycle, Measures for disaster risk reduction- prevention, mitigation, preparedness, disaster response, relief, Participatory stakeholder engagement, Disaster communication, Capacity building.

Common disaster types in India, Legislations in India on Disaster Management- National Disaster Management Policy- Institutional arrangements for disaster management in India, The Sendai Framework for Disaster risk reduction.

iv) a) TEXTBOOKS

1) Coppola, D.P., Introduction to International Disaster Management, Elsevier Science (B/H), London, 2020. ISBN : 9780128173688.
2) Srivastava, H.N., Gupta, G.D., Management of Natural Disasters in developing countries, Daya Publishers, 2007. ISBN-13: 9789389569438

3) Subramanian, R., Disaster Management, Vikas Publishing House, 2018. ISBN-13: 9789352718702
4) Sulphey, M.M., Disaster Management, PHI Learning, 2016. ISBN-13: 9788120352209

b) REFERENCES

1) NDMA, National Policy on Disaster Management, Ministry of Home Affairs, Government of India,2009.
2) National Disaster Management Division, Disaster Management in India - A Status Report, Ministry of Home Affairs, Government of India, New Delhi,2004.
3) National Disaster Management Plan, NDMA, Ministry of Home Affairs, Government of India, 2019.
4) Disaster Management Training Manual, UNDP, 2016
5) United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster Risk Reduction 2015-2030, 2015

v) COURSE PLAN

Module	Contents	No. of hours
I	Interaction between various Earth Systems (Lithosphere, Atmosphere, Hydrosphere, Biosphere) and their role in disasters, Climate change and its impact on disasters. Definition and meaning of key terms in Disaster mitigation and management – disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment	**9**
II	Hazards- types- hazard mapping, Vulnerability types and their assessment- Physical, social, economic and environmental vulnerability. GIS and Remote Sensing applications in disaster risk mapping. Core elements of disaster risk assessment, Process of risk assessment, Methodologies for risk assessment.	**9**
III	Disaster management phases- prevention, mitigation, preparedness, response, relief. Role of Artificial Intelligence and IOT in Disaster Early Warning Systems. Case studies on successful disaster response models.	**9**
IV	Participatory stakeholder engagement, Disaster communication-methods, barriers, Crisis counselling. Capacity building- Structural measures, non-structural measures Capacity assessment. Disaster simulation exercises and role-playing activities.	**9**

V	Common disaster types in India. Disaster legislations in India- National disaster management policy, Institutional arrangements for disaster management in India. The Sendai Framework for Disaster risk reduction and targets- priorities for action, guiding principles.	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL31X	ENVIRONMENTAL IMPACT ASSESSMENT AND LIFE CYCLE ANALYSIS	IEC	3	0	0	0	3	2023

PRE-REQUISITE: Nil

i) COURSE OVERVIEW

This course introduces students to Environmental Impact Assessment (EIA) and Life Cycle Analysis (LCA) as key tools for assessing environmental impacts from developmental projects, industries and products**.** Students will learn about environmental regulations and EIA methodologies along with LCA principles and applications in environmental management and circular economy. The course will also cover environmental management plans, audits, and case studies on real-world applications**.**

ii) COURSE OUTCOMES

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

CO 1	Explain the fundamental concepts and importance of Environmental Impact Assessment (EIA) and Life Cycle Analysis(LCA)	Understand
CO 2	Discuss the various environmental legislations and EIA clearance procedure in India	Understand
CO 3	Apply various EIA and LCA methodologies for impact assessment and decision making	Apply
CO 4	Prepare impact assessment and audit reports and LCA frameworks for real-world applications	Apply

iii) SYLLABUS

Introduction to EIA and Environmental Legislations, Environmental clearance process in India, Types of EIA, EIA methodologies, Life cycle analysis- fundamentals and applications, Environmental Management Plan (EMP), Environment Audit, ISO 14001 standards , EIA & LCA case studies - highway project, hydro-electric power plant, airport project, quarry mining project, solid waste management project.

iv) a) TEXTBOOKS

1) Canter, L. W., Environmental Impact Assessment, McGraw Hill Inc., New York, 1996. ISBN-10: 0071141030
2) Curran, M. A., Life Cycle Assessment Handbook: A Guide for Environmental Sustainability, Wiley, 2012. ISBN-13: 978-1118099728
3) Marriott, B.B., Environmental Impact Assessment: A Practical Guide, McGraw Hill Professional, 1997. ISBN-13: 978-0070404106

b) REFERENCES

1) Glasson, J. and Therivel, R., Introduction to Environmental Impact Assessment, Routledge Publications, Fifth edition, 2019. ISBN-13: 978-1138600751
2) Lawrence, D. P., Environmental Impact Assessment (Practical Solutions to Recurrent Problems), Wiley International, New Jersey, 2003. ISBN-13: 978-0471457220
3) Ministry of Environment and Forests, Govt. of India, EIA Notification, 2006.
4) Guinée, J. B. (Ed.), Handbook on Life Cycle Assessment: Operational Guide to the ISO Standards, Springer, 2002. ISBN-13: 978-1402002281

