



VARDHAMAN
COLLEGE OF ENGINEERING

CURRICULUM
For
Bachelor of Technology
Civil Engineering (Honors)

Under
Choice Based Credit System (CBCS)

B. Tech. - Honors Program

(For batches admitted from the Academic Year 2025 - 2026)

August 2025



VARDHAMAN COLLEGE OF ENGINEERING
(Autonomous)

Affiliated to JNTUH, Approved by AICTE, Accredited by NAAC with A++ Grade
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III B.Tech. I Semester												
#	Course Code	Title of the Course	Category	Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
				CI		LI	TW + SL			H	C	CIE
				L	T	P	SL					
Theory Courses												
1	H2101	Theory of Elasticity and Plasticity	PC	45	-	-	45	90	3	40	60	100
	H2102	Structural Health Monitoring										
2	H2103	Advanced Water Supply Systems and Smart Distribution	PC	45	-	-	45	90	3	40	60	100
	H2104	Urban Storm water Management and Sustainable Drainage										
Total				90	0	0	90	180	6	80	120	200

III B.Tech. II Semester												
#	Course Code	Title of the Course	Category	Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
				CI		LI	TW + SL			H	C	CIE
				L	T	P	SL					
Theory Courses												
1	H2105	Finite Element Analysis	PC	45	-	-	45	90	3	40	60	100
	H2106	Structural Dynamics										
2	H2107	Sustainable and Resilient Transportation Systems	PC	45	-	-	45	90	3	40	60	100
	H2108	Pavement Asset Management										
Total				90	0	0	90	180	6	80	120	200

IV B.Tech. I Semester												
#	Course Code	Title of the Course	Category	Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
				CI		LI	TW + SL			H	C	CIE
				L	T	P	SL					
Theory Courses												
1	H2109	Advanced Design of Steel Structures	PC	45	-	-	45	90	3	40	60	100
	H2110	Bridge Engineering										
2	H2111	Geotechnical Earthquake Engineering	PC	45	-	-	45	90	3	40	60	100
	H2112	Environmental Geotechnology										
Total				90	0	0	90	180	6	80	120	200

IV B.Tech. II Semester												
#	Course Code	Title of the Course	Category	Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
				CI		LI	TW + SL			H	C	CIE
				L	T	P	SL					
Experiential Learning Course												
1	H2041	Technical Report Writing	PW	-	-	-	90	90	2	40	60	100
Total				0	0	0	90	90	2	40	60	100

III B.Tech. I Semester

H2101 – Theory of Elasticity and Plasticity

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course deals with isotropic materials subjected to elastic stresses, strains, and displacements. Different problems related to plane strain, plane stress and other boundary conditions are also covered. Two-dimensional and three-dimensional elastic problems are solved using equilibrium equations, compatibility equations for various boundary conditions. An introduction to plasticity involving one-dimensional elastic-plastic relations, hardening and governing equations is discussed.

Course Pre/Co-requisites

The course has no specific pre-requisite and co-requisite.

Relevant Sustainable Development Goals (SDGs)

SDG 9: Industry, Innovation, and Infrastructure – Enhances material modeling for advanced and resilient infrastructure design.

SDG 11: Sustainable Cities and Communities – Promotes safety and sustainability in structures through elastic and plastic analysis.

Course Outcomes

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

- H2101.1. Demonstrate theory, concepts, principles, and governing equations of elasticity.
- H2101.2. Illustrate concepts of plasticity and its governing equations.
- H2101.3. Develop equations of equilibrium and compatibility for two-dimensional problems in rectangular and polar coordinates.
- H2101.4. Analyse three-dimensional elasticity problems to determine principal stresses and planes.
- H2101.5. Solve elastic problems using equilibrium and compatibility equations under various boundary conditions.

Course Syllabus

Unit-I:

Introduction: Elasticity – notation for forces and stresses – components of stress and strain – Hooke's law. Plane stress and plane strain analysis – differential equations of equilibrium – boundary conditions – strain displacement relations – compatibility equations – stress function – orthogonal transformation of axes.

Unit-II:

Normal and Shear Strain: Stress and strain in three dimensions – equilibrium and compatibility conditions in 3D – stress and strain tensors – principal stresses and strains – stress invariants – maximum shear stress – plane stress and plane strain cases – strain energy – general theorems including superposition, uniqueness, and reciprocal theorem.

Unit-III:

Two-Dimensional Problems in Rectangular Coordinates: Solution by polynomials – Airy’s stress function – Saint-Venant’s principle – determination of displacements – bending of simple beams – simply supported and cantilever beams.

Unit-IV:

Two-Dimensional Problems in Polar Coordinates: Axisymmetric stress distribution – Airy’s stress function – pure bending of curved bars – strain components in polar coordinates – displacements for symmetrical stress distribution – general and specific polar coordinate problems – applications to symmetric and asymmetric stress states.

Unit-V:

Analysis of Stress and Strain in Three Dimensions: Stress ellipsoid – director surface – homogeneous deformation – principal axes of strain rotation.

Introduction to Plasticity: One-dimensional elastic-plastic relations – isotropic and kinematic hardening – yield function – flow rule – hardening rule – consistency condition – incremental stress-strain relations – governing equations of elasto-plasticity.

Books and Materials

Text Book:

1. S. P. Timoshenko and J. N. Goodier. *Theory of Elasticity*. 3rd ed., McGraw-Hill Education, 2017.

Reference Books:

1. Sadhu Singh. *Theory of Elasticity*. 4th ed., Khanna Publishers, 1978.

H2102 – Structural Health Monitoring

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

The course introduces different structural health monitoring techniques and instruments used for sensing and methodologies. Different field-testing methods along with their corresponding data acquisition systems are thoroughly discussed. Also, concept of remote structural health monitoring and its hardware are discussed along with their importance and applications in IoT and machine learning techniques.