v) COURSE PLAN

Module	Contents	No. of hours
I	Definition and need for EIA, Evolution of EIA- Global and Indian Scenario, Environmental legislations in India- The Environmental (Protection) Act 1986, Environmental standards for water, air and noise quality, EIA Notification 2006 and draft amendments 2024, Environmental clearance process in India- screening- scoping- public participation-stakeholder involvement- public hearings, Appraisal- Form1- Categorisation of projects- Generic structure of EIA report- Terms of Reference (ToR),Single Window Clearance.	**9**
II	Types of EIA- Strategic-Regional- Sectoral- Project level, Rapid EIA and comprehensive EIA, EIA Methodologies- Ad hoc-Checklist-Matrix-Network-Overlay methods, Impact prediction and assessment (water , air, noise, ecology), Socio-economic and cultural impacts	**10**
III	Introduction to Life Cycle Analysis (LCA) – Definition—Need-importance –applications in environmental management and sustainability, Phases of LCA- Goal & Scope Definition- Life Cycle Inventory (LCI)- Life Cycle Impact Assessment (LCIA)- Interpretation of LCA results, LCA Methodologies-Process-based, Input-Output, Hybrid Approaches, LCA and circular economy-role of LCA in sustainable product design-circular economy principles and lifecycle thinking	**10**
IV	Environmental Management Plan (EMP)- purpose and importance of EMP- Content of an EMP- Environmental monitoring programs, Environment Audit- need, types and benefits-Environmental audit procedures, ISO 14001 standards for Environmental Management- importance, salient features - stages in implementation- benefits- corporate environmental	**8**

	responsibility	
V	Case studies on EIA and LCA applications- Highway Projects- Hydro-Electric Power Plants, Airport Projects, Quarry Mining projects, Solid waste management Projects. Comparison of EIA and LCA approaches in decision making	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

HONOURS COURSES

Semester	Basket I				Basket II				Basket III			
	Course Code	Course	L-T-P-J	Credits	Course Code	Course	L-T-P-J	Credits	Course Code	Course	L-T-P-J	Credits
S4	23CEL2HB	Advanced Mechanics of Solids	3-0-0-0	3	23CEL2HD	Environmental Pollution Control Techniques	3-0-0-0	3	23CEL2HF	Geographical Information System	2-0-2-0	3
S5	23CEL3HA	Modern Construction Materials	3-0-0-0	3	23CEL3HC	Groundwater Hydrology	3-0-0-0	3	23CEL3HE	Pavement Construction and Management	3-0-0-0	3
S6	23CEL3HB	Finite Element Method	3-0-0-0	3	23CEL3HD	Environmental Pollution Modelling	3-0-0-0	3	23CEL3HF	Transportation System Management	3-0-0-0	3
S7	23CEL4HA	Structural Dynamics	3-0-0-0	3	23CEL4HC	Earth Dams and Earth Retaining Structure	3-0-0-0	3	23CEL4HE	Soil Dynamics and Machine Foundation	3-0-0-0	3
S8	23CEJ4HB	Mini Project	0-0-6–0	3	23CEJ4HD	Mini Project	0-0-6–0	3	23CEJ4HF	Mini Project	0-0-6–0	3

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL3HB	FINITE ELEMENT METHOD	VAC	3	0	0	0	3	2023

PRE-REQUISITE: 23CEL20A Mechanics of Structures, 23CEL2HB Advanced Mechanics of Solids, 23CEL20D Structural Analysis

i) COURSE OVERVIEW

This course introduces the Finite Element Method (FEM) as a numerical tool for solving complex engineering problems, covering foundational theories, element formulations (1D to 3D) and practical software applications. Students will learn to derive stiffness matrices, analyse structural systems (bars, trusses, beams) and validate computational results using FEM principles and FEM software.

ii) COURSE OUTCOMES

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

CO 1	Explain the fundamentals, theoretical basis, steps and applications of FEM in Engineering.	Understand
CO 2	Apply variational principles to formulate finite element equations for structural systems.	Apply
CO 3	Develop shape functions, stiffness matrices and load vectors for various elements.	Apply
CO 4	Apply isoparametric formulation and numerical integration techniques to develop two-dimensional elements	Apply
CO 5	Analyse various structural systems using finite element methods	Analyse

iii) SYLLABUS

Review of theory of elasticity, Overview of FEM- History, applications, advantages and procedural steps, Types of elements (1D, 2D, 3D), Governing equations- Equilibrium and compatibility conditions, convergence requirements.

Finite Element Formulation- Variational principles, Weighted residual methods, Coordinate systems- Global, local and natural coordinates.

One-Dimensional Elements- Bar elements- Shape functions, stiffness matrices. Transformation matrices, local/global stiffness matrices, analysis of trusses, Beam elements- Shape functions, stiffness matrices, load vectors, beam analysis.

Two-Dimensional and Three-Dimensional Elements- 2D elements-, triangular/rectangular/quadrilateral elements, Plane stress/strain, Isoparametric formulation and numerical integration, 3D elements- Tetrahedron and hexahedron (brick) elements.

Applications in Solid Mechanics- Computation of stresses and strains using FEM, Software-based analysis for simple structural problems. Validation and interpretation of FEM results.

iv) a) TEXTBOOKS

1) D. L. Logan, A First Course in the Finite Element Method, 7th edition, Cengage Learning, 2021, ISBN-13: 978-0357676431.
2) C. S. Krishnamoorthy, Finite Element Analysis: Theory and Programming, 2nd edition, Tata McGraw-Hill, 2018, ISBN-13: 978-0074622100.
3) S. S. Rao, The Finite Element Method in Engineering, 7th edition, Butterworth-Heinemann, 2020, ISBN-13: 978-0128117682.
4) J. N. Reddy, An Introduction to the Finite Element Method, 5th edition, McGraw-Hill Education, 2022, ISBN-13: 978-1259861901.

b) REFERENCES

1) Chandrupatla, T. R. and Belegundu, A. D., Introduction to Finite Elements in Engineering, 5th edition, Pearson Education, 2018.
2) Bathe, K. J., Finite Element Procedures, 2nd edition, Pearson Education, 2014.
3) Zienkiewicz, O. C., Taylor, R. L., and Zhu, J. Z., The Finite Element Method: Its Basis and Fundamentals, 7th edition, Elsevier, 2013.
4) Moaveni, S., Finite Element Analysis: Theory and Application with ANSYS, 5th edition, Pearson Education, 2020.
5) Gupta, A. K., Finite and Boundary Element Methods in Engineering, 1st edition, CRC Press, 2017.
6) Seshu, P., Finite Element Method: Concepts and Applications in Geomechanics, 3rd edition, PHI Learning, 2020.

V) COURSE PLAN

Module	Contents	No. of hours
I	**Review of theory of elasticity**- Equations of equilibrium, Strain-displacement relation, constitutive relation **Introduction to FEM:** Brief history of the method, General description of the method, applications, advantages of the finite element method, steps in the finite element method. Types of elements, Equations of equilibrium and compatibility conditions, convergence requirements.	**9**
II	**Finite Element Formulation:** Principle of minimum potential energy, Principle of virtual displacement, Raleigh Ritz method, Weighted Residual method- Galerkin's method. Coordinate system - Global coordinate, local coordinate and natural coordinate system.	**9**
III	**One Dimensional Elements** Bar Elements: Shape functions, stiffness matrix for a 2- noded bar element, Transformation matrix, Stiffness matrix of truss	**9**

	member in local and global coordinates. Beam Elements: Shape functions, beam element stiffness matrix, element load vector, polynomial approximations using Lagrange polynomials.	
IV	**Two Dimensional Elements** Development of shape functions for CST and LST, Lagrange and Serendipity elements, Plane stress and plane strain problems. **Concept of isoparametric formulation:** Bilinear element-Sub-parametric and super-parametric elements. Gauss quadrature technique. **Three-Dimensional Elements:** Tetrahedron and Brick elements.	**9**
V	**Applications in Solid Mechanics**: Computation of stresses and strains using FEM. Use of a computer software to analyse simple problems- Interpretation of results obtained from the finite element analysis.	**9**
	Total hours	**45**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

IX) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL3HD	ENVIRONMENTAL POLLUTION MODELLING	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

Goal of this course is to introduce various approaches for environmental pollution modeling. Students will learn how to develop a verified and validated model. The mathematics behind various environmental pollution models with their uncertainties will be discussed.

ii) COURSE OUTCOMES

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

CO 1	Explain the principles of mathematical modeling and its role in assessing environmental pollution.	Understand
CO 2	Identify mathematical models to simulate pollutant transport in air, water, and noise environments.	Apply
CO 3	Make use of model predictions to evaluate environmental pollution levels	Apply
CO 4	Apply modeling results to support decisions for pollution control and management.	Apply

iii) SYLLABUS

Role of models in environmental pollution studies, objectives and principles of modelling, types and classification of mathematical models, verification and sensitivity analysis, distributions in modelling data of environmental pollutant concentrations.

Air pollution modelling- Transport and dispersion of air pollutants, estimating concentrations from point sources, dispersion modelling, atmospheric stability, box models, line source model, area source model, indoor air quality modelling.

Water quality modeling- rivers and streams water quality modelling, low flow analysis, pollutant transport, Modelling lake water quality, mass balance for well mixed lakes, models for dissolved oxygen, sediment transport modelling.

Groundwater modelling- groundwater flow modeling, Darcy's law water flow equations, mass transport of solutes, advection diffusion equation, seawater intrusion, Ghyben–Herzberg formula.

Environmental noise- noise generation mechanisms, modelling inputs sound propagation factors, Equivalent Continuous Sound Pressure Level (Leq), noise mapping methodology, modelling traffic noise

iv) a) TEXTBOOKS

1) Gilbert M., Masters and Wendell P. Ela, Introduction to Environmental Engineering & Science, Pearson Publishing, 3rd edition, ISBN-13: 978-0321815403, 2013
2) Steven C. Chapra, Surface Water Quality Modeling, The McGraw-Hill Companies, Waveland Press, New York, 2nd edition, ISBN-13: 978-1577666059, 2008.
3) David Keith Todd and Larry W. Mays, Groundwater Hydrology, 4th edition, John Wiley and Sons, New York, 4th edition, ISBN-13:978-0471661447, 2004.
4) C.P Kumar, Groundwater Assessment and Modelling, Createspace Independent Publishing, 1st edition, ISBN-13:978-1511520492, 2015.

b) REFERENCES

1) Seinfeld and Pandis, Atmospheric Chemistry and Physics, Wiley, 3rd edition,ISBN-13: 978-1118770740, 2016.
2) Marcello Benedini and George Tsakiris, Water Quality Modelling for Rivers and Streams, Springer, 1st edition, ISBN-13: 978-94-007-5509-3, 2013.
3) Mary Anderson William Woessner Randall Hunt, Applied groundwater modelling, Academic Press, 2nd edition, ISBN-13: 978-0120581030, 2015.
4) Enda Murphy Eoin King, Environmental Noise Pollution, Elsevier, 1st edition, ISBN-13: 978-0124115958, 2014

v) COURSE PLAN

Module	Contents	No. of hours
I	Role of models in environmental pollution studies- objectives of modelling- modelling principles- types of models- classification of mathematical models- deterministic, stochastic, continuous, discreet, static, dynamic, linear and nonlinear model building framework model calibration, validation, verification and sensitivity analysis , model scales, error and uncertainty - distributions in modelling data of environmental pollutant concentrations- log-normal, Weibull, and gamma.	**9**
II	Air pollution modelling: Transport and dispersion of air pollutants- estimating concentrations from point sources – dispersion modelling- Gaussian Plume Model – determination of dispersion parameters, atmospheric stability box models- line source model-area source model -puff model, indoor air quality model, Software- AEROMOD, CALINE.	**9**
III	Water quality modeling: historical development of water quality models Rivers and streams water quality modelling– low flow analysis– pollutant transport-advection, diffusion and dispersion Modelling lake water quality-mass balance for well mixed lakes models for dissolved oxygen; Streeter Phelps model- sediment transport modelling	**9**