Course Pre/Co-requisites

There are no specific prerequisites or co-requisites for this course.

Relevant SDG(s)

SDG 4: Quality Education – Provides students with advanced knowledge in cutting-edge monitoring technologies, promoting high-quality engineering education aligned with modern industry needs.

SDG 9: Industry, Innovation, and Infrastructure – Focuses on innovative monitoring techniques that enhance the reliability, safety, and longevity of infrastructure through modern technologies such as IoT and machine learning.

SDG 11: Sustainable Cities and Communities – Supports the development of safe and resilient structures by enabling continuous monitoring and maintenance of buildings, bridges, and other infrastructure systems.

Course Outcomes

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

- H2102.1. Illustrate various structural sensing technologies used for health monitoring.
- H2102.2. Identify and differentiate between various SHM techniques and their applications.
- H2102.3. Apply appropriate field-testing and monitoring methods for data collection.
- H2102.4. Utilize different data acquisition systems for structural assessment.
- H2102.5. Integrate IoT-based hardware and software for remote monitoring and data analysis using machine learning.

Course Syllabus

Unit I:

Introduction: Definition of SHM – Classification, Types and Components of SHM – Advantages and Benefits of SHM.

Sensing Technologies: Strain Measurement – LVDT – Temperature Sensors – Fiber Optic Sensing Technology - DIC.

Unit II:

SHM Methodology: Sensors – Selection of Sensors – Installation and placement – Data acquisition – Communication – Processing and Analysis – Storage – Diagnostics and Prognostics – Retrieval of data.

Unit III:

Testing: Static Field Testing – Dynamic field testing - Stress history data - Dynamic load allowance tests - Ambient vibration tests - Forced Vibration Method - Dynamic response methods.

Unit IV:

Data Acquisition: Static data acquisition systems - Dynamic data acquisition systems - Components of Data acquisition system - Hardware for Remote data acquisition systems.

Unit V:

Remote structural health monitoring: Remote Structural Health Monitoring – Importance and Advantages – Methodology – IoT applications in SHM – Application Machine learning Techniques in SHM.

Books and Materials

Text Books:

1. Balageas, Daniel, et al., editors. *Structural Health Monitoring*. 1st ed., John Wiley & Sons, 2006.
2. Adams, Douglas E. *Health Monitoring of Structural Materials and Components: Methods with Applications*. John Wiley & Sons, 2007.

Reference Books:

1. Ou, J. P., H. Li, and Z. D. Duan, editors. *Structural Health Monitoring and Intelligent Infrastructure*. Vol. 1, Taylor & Francis Group, 2006.
2. Giurgiutiu, Victor. *Structural Health Monitoring with Piezoelectric Wafer Active Sensors*. 3rd ed., Academic Press, 2023.

H2103 – Advanced Water Supply Systems and Smart Distribution

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL			H	C	CIE
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course aims to provide an in-depth understanding of modern water supply systems with a focus on design, treatment, distribution, automation, and sustainability. It emphasizes the use of digital tools, smart technologies, and economic frameworks for planning and managing urban water infrastructure. Through real-world case studies, software tools, and design principles, students will gain practical skills and strategic thinking required for 21st-century water professionals.

Course Pre/Co-requisites

The course has no specific pre-requisite and co-requisite.

Relevant Sustainable Development Goals (SDGs)

SDG 6: Clean Water and Sanitation – Directly supports the goal of ensuring availability and sustainable management of water by focusing on design, treatment, and distribution systems that provide safe and reliable water supply.

SDG 9: Industry, Innovation, and Infrastructure - Encourages the use of digital tools, automation, and smart technologies to develop resilient and innovative water infrastructure systems.

SDG 11: Sustainable Cities and Communities - Promotes sustainable urban water management, contributing to the creation of smart, safe, and resilient communities.

Course Outcomes

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

- H2103.1. Explain components and demand forecasting in water supply systems.
- H2103.2. Design intake, storage, and conveyance structures.
- H2103.3. Evaluate treatment methods for water quality assurance.
- H2103.4. Analyze and optimize water distribution networks using software tools.
- H2103.5. Demonstrate the use of automation and pricing approaches for efficient and sustainable water supply systems.

Course Syllabus

Unit-I:

Fundamentals of Water Supply and Demand: Overview of water supply systems, Water availability and distribution (temporal & spatial), Key issues and system components, Types of water demand and influencing factors, Demand fluctuations and estimation, Population forecasting methods.

Unit-II:

Water Intake, Conveyance, and Storage: Types of intake structures, design considerations of intake structures, conveyance systems – gravity and pressure flow, pumping systems – types and capacity estimation, economic pipe diameter – concept and calculation, storage structures and balancing reservoirs, mass curve analysis for storage capacity estimation, regulation of storage – daily, weekly, and seasonal.

Unit-III:

Water Quality and Treatment Processes: Water quality parameters, drinking water standards (IS 10500), philosophy of water treatment, unit operations – aeration, sedimentation, coagulation, flocculation, filtration methods – slow sand filter, rapid sand filter, multimedia filter, pressure filter, disinfection methods – chlorination, ozone, UV, advanced water treatment – advanced oxidation processes (AOPs), removal of fluoride, iron, manganese, hardness, color, taste, odor, dissolved gases and metals.

Unit-IV:

Distribution Network Design and Loss Management: Types of water distribution layouts – grid, radial, ring, hydraulics of distribution systems, Hardy Cross method for pipe network analysis, concept of water losses – apparent and real losses, non-revenue water (NRW), unaccounted-for water (UFW), leakage detection methods, water loss reduction strategies, sectorization of distribution networks, district metering areas (DMA), introduction to network analysis software – EPANET, WaterGEMS.