IV	Groundwater modelling: use of groundwater models groundwater flow modeling-Darcy's law-groundwater flow equations for homogenous, heterogenous, isotropic and anisotropic conditions mass transport of solutes, advection dispersion equation, favorable conditions for contaminant transport-modelling parameters and boundary conditions seawater intrusion – basic concepts and modeling Ghyben–Herzberg formula, popular groundwater models.	**9**
V	Environmental noise - noise generation mechanisms needed for noise modelling noise mapping methodology modelling inputs-sound propagation factors - Equivalent Continuous Sound Pressure Level (Leq)- modelling traffic noise- CoRTN and RLS90 models.	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL3HF	TRANSPORTATION SYSTEM MANAGEMENT	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

Goal of this course is to expose the students to the strategies that can be adopted for transportation system management. This course gives insights to the benefits acquired through various non-motorized modes of transportation. The concept of multimodal coordination is also included. An introduction to mass transportation system and preferential treatment of high occupancy vehicles is also given.

ii) COURSE OUTCOMES

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

CO 1	Identify appropriate strategies for management of transportation system	Apply
CO 2	Select suitable measures to improve the service of transit systems	Apply
CO 3	Determine the efficiency of design and frequency setting in a bus route network.	Apply
CO 4	Explain the various non-motorized transport and mass transportation systems.	Understand
CO 5	Make use of various software's for transport service planning and management.	Apply

iii) SYLLABUS

Transportation System Management (TSM)- Goal, Characteristics, frame work, Relevance in Indian context, TSM strategies for improving vehicular flow.

Public transportation and Preferential treatment to high occupancy vehicles. Transit service improvement measures, Multi-Modal Coordination.

Framework and indices for evaluation of bus route network design and frequency setting.

Non-motorised transport- challenges, opportunities, institutional framework, Key actions to improve and promote NMT, guidelines and policies.

Types of mass transportation systems - Bus Rapid Transit (BRT) System, Regional Rapid Transit System (RRTS), Metro, Light Rail Transit, Monorail, Automated Highways.

iv) a) TEXTBOOKS

1) C. S. Papacostas and P. D. Prevedouros, Transportation Engineering and Planning, 3rd edition, Pearson, 2015, ISBN: 9789332555150, 933255515X.
2) C. J. Khisty and B. K. Lall, Transportation Engineering: An Introduction, 3rd edition, Pearson Education, 2017, ISBN-13 978-9332569706.
3) C. A. O' Flaherty, Transport Planning and Traffic Engineering, CRC Press, 2018, eBook ISBN 9780429213991.

b) REFERENCES

1) J. Tumlin, Sustainable Transportation Planning: Tools for Creating Vibrant, Healthy, and Resilient Communities, 1st edition, Hoboken, New Jersey, John Wiley & Sons, 2012, ISBN-13: 978-0470540930.
2) T. Abdallah, Sustainable Mass Transit: Challenges and Opportunities in Urban Public Transportation, 1st edition, Netherlands, Elsevier, 2017, ISBN-13: 978-0128112991.
3) C. Patton, Public Transit Operations: The Strategic Professional, 1st edition, *USA, 2017,* ISBN-13: 978-1521576533.
4) E. E. Wilhelmsson, S. Sankari and A. Bask, Sustainable and Efficient Transport: Incentives for Promoting a Green Transport Market, 1st edition, Cheltenham, UK, Edward Elgar Publishing, 2019, ISBN-13: 978-1788119276.
5) R. Iyer, Green Transport: Exploring Eco-Friendly Travel for a Better Tomorrow, 1st edition, New Delhi, The Energy and Resources Institute, 2016, ISBN-13: 978-8179934449.
6) Y. Deng and Y. Yan**,** Evaluating Route and Frequency Design of Bus Lines Based on Data Envelopment Analysis with Network Epsilon-Based Measures, Journal of Advanced Transportation, Volume 2019, Article ID 5024253.
7) S. Ravishankar, A.D. Sharma, Non-Motorised Transport in the City, Training Manual, Climate Smart Cities Assessment Framework, Mobility and Air Quality, Climate Centre for Cities, National Institute of Urban Affairs, 2021.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Transportation System Management (TSM)- Goal, Characteristics, Methodological frame work, Relevance of TSM actions in Indian context. TSM strategies for improving vehicular flow – One-way streets - Signal improvement - Right turn phase-transit stop relocation - parking management - reversible lanes - reroute turning traffic-reducing peak period traffic-strategies for working hours-high peak period tolls-congestion pricing-traffic calming measures.	**9**
II	Public transportation and Preferential treatment to high occupancy vehicles. Transit system operations - service and characteristics, transit service improvement measures - toll discounts for car pools	**9**

	during peak periods, park and ride, car-pooling, exclusive lanes, priority at ramp terminals, bus transfer stations, limited and skip-stop bus services, shared ride, multi-modal coordination - transit and para transit integration.	
III	Framework and indices for evaluation of bus route network design and frequency setting. Indices of network route design- number of stops, route length, route directness, bus and metro overlapping, residential and employment coverages, bus and metro connectivity, operation speed, annual average daily ridership. Indices of frequency setting- number of buses and drivers, daily operation time, frequency, on-time arrival rate.	**9**
IV	Non-motorised transport-different modes-comparison across different modes in terms of traffic handling capacity, space requirement, cost of infrastructure, material requirement energy consumption, benefits. Scenario in India-challenges- opportunities-institutional framework. Key actions to improve and promote NMT, guidelines and policies. Case Studies	**9**
V	Types of mass transportation systems - Bus Rapid Transit (BRT) System, Regional Rapid Transit System (RRTS), Metro, Light Rail Transit, Monorail, Automated Highways. Introduction to various software's for transport service planning and management.	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60 marks
Exam Duration	:	3 Hours