Unit-V:

Smart Systems and Water Economics: Automation in water supply systems, SCADA – real-time monitoring and control, case studies of automated WTP and distribution systems, smart water supply system concept, investment and operational cost estimation, cost optimization techniques, water metering approaches, water pricing models, sustainability in pricing, water tariff structures in Indian cities, issues and challenges in water pricing.

Books and Materials

Text Books:

1. Punmia, B. C., Ashok Jain, and Arun Jain. *Water Supply Engineering*. 3rd ed., Laxmi Publications, 2016.
2. Garg, S. K. *Environmental Engineering: Vol. I – Water Supply Engineering*. 3rd ed., Khanna Publishers, 2017.

Reference Books:

1. Steel, E. W., and Terence J. McGhee. *Water Supply and Sewerage*. 6th ed., McGraw-Hill, 1985.
2. Hammer, Mark J., and Mark J. Hammer Jr. *Water and Wastewater Technology*. 7th ed., Pearson Education, 2012.

H2104 – Urban Stormwater Management and Sustainable Drainage

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL			H	C	CIE
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces students to the principles and practices of managing urban stormwater using sustainable and innovative drainage solutions. It covers the impacts of urbanization on hydrology, conventional and green infrastructure design, flood mitigation, water quality control, and the integration of SuDS in urban planning. The course emphasizes resilience, sustainability, and adaptability of stormwater systems under changing climatic conditions.

Course Pre/Co-requisites

The course has no specific pre-requisite and co-requisite.

Relevant Sustainable Development Goals (SDGs)

SDG 6: Clean Water and Sanitation – Promotes sustainable management of stormwater to improve water quality, reduce pollution, and enhance water reuse through SuDS and green infrastructure.

SDG 11: Supports the development of resilient and adaptable urban drainage systems that protect cities from flooding and ensure sustainable urban living.

SDG 13: Climate Action - Addresses the need for climate-resilient infrastructure by adapting stormwater systems to the increasing impacts of climate change and extreme weather events.

Course Outcomes

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

- H2104.1. Explain the hydrological impact of urbanization and the need for sustainable stormwater management.
- H2104.2. Identify and classify various SuDS techniques used in modern urban drainage systems.
- H2104.3. Analyze rainfall-runoff processes and design components of SuDS like swales, permeable pavements, detention ponds, and green roofs.
- H2104.4. Evaluate the performance of stormwater systems using modeling tools and performance criteria.
- H2104.5. Integrate SuDS in urban planning to achieve water-sensitive urban design and environmental sustainability.

Course Syllabus

Unit-I:

Urban Hydrology and Stormwater Issues: Concepts of urban hydrology, impact of urbanization on natural hydrologic cycle, increase in surface runoff and reduction in infiltration, flash floods and urban drainage challenges, pollution load in stormwater, limitations of conventional drainage systems.

Unit-II:

Fundamentals of Sustainable Drainage Systems (SuDS): Definition and philosophy of SuDS, objectives: quantity control, quality improvement, amenity, biodiversity, nature-based solutions and principles, SuDS vs. traditional piped drainage systems, environmental and economic benefits.

Unit-III:

Design of SuDS Components: Swales, rain gardens, bio-retention cells, infiltration trenches and soakaways, detention and retention basins, permeable pavements and green roofs, constructed wetlands, design parameters and selection criteria.

Unit-IV:

Modeling and Performance Assessment: Rainfall-runoff modeling basics, use of simulation tools (e.g., SWMM, MIKE URBAN), hydraulic and hydrologic parameters, storage and peak flow design, performance indicators and monitoring, effectiveness evaluation of SuDS.

Unit-V:

Urban Planning, Policies, and Case Studies: Integration of SuDS in urban planning, national and international guidelines and policies, regulatory frameworks for SuDS, case studies from India and abroad, SuDS in climate resilience and urban sustainability, challenges and best practices in implementation.

Books and Materials

Text Books:

1. Sharma, R. K. *Urban Hydrology and Drainage*. Khanna Publishers, 2014.
2. Marsalek, Jiri, Bernard Chocat, and Werner Rauch. *Urban Drainage Systems*. Springer, 2008.

Reference Books:

1. Butler, David, and John W. Davies. *Urban Drainage*. 3rd ed., CRC Press, 2010.
2. CIRIA (UK). *The SuDS Manual (C753)*. Construction Industry Research and Information Association, 2015.
3. Mays, Larry W. *Stormwater Collection Systems Design Handbook*. McGraw-Hill, 2001.
4. Novotny, Vladimir. *Urban Water Management and Water Quality*. Wiley, 2003.

III B.Tech. II Semester

H2105 – Finite Element Analysis

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

The course introduces advanced numerical methods to solve civil engineering problems using the Finite Element Method (FEM). It includes concepts of plane stress and plane strain constitutive relationships along with matrix algebra and discretization techniques. The course focuses on the formulation of stiffness matrices and load vectors for one-dimensional and two-dimensional systems of various elements. It provides an understanding of shape functions, generalized coordinate systems, axi-symmetric analysis, and convergence requirements of different elements, including plates.

Course Pre/Co-requisites

There are no specific prerequisites or co-requisites for this course.

Relevant Sustainable Development Goals (SDGs)

SDG 4: Quality Education – Enhances analytical, computational, and problem-solving skills through advanced numerical techniques, promoting quality and modern engineering education.

SDG 9: Industry, Innovation, and Infrastructure – Supports innovation in structural and civil engineering design by enabling precise and efficient analysis of complex systems, contributing to resilient and sustainable infrastructure.

SDG 11: Sustainable Cities and Communities – Applies FEM tools to ensure the safety, reliability, and sustainability of urban infrastructure, aiding in the creation of well-planned and resilient communities.

Course Outcomes

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

- H2105.1. Illustrate concepts of Finite Element Analysis (FEA) and relate energy principles in functional approximations.
- H2105.2. Develop shape functions and stiffness matrices for 1D and 2D elements.
- H2105.3. Solve problems using 2D and 3D iso-parametric elements.
- H2105.4. Analyse Lagrange and axisymmetric 2D and 3D elements.
- H2105.5. Evaluate plate elements using plate bending concepts.

Course Syllabus

Unit I:

Introduction: Concepts of FEM - steps involved - merits and demerits - energy principles – Discretization - Raleigh - Ritz method of functional approximation.

Principles of Elasticity: Stress equations - strain displacement relationships in matrix form plane stress, plane strain.

Unit II:

One-Dimensional FEA: Stiffness matrix for beam and bar elements - shape functions for 1-D elements.

Two dimensional FEA: Different types of elements for plane stress and plane strain analysis - displacement models - generalized coordinates - shape functions - convergent and compatibility requirements - geometric invariance - natural coordinate system - area and volume coordinates - generation of element stiffness and nodal load matrices.

Unit III:

Axi-symmetric formulation: Finite element formulation for plane stress, plane strain and axi-symmetric problems - Derivation of CST and LST stiffness matrix and equations- treatment of body and surface forces- Finite Element solution for plane stress and axi- symmetric problems- comparison of CST and LST elements - convergence of solution-interpretation of stresses.

Unit IV:

Iso-parametric formulation: Concept - different iso-parametric elements for 2D analysis -formulation of 4-noded and 8-noded iso parametric quadrilateral elements - Lagrange elements - serendipity elements.

Three-Dimensional FEM: Different 3D elements – strain-displacement relationships – formulation of hexahedral and iso-parametric solid elements.

Unit V:

Introduction to finite element analysis of plates: Concept and types of iso-parametric elements for 2D analysis – formulation of 4-noded and 8-noded iso-parametric quadrilateral elements – Lagrange elements – serendipity elements.

Books and Materials

Text Books:

1. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt. *Concepts and Applications of Finite Element Analysis*. 4th ed., Wiley, 2001.

Reference Books:

1. Tirupathi R. Chandrupatla, Ashok D. Belegundu. *Introduction to Finite Element Method*. 3rd ed., Pearson, 2002.
2. C. S. Krishnamoorthy. *Finite Element Analysis: Theory and Programming*. 2nd ed., McGraw Hill Education, 2013.
3. J. N. Reddy. *Introduction to Finite Element Method*. 3rd ed., McGraw Hill Education, 2005.

H2106 – Structural Dynamics

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

The course introduces the equations of the motion using D-Alembert's, Hamilton and virtual work principles. Vectorial representation of simple harmonic motion and oscillatory motions are discussed. Free vibrations of single degree of freedom and multi degree of freedom including damping categories, dynamic magnification factors are explained. Also explained the shear building idealizations extends to estimation of natural frequency of discrete and continuous systems. Response of the multi degree of freedom systems giving insight to the modal analysis is presented in the course. Transverse vibrations in the continuous systems are highlighted.

Course Pre/Co-requisites

There are no specific prerequisites or co-requisites for this course.

Relevant Sustainable Development Goals (SDGs)

SDG 4: Quality Education – Develops strong analytical and conceptual understanding of dynamic behavior in structures, providing students with quality higher education in advanced structural mechanics.

SDG 9: Industry, Innovation, and Infrastructure – Enhances the ability to design and analyze vibration-resistant and resilient infrastructure, supporting innovation and safety in modern engineering systems.

SDG 11: Sustainable Cities and Communities – Contributes to creating safer and more sustainable built environments by improving structural performance under dynamic and seismic loads.

Course Outcomes

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

- H2106.1. Apply equilibrium equations of motion in dynamic systems.
- H2106.2. Determine dynamic characteristics of systems subjected to various loadings.
- H2106.3. Analyse multi-degree-of-freedom systems using discrete approach.
- H2106.4. Estimate natural frequencies using approximate methods.
- H2106.5. Deduce natural frequencies and mode shapes for continuous systems.

Course Syllabus

Unit I:

Introduction: Elements of vibratory system, degree of freedom, continuous system, lumped mass idealization, oscillatory motion, simple harmonic motion, vectorial representation of S.H.M. Fundamental objectives of dynamic analysis- Types of prescribed loading - Methods of discretization - Formulation of equations of motion by different methods - Direct equilibration using Newton's law of motion / D'Alembert's principle, Principle of virtual work and Hamilton principle.

Fundamental objectives of dynamic analysis: Types of prescribed loading - Methods of discretization - Formulation of equations of motion by different methods – Direct equilibration using Newton's law of motion / D'Alembert's principle, Principle of virtual work and Hamilton principle.

Unit II:

Single Degree of Freedom Systems: Free vibrations of single degree of freedom system, un-damped and damped vibration, critical damping, logarithmic decrement, forced vibrations of SDOF systems, harmonic excitation, dynamic magnification factor, phase angle, Band width. Formulation and solution of the equation of motion – Response to Harmonic, Periodic, Impulsive and general dynamic loadings -Duhamel integral.

Unit III:

Multi-Degree of Freedom Systems: Selection of the degrees of Freedom - Evaluation of structural property matrices - Formulation of the MDOF equations of motion -Undamped free vibrations - Solutions of Eigen value problem for natural frequencies and mode shapes - Analysis of Dynamic response – Normal co-ordinates - Uncoupled equations of motion - Orthogonal properties of normal modes - Mode superposition procedure.

Unit IV:

Practical Vibration Analysis: Introduction - Stodola method - Fundamental mode analysis – Analysis of second and higher modes - Holzer method - Basic procedure.