MINOR COURSES

Semester	Basket I				Basket II				Basket III			
	Infrastructure Development and Management				Environmental and Water Resource Engineering				Transportation Engineering			
	Course Code	Course	L-T-P-J	Credits	Course Code	Course	L-T-P-J	Credits	Course Code	Course	L-T-P-J	Credits
S3	23CEL2MA	Building Information Modelling	3-0-0-0	3	23CEL2MC	Climate Change and Disaster Mitigation	3-0-0-0	3	23CEL2ME	Traffic Engineering	3-0-0-0	3
S4	23CEL2MB	Infrastructure Health Monitoring	3-0-0-0	3	23CEL2MD	Watershed Management	3-0-0-0	3	23CEL2MF	Urban Transportation Planning	3-0-0-0	3
S5	23CEL3MA	Infrastructure Project Management	3-0-0-0	3	23CEL3MC	Air Pollution and Control Techniques	3-0-0-0	3	23CEL3ME	Traffic Flow Theory and Modelling	3-0-0-0	3
S6	23CEL3MB	Performance and Risk Assessment of Infrastructure Systems	3-0-0-0	3	23CEL3MD	Integrated Waste Management for Smart Cities	3-0-0-0	3	23CEL3MF	Transportation and logistics management	3-0-0-0	3
S7/ S8	23CEJ4MA	Mini Project	0-0-6–0	3	23CEJ4MC	Mini Project	0-0-6–0	3	23CEJ4ME	Mini Project	0-0-6–0	3

Semester	Basket IV				Basket V			
	Virtual Reality and Automation Technologies in Construction				Engineering Project Management			
	Course Code	Course	L-T-P-J	Credits	Couse Code	Course	L-T-P-J	Credits
S3	23CEL2MG	Infrastructure Management with Informatics	3-0-0-0	3	23CEL2MI	Advanced Project Management	3-0-0-0	3
S4	23CEL2MH	Construction Automation and Robotics	3-0-0-0	3	23CEL2MJ	Building Information Modelling in Management	3-0-0-0	3
S5	23CEL3MG	Machine Learning for Construction Automation	3-0-0-0	3	23CEL3MI	Contract Management	3-0-0-0	3
S6	23CEL3MH	Virtual Reality in Construction	3-0-0-0	3	23CEL3MJ	Quality, Risk and Safety Management	3-0-0-0	3
S7/ S8	23CEJ4MG	Mini Project	0-0-6-0	3	23CEJ4MI	Mini Project	0-0-6-0	3

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL3MB	PERFORMANCE AND RISK ASSESSMENT OF INFRASTRUCTURE SYSTEMS	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course is aimed to provide fundamental concepts to infrastructure asset management related to various Civil Engineering services such as transportation, water and wastewater systems. The course also provides an introduction to elements of performance measurement and modelling, including condition assessment, failure and impact analysis. Decision and risk analysis covered enable students to develop an economic, performance and risk analysis approach to infrastructure management systems.

ii) COURSE OUTCOMES

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

CO 1	Explain the influence of core sectors on infrastructure planning and development.	Understand
CO 2	Identify the strategies to be adopted for successful implementation of infrastructure projects.	Apply
CO 3	Explain the need of life cycle management and suggest suitable analysis techniques.	Apply
CO 4	Examine the feasibility of sustainable infrastructure management systems	Apply

iii) SYLLABUS

Introduction To Infrastructure - Definition, Role of Infrastructure in Economic Development, Types of Infrastructure, Indian scenario in respect to adequacy and quality.
Overview of urban, rural infrastructure in India; Performance analysis in Infrastructure systems **-** Case studies.
Challenges in Infrastructure Planning and Implementation - Need for Infrastructure planning, Risks faced in infrastructure Projects, Challenges in construction and maintenance of infrastructure.
Strategies for Infrastructure Project Implementation **-** Risk Management to mitigate risks - Innovative design and maintenance of infrastructure facilities.
Sustainable Infrastructure Management Systems.

iv) a) TEXTBOOKS

1. Neil S. Grigg, Infrastructure Engineering and Management, John Wiley and sons, 1988, ISBN: 978-0471849742 (Digitized 2007).
2. W. Hudson, Ralph Haas and Waheed Uddin, Infrastructure Management: Integrating Design, Construction, Maintenance, Rehabilitation, and Renovation, McGraw Hill, 1997, ISBN: 978-0070308954 (Digitized 2007).

3. Ernie Haydeen, Critical Infrastructure Risk Assessment: The Definitive Threat Identification and Threat Reduction, Rothstein Publishing, 2020, ISBN: 978-1944480714.

b) REFERENCES

i) Kunal P. Shukla, and Jayeshkumar R. Pitroda, Infrastructure Engineering and Management, Lambert Academic Publishing, ISBN: 978-6139936700.
ii) Pravin Jadhav and Rahul Nath Choudhury, Infrastructure Planning and Management in
iii) India: Opportunities and Challenges, Rawat Publications, 2024, ISBN: 9789811932014.
iv) David G. Carmichael, Risk and Systems: With Applications in Infrastructure Project Management, CRC Press, 1st edition, 2022, ISBN 9781032381213.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Infrastructure Definition of Infrastructure, Role of Infrastructure in Society, Overview of Infrastructure development, Infrastructure assets, Challenges in maintenance, preservation and innovation of infrastructure, quality assurance and its importance.	**9**
II	Infrastructure Asset Management Overview of Infrastructure Asset management, key issues, development of an infrastructure asset management system, concept of life cycle analysis, life cycle management, case studies on life cycle management, inference from case studies.	**9**
III	Infrastructure Planning and Performance Need for Infrastructure planning, Case studies on planning, Infrastructure service life and assessment, decisions from case studies, Infrastructure performance analysis, risks faced in infrastructure projects, challenges in construction and maintenance of infrastructure.	**9**
IV	Quality management Need for quality management, objectives and constraints, effectiveness of quality management system, construction quality control, new technologies in quality management, Importance of stakeholder management.	**9**
V	Decision and Risk Assessment Risk Management for infrastructure projects, uncertainty to be faced, infrastructure decision/risk analysis, risk mitigation measures, case studies on risk assessment, interpretation from case studies.	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL3MD	INTEGRATED WASTE MANAGEMENT FOR SMART CITIES	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