Unit V:

Continuous Systems: Introduction - Flexural vibrations of beams - Elementary case – Derivation of governing differential equation of motion - Analysis of undamped free vibrations of beams in flexure - Natural frequencies and mode-shapes of simple beams with different end conditions - Principles of application to continuous beams.

Books and Materials

Text Books:

1. Anil K. Chopra, *Dynamics of Structures*. 4th ed., Pearson Education, New Delhi, India, 2011.
2. Mario Paz, *Structural Dynamics*. C.B.S. Publishers, New Delhi, India, 1980.

Reference Books:

1. Vinod Hosur, *Earthquake Resistant Design of Building Structures*. Wiley, India.
2. Clough and Penzien, *Structural Dynamics*. Tata McGraw-Hill.
3. Timoshenko, S., *Vibration Problems in Engineering*. Van-Nostrand Co.

H2107 – Sustainable and Resilient Transportation Systems

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course addresses the planning, design, operation, and maintenance of transportation systems that are both environmentally sustainable and resilient to climate change, extreme events, and long-term socio-economic challenges. Students will learn about sustainable transport concepts, life-cycle environmental assessment, green construction materials, climate adaptation strategies, and resilient infrastructure design. The course integrates technical, economic, and policy perspectives to develop transportation systems that minimize environmental impacts while maintaining operational reliability under adverse conditions. Emphasis is placed on practical tools, performance-based approaches, and global best practices, with applications in highways, railways, air transport, and urban mobility systems.

Course Pre/Co-requisites

There are no specific prerequisites or co-requisites for this course.

Relevant Sustainable Development Goals (SDGs)

SDG 9: Industry, Innovation, and Infrastructure – Promotes the design and maintenance of innovative, resilient, and sustainable transportation infrastructure that supports economic growth and technological advancement.

SDG 11: Sustainable Cities and Communities – Focuses on developing environmentally friendly and efficient mobility systems, enhancing accessibility, safety, and sustainability in urban and regional transport networks.

SDG 13: Climate Action – Addresses climate resilience and adaptation strategies in transportation planning to reduce greenhouse gas emissions and mitigate the impacts of climate change on infrastructure.

Course Outcomes

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

- H2107.1. Explain the concepts and principles of sustainability and resilience in transportation systems.
- H2107.2. Evaluate transportation projects using environmental and socio-economic sustainability indicators.
- H2107.3. Apply life-cycle assessment methods to transportation infrastructure and materials.
- H2107.4. Formulate climate change adaptation and disaster-resilience strategies for transport networks.
- H2107.5. Recommend sustainable design, construction, and maintenance practices for various modes of transportation.

Course Syllabus

Unit I:

Introduction to Sustainable and Resilient Transportation: Sustainability concepts in transportation, Pillars of sustainability: environmental, social, and economic dimensions, Resilience in transport systems: definitions, frameworks, and metrics, Policy frameworks: UN Sustainable Development Goals, NMT policies, and National Infrastructure Pipeline.

Unit II:

Sustainability Indicators and Assessment Methods: Environmental performance indicators: emissions, energy use, air quality impacts, Economic performance indicators: life-cycle costs, economic productivity, social performance indicators: accessibility, equity, safety, multi-criteria decision-making in sustainability evaluation, Case studies: BRTS, metro rail, highway green rating systems.

Unit III:

Life-Cycle Assessment and Green Transportation Infrastructure: Life-Cycle Assessment (LCA) concepts and ISO 14040/14044 standards, Carbon foot printing and embodied energy of transport infrastructure, Sustainable construction materials: recycled aggregates, fly ash concrete, warm-mix asphalt, Green certification systems (GRIHA, LEED, Envision) for transport projects.

Unit IV:

Climate Change Adaptation and Disaster Resilience: Climate risks to transportation: flooding, heat waves, sea-level rise, extreme precipitation, Vulnerability and risk assessment for transport networks, Adaptation measures in design and maintenance, Resilient pavement and bridge design principles, Disaster risk management and recovery planning in transportation systems.

Unit V:

Innovations, Tools, and Case Studies: Smart mobility solutions for sustainability (ITS, EV integration, shared mobility), GIS and remote sensing for climate resilience planning, Modelling tools for resilience assessment, International best practices: Netherlands flood-resilient transport, Japan seismic resilience, India's coastal highway projects, Future trends: autonomous and connected transport for sustainability.

Books and Materials

Text Books:

1. Black, William R. *Sustainable Transportation: Problems and Solutions*. 3rd ed., The Guilford Press, 2010.
2. Litman, Todd. *Transportation and Environmental Policy*. 3rd ed., Routledge, 2021.
3. Jeon, Choon M., and Abid A. Amekudzi. *Transportation Planning for Sustainability Guidebook*. NCHRP Report 708, Transportation Research Board, 2013.

Reference Books:

1. National Academies of Sciences, Engineering, and Medicine. *Climate-Resilient Transportation Infrastructure*. TRB Special Report 330, Transportation Research Board, 2021.
2. Meyer, Michael D., and Barbara Weigel. *Climate Change and Transportation Systems*. U.S. Department of Transportation, Federal Highway Administration, 2013.
3. United Nations Environment Programme (UNEP). *A Practical Guide to Sustainable Transport*. UNEP, 2016.
4. Muench, Steven T., et al. *Greenroads Manual Version 2*. Greenroads Foundation, 2019.

H2108 – Pavement Asset Management

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

Pavement Asset Management (PAM) is a systematic process of maintaining, upgrading, and operating a network of pavements cost-effectively. This course provides students with a comprehensive understanding of the principles, methods, and tools used to manage pavement infrastructure throughout its life cycle. Topics include asset inventory creation, pavement condition assessment, performance modelling, deterioration forecasting, preservation strategies, life-cycle cost analysis, optimization techniques, and reliability concepts. The course also introduces decision-support tools such as HDM-4, MicroPAVER, and GIS-based systems, along with emerging technologies like UAV-based distress mapping and AI/ML for predictive maintenance. Real-world case studies from India and abroad will be discussed to link theoretical knowledge with practical applications. Upon completion, students will be able to plan and implement effective pavement asset management strategies for sustainable and economical infrastructure performance. .