Goal of this course is to introduce students to the fundamentals of waste generation, classification and characteristics. It explores innovative waste management strategies for smart cities. The course discusses various waste treatment and disposal technologies and integrates digital and IoT-based solutions for efficient waste management. The course also covers policies, regulations, and sustainable approaches to urban waste management.

ii) COURSE OUTCOMES

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

CO 1	Explain the fundamental concepts and challenges of waste management in smart cities.	Understand
CO 2	Explain the methods of waste collection, segregation and transportation in urban waste management systems.	Understand
CO 3	Identify different treatment and disposal methods for sustainable waste management.	Apply
CO 4	Apply smart technologies and IoT-based solutions for efficient waste management.	Apply
CO 5	Apply national and international waste management policies and circular economy principles for smart city development.	Apply

iii) SYLLABUS

Fundamentals of Waste Management- sources, classification and characteristics.

Waste Collection, Segregation and Transportation systems.

Waste Treatment and Processing Technologies - Biological treatment, Thermal treatment, Recycling and recovery, Landfilling

Smart Technologies in Waste Management, Case studies of smart and sustainable waste management projects

Policies, Regulations, and Sustainable Practices in waste management, Integrated waste management - challenges and research opportunities.

iv) a) TEXTBOOKS

1) William A Worrell and P. Aarne Veslind, Solid Waste Engineering, 2nd Edition (SI Edition) Cengage Learning, 2012 (ISBN-13: 978-1-4390-6217-3).
2) George Tchobanoglous, Hilary Theisen and Samuel A Vigil, Integrated Solid Waste management, 4th Edition, Tata McGraw Hill, 2014 (ISBN-13: 978-0071806128).

b) REFERENCES

1) Manual on Solid Waste Management, prepared by The Central Public Health and Environmental Engineering Organization(CPHEEO), India, 2000.
2) MSW Management Rules 2016, Govt. of India, available online at CPCB website.
3) Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website.
4) Construction and Demolition Waste Management Rules 2016, Ministry of Environment and Forest and Climate Change, Govt. of India, 2016.
5) S. K. Sharma and P. Singh, Smart Waste Management, Springer, 2021.
6) John R. Vacca, Solving Urban Infrastructure Problems Using Smart City Technologies: Handbook on Planning, Design, Development, and Regulation, Elsevier, 2024 (ISBN-13: 978-0-443-22473-5).
7) Pallavi Jain, Sunil Kumar Yadav, and Ishaani Priyadarshini (Eds.), Waste Management for Smart Cities, Springer, 2025 (ISBN-13: 978-981-99-6911-2)

V) COURSE PLAN

Module	Contents	No. of hours
I	**Fundamentals of Waste Management** Smart city- key features, significance of waste management in smart cities. Classification of waste – municipal solid waste (MSW), biomedical waste, hazardous waste, electronic waste (E-waste), industrial waste and construction & demolition (C&D) waste. characteristics of different types of waste. Sources of waste generation and trends in urban waste production. Environmental and health impacts of poor waste management.	9
II	**Waste Collection, Segregation, and Transportation** Waste collection systems – door-to-door collection, community bins and underground waste bins. Waste segregation – at-source segregation, importance and best practices. Transportation of waste – traditional and modern transportation systems.	8
III	**Waste Treatment and Processing Technologies** Biological treatment – composting, anaerobic digestion and	8

	vermicomposting. Thermal treatment – incineration, pyrolysis and gasification. Recycling and recovery – material recovery facilities (MRF), plastic recycling and E-waste processing. Landfilling – sanitary landfills, bioreactor landfills. Leachate management.	
IV	**Smart Technologies in Waste Management** IoT-based smart bins and real-time waste monitoring. Applications of GIS and GPS in waste collection systems. Role of AI and big data analytics in sustainable waste management. Blockchain for waste traceability and management. Waste-to-energy (WTE) technologies and their role in sustainable urban development. Case studies of smart and sustainable waste management projects in India and global smart cities (India- Surat Model, Raipur Model, Japan- Kamikatsu model).	**10**
V	**Policies, Regulations, and Sustainable Practices** National and international policies on waste management. Regulations - Solid Waste Management Rules 2016, E-Waste Management Rules 2016, Plastic Waste Management Rules 2016, Swachh Bharat Mission. Extended Producer Responsibility (EPR) and its implementation in smart cities. Public participation and behavioral change in waste management. Green initiatives, SDGs, zero-waste cities and circular economy approaches. The future of integrated waste management- challenges and research opportunities.	**10**
	Total hours	**45**

VI) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	**:**	**40 marks**
End Semester Examination	**:**	**60 marks**
TOTAL	**:**	**100 marks**

VII) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

VIII) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL3MF	TRANSPORTATION AND LOGISTICS MANAGEMENT	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

Goal of this course is to equip students with the knowledge, skills, and tools necessary to comprehend fundamental aspects of logistics and transportation systems. Students will gain an understanding of the dynamics of key logistics and transportation decisions. This includes considerations such as designing the distribution network, selecting transportation modes and routes, location and design of distribution centres, and management of last mile logistics.