Course Pre/Co-requisites

There are no specific prerequisites or co-requisites for this course.

Relevant Sustainable Development Goals (SDGs)

SDG 9: Industry, Innovation, and Infrastructure – Focuses on developing efficient, reliable, and innovative pavement management systems that enhance the quality, durability, and sustainability of transportation infrastructure.

SDG 11: Sustainable Cities and Communities – Promotes sustainable urban mobility and infrastructure management by ensuring well-maintained and safe road networks that support inclusive and resilient communities.

SDG 12: Responsible Consumption and Production – Encourages resource-efficient and cost-effective pavement maintenance practices through life-cycle assessment, optimization, and preservation strategies that minimize material and energy use.

Course Outcomes

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

- H2108.1. Explain the components, objectives, and framework of pavement asset management systems.
- H2108.2. Apply methods for pavement condition assessment and develop performance models.
- H2108.3. Perform life-cycle cost analysis and economic evaluation for maintenance strategies.
- H2108.4. Select and apply optimization and ranking techniques for network-level maintenance planning.
- H2108.5. Utilize software tools and emerging technologies for pavement asset management.

Course Syllabus

Unit I:

Introduction to Pavement Asset Management: Concept and objectives of PAM systems, Differences between project-level and network-level management, Asset inventory: data types, collection methods, database management, Performance measures and serviceability concepts (IRI, PCI, etc.).

Unit II:

Pavement Condition Assessment and Performance Modelling: Functional and structural condition assessment techniques, Visual surveys, automated distress detection, NDT methods (FWD, GPR), Performance models: deterministic, probabilistic (Markov chains), mechanistic–empirical models, Calibration and validation of models.

Unit III:

Deterioration, Preservation and Life-Cycle Cost Analysis: Pavement deterioration mechanisms and influencing factors, Preservation vs rehabilitation strategies, Life-cycle cost analysis (LCCA): methods, discount rate, salvage value, Economic evaluation: benefit–cost analysis, ROI, net present value, Budget allocation and prioritization.

Unit IV:

Decision-Making, Optimization and Reliability: Ranking techniques (condition-based, benefit-based, multi-criteria), Optimization methods: linear programming, genetic algorithms, integer programming, Reliability concepts in pavement performance and decision-making, Risk analysis in maintenance planning.

Unit V:

Tools, Software and Emerging Technologies: Overview and applications of HDM-4, MicroPAVER, and PMS software, GIS integration for asset management, Expert systems for decision support, Emerging technologies: UAVs for distress mapping, AI/ML for condition prediction, IoT-based monitoring, Case studies from India and abroad.

Books and Materials

Text Books:

1. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt. *Concepts and Applications of Finite Element Analysis*. 4th ed., Wiley, 2001.

Reference Books:

1. Tirupathi R. Chandrupatla, Ashok D. Belegundu. *Introduction to Finite Element Method*. 3rd ed., Pearson, 2002.
2. C. S. Krishnamoorthy. *Finite Element Analysis: Theory and Programming*. 2nd ed., McGraw Hill Education, 2013.
3. J. N. Reddy. *Introduction to Finite Element Method*. 3rd ed., McGraw Hill Education, 2005.

IV B.Tech. I Semester

H2109 – Advanced Design of Steel Structures

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course provides foundation knowledge and skills relevant to the concepts, principles and components of structural design. It introduces the design of steel structures using the limit state design philosophy. Students will gain an understanding of statutory requirements, design standards, steel industry practices and design documentation. Steel structural members, structural design principles and evaluation of loads and estimation of member capacities for steel structures will all be addressed by this course.

Course Pre/Co-requisites

There are no specific prerequisites or co-requisites for this course.

Relevant SDG(s)

SDG 4: Quality Education – Provides foundational knowledge and practical skills in steel structural design for engineering students.

SDG 9: Industry, Innovation, and Infrastructure – Equips students to design efficient and resilient steel structures supporting industrial and infrastructural development.

SDG 11: Sustainable Cities and Communities – Promotes safe and durable steel structures for sustainable urban and industrial infrastructure.

SDG 12: Responsible Consumption and Production – Encourages efficient use of steel and optimization of structural members through design principles.

Course Outcomes

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

- H2109.1. Classify the different structural design philosophies.
- H2109.2. Determine the strength parameters of different connection types.
- H2109.3. Apply design principles, procedures, and current IS code requirements.
- H2109.4. Identify failure modes and assess design strength of axial steel members.
- H2109.5. Design various members and connections in steel structural systems.

Course Syllabus

Unit I:

Simple connections – riveted, bolted, pinned and welded connections: Riveted Connections – Bolted Connections – Load Transfer Mechanism – Failure of Bolted Joints – Specifications for Bolted Joints – Bearing type Connections – Tensile Strength of Plate – Strength and Efficiency of the Joint – Combined Shear and Tension – Slip - Critical connections – Prying Action. Design of Groove Welds - Design of Fillet Welds – Design of Intermittent Fillet Welds – Failure of Welds.

Unit II:

Eccentric and moment connections: Introduction – Beams – Column Connections – Connections Subjected to Eccentric Shear – Bolted Framed Connections – Bolted Seat Connections – Bolted Bracket Connections. Bolted Moment Connections – Welded Framed Connections - Welded Bracket Connections – Moment Resistant Connections.

Unit III:

Analysis and design of industrial buildings: Dead loads, live loads and wind loads on roofs. Design wind speed and pressure, wind pressure on roofs; wind effect on cladding and louvers; Design of angular roof truss, tubular truss, truss for a railway platform. Design of purlins for roofs. Design of bracings.