ii) COURSE OUTCOMES

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

CO1	Explain the core elements of logistics and transportation systems	Understand
CO2	Explain the dynamics of key logistics and transportation decisions	Understand
CO3	Design a distribution network and choose transportation modes	Apply
CO4	Design routes, location and distribution centres for logistics management	Apply

iii) SYLLABUS

Foundations of Logistics and Transportation, Introduction to Course Communications, Origins and History of Logistics

Demand Forecasting and Procurement Logistics, Forecasting Demand, Procurement Logistics

Warehouse Management and Technology, Warehouse Logistics and Design, Warehouse Systems and Technology

Freight Transport, Route Planning, Logistic information system, Future Trends in Logistics Management

iv) a) TEXTBOOKS

1. Council of supply chain management professionals and Goldsby, T.J., Iyengar, D., and Rao, S., The Definitive Guide to Transportation: Principles, Strategies, and Decisions for the Effective Flow of Goods and Services, Pearson Education Ltd., 2014. ISBN-10: 0133449092
2. Srinivasan, M., Stank, T., Dornier, P., and Petersen, K. J., Global Supply Chains: Evaluating Regions on an EPIC Framework – Economy, Politics, Infrastructure, and Competence, McGraw Hill Education, 2014. ISBN-10: 0071792317

b) REFERENCES

1. Watson, M., Hoormann, S., Cacioppi, P., and Jayaraman, J., Supply Chain Network Design: Understanding the Optimization behind Supply Chain Design Projects, Aspen Blue Publishing, 2012. ISBN-10: 1981277528

v) COURSE PLAN

Module	Contents	No. of hours
I	Foundations of Logistics and Transportation: Introduction to Course Communications, Overview of the course structure and communication channels, Origins and History of Logistics, Evolution from logistics to supply chain management, Competitive advantages through effective logistics	7
II	Demand Forecasting and Procurement Logistics: Forecasting Demand, Qualitative and quantitative methods for demand forecasting, Role of the demand planner and its impact on stock policies, Procurement Logistics, Purchasing and outsourcing strategies, Management of suppliers and creation of a supplier pool	10
III	Warehouse Management and Technology: Warehouse Logistics and Design, Location, staffing, and design considerations, Handling, shelving, storing, and picking systems, Warehouse Systems and Technology, EAN coding, inventory systems, barcodes, and radiofrequency, Packing and palletization techniques	9
IV	Freight Transport: International Freight Transport, Logistic platforms, vehicles, and containment, Modalities: road, rail, maritime, and intermodal transportation, Fleet management and route planning, Vehicle routing, One-to-one distribution, One-to-many distribution, shortest path algorithm, Quickest time algorithm	9
V	Logistics information system; Designing and planning transportation networks; City logistics, Applied techniques in city logistics; Future trends: Uses of big data and technologies in logistics, Emerging technologies for logistics - drones, IoT and new models for logistics	10
	Total	**45 hours**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

ix) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CEL3MH	Virtual Reality in Construction	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

The goal of this course is to introduce the concepts and applications of virtual reality (VR) in the construction industry. The course highlights the use of VR for visualization, design collaboration, safety training, and project management, providing both theoretical knowledge and hands-on experience with VR tools and technologies.

ii) COURSE OUTCOMES

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

CO 1	Explain the fundamental concepts of virtual reality and its relevance in construction.	Understand
CO 2	Utilize VR tools for site visualization, design collaboration, and project planning.	Apply
CO 3	Apply VR technologies in construction processes, project execution, and real-time site monitoring.	Apply
CO 4	Utilize VR-based solutions for construction safety training and risk mitigation.	Apply
CO 5	Integrate VR with BIM for project scheduling and resource management	Apply

iii) SYLLABUS

Introduction to Virtual Reality (VR) and Augmented Reality (AR), key differences, and applications in construction. Overview of VR hardware components, software tools, and historical evolution.

VR applications in construction visualization, 3D model walkthroughs, and design collaboration. Use of VR for client presentations and interactive project reviews.

VR-based safety training, hazard simulations, and risk assessment in construction. Accident prevention, workforce training, and emergency response planning using VR.

Integration of VR with BIM for project planning, scheduling, and real-time site monitoring. Use of drones and 360° VR cameras for progress tracking. Challenges in VR adoption.

Advanced VR applications, AI-driven analytics, and digital twins for construction management. Role of VR in sustainable construction and smart infrastructure. Ethical and security considerations in VR adoption.

a) TEXTBOOKS

1. William R. Sherman & Alan B. Craig, Understanding Virtual Reality: Interface, Application, and Design, Morgan Kaufmann, 2019, ISBN: 978-1558603530
2. Jennifer Whyte, Virtual Reality and the Built Environment, Routledge, 2018, ISBN: 978-1138668768

3. Grigore C. Burdea & Philippe Coiffet., Virtual Reality Technology, Wiley-IEEE Press, 2003, ISBN: 978-1-118-01480-6

b) REFERENCES

1. Jason Jerald, The VR Book: Human-Centered Design for Virtual Reality, ACM Books, 2015, ISBN: 978-1-970001-12-9
2. Jesse J. Kim, Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Addison-Wesley, 2018, ISBN: 978-0134094236
3. Tomasz Mazuryk & Michael Gervautz, Virtual Reality: History, Applications, Technology and Future, Springer, 1996

V) COURSE PLAN

Module	Contents	No. of hours
I	**Fundamentals of Virtual Reality in Construction**: Definitions and key differences between Virtual Reality (VR) and Augmented Reality (AR). Applications of VR in design, visualization, and project planning; Components of VR systems: hardware (head-mounted displays, haptic devices, motion tracking systems). Historical evolution of VR and its growth in Architecture, Engineering, and Construction (AEC). VR software and development platforms: Unity, Unreal Engine, and VR tools for BIM integration.	**9**
II	**VR for Construction Visualization and Design Collaboration**: Immersive 3D walkthroughs and interactive virtual models for architectural visualization, Visualization through Tablet and Mobile; Collaborative VR design reviews for resolving conflicts between engineers, architects, and clients; Comparison of real-time rendering, 3D modeling, and traditional visualization techniques; Software tools: VR-based applications in Revit, Navisworks, and game engines; Enhancing client communication and stakeholder engagement using VR in presentations.	**9**
III	**VR in Construction Processes and Site Monitoring**: VR-enabled construction planning and scheduling for efficient project execution; BIM-VR integration for real-time progress monitoring and project visualization; Use of drones and 360° VR cameras for remote construction site supervision; VR applications in resource management, sequencing, and logistics planning; Challenges in VR adoption: cost implications, technological barriers, and accessibility.	**9**
IV	**VR for Training and Safety in Construction**: Virtual simulation of hazardous scenarios and risk assessment in construction sites; Accident prevention and VR-based workforce training for handling	**9**

	site emergencies; Application of VR in heavy equipment operation training and site safety protocols; Development of realistic VR simulations for high-risk environments such as confined spaces and high-altitude work; Case studies on global implementation of VR-based safety training programs.	
V	**Advanced VR Applications and Future Trends in Construction**: AI-enhanced VR for predictive analytics and risk modeling in construction; Digital twins and virtual prototyping for large-scale infrastructure projects; Role of VR in sustainable construction practices and reducing material waste; Ethical considerations in VR applications: privacy, security, and data bias; Future trends in smart cities, mixed reality (MR), and AI-driven VR applications.	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23CEL3MJ	Quality, Risk and Safety Management	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW

Goal of this course is to provide students a strong background of the principles of quality, risk, and safety management, focusing on quality control, assurance, and improvement techniques like TQM, Six Sigma, and statistical quality control. It also explores risk assessment, hazard management, accident prevention, and safety planning for ensuring workplace and product safety

COURSE OUTCOMES

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

CO 1	Explain the principles of quality and total quality management in construction industry	Understand
CO 2	Identify and apply the safety in Construction organization. `	Understand
CO 3	Identify the causes of Hazards in construction industry	Understand
CO 4	Explain the objectives, specifications, and standards in quality assurance	Understand
CO 5	Make use of the steps in risk management and assessment to identify the major project risks	Apply

ii) SYLLABUS

Quality, Approach to quality control , Quality Management , Quality Planning The PSDA Cycle, Six sigma Quality.

Total quality Management- TQM Organization Taguchi's concept of quality.

Quality Assurance, Statistical Quality control, types of control charts.

Introduction to Safety Management, Investigations and Prevention of Accidents, Hazards-Nature, Causes and Control Measures.

Steps in risk management and assessment, Safety programmes, Safety measures, Safety assessment.

a) TEXTBOOKS

1) Evans, J. R., & Lindsay, W. M. Managing for quality and performance excellence (9th ed.). Cengage Learning.2014. ISBN: 978-1285074811
2) Goetsch, D. L., & Davis, S. B. Quality management for organizational excellence: Introduction to total quality (7th ed.). Pearson.2014 ISBN: 978-0132885409

3) Harris, D. (2008). Introduction to safety management (7th ed.). Butterworth-Heinemann.2008. ISBN: 978-0750684692

b) REFERENCES

1) Gambatese, John A., and Michael Behm. Prevention through Design: A New Way to Safety in Construction and Industry. CRC Press, 2020. ISBN: 978-0367331259
2) Zou, Patrick X. W., Riza Y. Arditi, and Guomin Zhang. Strategies for Minimizing Construction Risks. Wiley-Blackwell, 2022. ISBN: 978-1119785572
3) Loosemore, Martin, and Florence Yean Yng Lim. Routledge Handbook of Construction Project Management. 2nd edition, Routledge, 2021. ISBN: 978-0367339286
4) Howell, Gregory A., and Glenn Ballard. Managing Construction Safety and Health. CRC Press, 2020. ISBN: 978-0367333673

V) COURSE PLAN

Module	Contents	No. of hours
I	**Quality & quality control:** Evolution of quality, definition, elements of quality, Quality Control: Definition, Approach to quality control, Objectives of quality control, quality characteristics. Quality Management: Quality policy, Quality Planning- tools, role of leaders in quality control, Continuation Process improvement. The PSDA Cycle, Six sigma Quality	9
II	**Total quality management:** TQM Concepts, Basic approach, The Deming's philosophy, principles of TQM, Benefits of TQM, Involvement of management in TQM, TQM Organization Consumer satisfaction-Ergonomics- Time of Completion-Taguchi's concept of quality	9
III	**Quality Assurance:** Objectives, specification. Codes and standards. standards. Inspection purpose, stage, procedure, methods, technical service for inspection. Quality audit-audit cycle. Statistical Quality control definition, process control, product control, sub-grouping	9
IV	**Safety management**: Objectives, safety planning and design Injury and Accidents-Definitions of Unsafe Act – Unsafe Condition-Causes, Investigations and Prevention of Accidents. Hazards, Type of Industrial Hazards-Nature, Causes and Control Measures, Hazard Identifications and Control Techniques -Cost of Construction Injuries	9
V	**Risk management:** Steps in risk management and assessment Safety Programmes – principles of Safety- Need- Safety measures adopted in work sites. Measurement of Safety	9

	Performance, Safety Audit, Problem Areas in Construction Safety- Elements of an effective and safety Programme Job site Safety assessment- Safety Meetings- Safety Policy, Safety Record Keeping, Safety Culture- safety organization	
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests	:	02
Maximum Marks	:	30
Test Duration	:	1 ½ hours
Topics	:	2 ½ modules

viii) END SEMESTER EXAMINATION

Maximum Marks	:	60
Exam Duration	:	3 hours