Unit IV:

Design of steel truss girder bridges: Types of truss bridges, component parts of a truss bridge, economic Proportions of trusses, self-weight of truss girders, design of bridge Compression members, tension members; wind load on truss girder Bridges; wind effect on top lateral bracing; bottom lateral bracing; portal Bracing; sway bracing Design of Lacing.

Unit V:

Plastic Analysis and Design: Introduction – Plastic Theory – Plastic neutral Axis plastic moment, Elastic & Plastic Section moduli shape factors plastic Hinge – Fundamental condition - conditions in plastic analysis, methods of plastic analysis – collapse load – simply supported, propped cantilever beam, fixed beams continuous beams, portal frame single bay single storey portal frame at different level subjected to vertical and horizontal loads.

Books and Materials

Text Books:

1. Duggal, Shashikant K. *Limit State Design of Steel Structures*. 3rd ed., McGraw Hill Education, 2019.
2. Ramachandra, Dr., and Virendra Gehlot. *Design of Steel Structures: Volume I & II*. 12th ed., Scientific Publishers, 2009.

Reference Books:

1. Beer, Ferdinand P., E. Russell Johnston Jr., John T. DeWolf, and David F. Mazurek. *Mechanics of Materials*. 5th ed., McGraw Hill, 2009.
2. Shames, Irving H., and James M. Pitarresi. *Introduction to Solid Mechanics*. 3rd ed., Pearson, 2009.
3. Kazimi, S. M. A. *Solid Mechanics*. 1st rev. ed., Tata McGraw-Hill, 1981.
4. Bureau of Indian Standards. *IS 800: 2007: General Construction in Steel – Code of Practice*. Bureau of Indian Standards, 2007.
5. Bureau of Indian Standards. *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, 2015.

H2110 – Bridge Engineering

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course begins with the classification of bridges and an introduction to their various components, followed by the design of substructure elements such as abutments, piers, and pier caps. It includes the study of flood discharge characteristics and their effects on bridge elements. The analysis and design of superstructure components, including slabs, beams, and box girder bridges, are covered in detail. An introductory treatment of cable-stayed bridges is also provided. The course further addresses bridge bearings and expansion joints, with emphasis on the design of elastomeric bearings and expansion joints used in bridges under varying service and environmental conditions.

Course Pre/Co-requisites

There are no specific prerequisites or co-requisites for this course.

Relevant SDG(s)

SDG 9: Industry, Innovation, and Infrastructure – Promotes the design and construction of safe, reliable, and innovative bridge structures that enhance transportation connectivity and support sustainable infrastructure development.

SDG 11: Sustainable Cities and Communities – Contributes to creating resilient urban and rural transport networks by ensuring durable and efficient bridge systems that improve accessibility and safety.

SDG 13: Climate Action – Encourages the consideration of hydraulic forces, flood impacts, and environmental conditions in bridge design, promoting resilience and adaptability to climate-related challenges.

Course Outcomes

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

- H2110.1. Classify various types of bridges and load patterns based on IRC standard recommendations.
- H2110.2. Select suitable bearings and expansion joints for different structural conditions.
- H2110.3. Analyse cables and towers under various loadings and perform design of bridge superstructure.
- H2110.4. Estimate forces and moments acting on bridge components such as abutments and piers.
- H2110.5. Design structural elements for both substructure and superstructure considering codal provisions.

Course Syllabus

Unit I:

Introduction: Bridge components - Classification – Investigation for bridges – Loads and Loading standards – IRC and Railway loads – Impact.

Unit II:

Bridge Substructure: Determination of maximum flood discharge - Determination of linear water way - Determination of maximum depth of scour - Loads acting on substructure - Design of abutment, pier and pier cap - Design of well elements - Sinking of wells.

Unit III:

Bridge Superstructure: Pigeaud's curves method for design of slab - Analysis of beams – Courbon's Method - Hendry Jaeger Method – Guyon and Massonet Method - Box Girder Bridges - Grillage analogy.

Unit IV:

Cable Bridges: Advantages - Arrangement of stay cables - types of towers - Linear analysis of cables and towers.

Unit V:

Bridge bearings and expansion joints: Functions, types and selection of bearings - Bearing materials - Design of elastomeric bearings and spherical pot bearings for different conditions - Expansion joints – types of expansion joints.

Books and Materials

Text Books:

1. Saran, Swami. *Analysis and Design of Substructures: Limit State Design*. 2nd ed., Oxford & IBH Publishing Co., 2015.
2. Victor, D. Johnson. *Essentials of Bridge Engineering*. 6th ed., Oxford & IBH Publishing Co., 2017.

Reference Books:

1. Raju, N. Krishna. *Design of Bridges*. 5th ed., Oxford & IBH Publishing Co., 2019.
2. Jagadeesh, T. R., and M. A. Jayaram. *Design of Bridge Structures*. 2nd ed., Prentice Hall of India Pvt. Ltd., 2020.

H2111 – Geotechnical Earthquake Engineering

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL			H	C	CIE
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the fundamentals of geotechnical earthquake engineering, covering earthquake causes, ground motion characteristics, and dynamic soil properties. It focuses on soil response under seismic loading, liquefaction and its mitigation, and the seismic analysis and design of foundations, slopes, and retaining structures. The course equips students with essential concepts and methods for assessing and designing geotechnical systems subjected to earthquakes.

Course Pre/Co-requisites

A9120 – Soil Mechanics

A9126 - Foundation Engineering

Relevant SDG(s)

SDG 9: Industry, Innovation, and Infrastructure – Promotes resilient and earthquake-resistant infrastructure through understanding soil behavior under dynamic loads.

SDG 11: Sustainable Cities and Communities – Ensures safer and more stable urban environments by applying seismic soil analysis in geotechnical design.

SDG 13: Climate Action – Supports disaster risk reduction and adaptation to seismic and environmental challenges.

Course Outcomes

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

- H2111.1. Identify causes of earthquakes.
- H2111.2. Interpret characteristics of ground motion parameters and response spectra.
- H2111.3. Summarize liquefaction and its effects and remedies.
- H2111.4. Determine dynamic soil properties and study their response in one dimensional analysis.
- H2111.5. Evaluate seismic stability of slopes, retaining walls, bearing capacity and settlement of foundations.

Course Syllabus

Unit I:

Earthquake Seismology: Introduction - Seismic waves - Causes of earthquake – Continental drift and Plate tectonics – Earthquake fault sources – Faults, fault geometry, fault movement - Elastic Rebound Theory – Location of Earthquakes – Quantification of Earthquakes – Intensity and magnitude – Earthquake Energy.

Unit II:

Earthquake ground motion: Seismograph - Characteristics of Ground motion: - Ground motion parameters – Amplitude Parameters – peak acceleration, peak velocity, peak displacement other amplitude parameters – Frequency content parameters – groundresponse spectra, Fourier spectra, Power spectra, response spectra – spectral parameters – duration. Local site Specification and Code based design.

Unit III:

Dynamic Soil Properties: Representation of Stress conditions by the Mohr Circle – Measurement of Dynamic

properties – field, laboratory, interpretation of observed ground response - One dimensional response analysis - linear approach, Equivalent linear approach.

Unit IV:

Liquefaction and Lateral Spreading: Liquefaction related phenomena – Liquefaction susceptibility – Initiation of Liquefaction – Effects of Liquefaction – Remedies on Seismic hazards – Densification – Reinforcement – Grouting and mixing Techniques – Drainage Techniques.

Unit V:

Seismic Design of Foundation, Slopes and Retaining Structures: Seismic Design requirements for Foundation – Seismic Bearing capacity - Seismic Settlement – Internal stability and weakened instability of slopes - Seismic design of retaining walls: Dynamic Response of Retaining walls - Seismic Displacement of Retaining walls - Seismic Design Considerations.

Books and Materials

Text Books:

1. Kramer, Steven L., and Jonathan P. Stewart. *Geotechnical Earthquake Engineering*. 2nd ed., CRC Press, 2024.

Reference Books:

1. Bolt, Bruce A. *Earthquakes*. 22nd ed., W.H. Freeman and Co., 2024.

H2112 – Environmental Geotechnology

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course on Environmental Geotechnology introduces the geotechnical principles involved in waste management and soil pollution control. It covers waste characterization and disposal methods, contaminant transport in soils, stabilization of solid wastes, and remediation techniques for contaminated sites, with emphasis on sustainable and safe geotechnical practices.

Course Pre/Co-requisites

A9120 – Soil Mechanics A9126 - Foundation Engineering

Relevant SDG(s)

SDG 9: Industry, Innovation, and Infrastructure – Encourages innovative geotechnical solutions for sustainable waste management and infrastructure development.

SDG 11: Sustainable Cities and Communities – Promotes safe and sustainable urban environments through effective waste stabilization and site rehabilitation.

SDG 12: Responsible Consumption and Production – Supports environmentally responsible waste disposal, recycling, and reuse practices to minimize environmental impact.

Course Outcomes

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

- H2112.1. Assess the extent of contamination in the soil.
- H2112.2. Categorize waste disposal methods.
- H2112.3. Compare transportation mechanism of contaminants.
- H2112.4. Select suitable remediation methods based on contaminant type.
- H2112.5. Apply suitable rehabilitation and reuse techniques for contaminated and waste-affected sites.

Course Syllabus

Unit I:

Introduction to Environmental Geotechnology: Environmental cycle – sources, production and classification of waste – causes of soil pollution – factors governing soil pollutant interaction – failures of foundations due to pollutants.

Unit II:

Safe disposal of waste: Site selection for landfills – characterization of landfill sites – rigid or flexible liners - waste characterization – current practice of waste disposal – Monitoring facilities - passive containment system – application of geosynthetics in solid waste management.

Unit III:

Transport of Contaminants: Contaminant transport in the subsurface – advection – diffusion – dispersion – contaminant transformation – sorption – biodegradation – ion exchange – precipitation - Hydrological consideration in landfill design.

Unit IV:

Stabilization: Solidification of wastes – micro and macro encapsulation – absorption, adsorption, precipitation-detoxification – mechanism of stabilization – organic and inorganic stabilization – utilization of solid waste for soil improvement.

Unit V:

Remediation of Contaminated Soils: Ex-situ and In-situ remediation Solidification, bio-remediation, incineration, soil washing, Phyto remediation, soil heating, vetrification, bio-venting.

Books and Materials

Text Books:

1. Sharma, Hari D., and Krishna R. Reddy. *Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies*. 1st ed., John Wiley & Sons, 2004.
2. Fang, Hsai-Yang, and Ronald C. Chaney. *Introduction to Environmental Geotechnology*. 1st ed., CRC Press, 2016.

Reference Books:

1. Datta, Manoj. *Waste Disposal in Engineered Landfills*. Narosa Publishing House, 1997.
2. Daniel, David E. *Geotechnical Practice for Waste Disposal*. Chapman & Hall, 1993.
3. Westlake, K. *Landfill Waste Pollution and Control*. Albion Publishing Ltd., 1995.
4. Ott, Wayne R. *Environmental Indices: Theory and Practice*. Ann Arbor Science, 1978.



Vision

To be a pioneer institute and leader in engineering education to address societal needs through education and practice.

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- To adopt innovative student centric learning methods.
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- To train the students to meet dynamic needs of the society.
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