HONOURS

S.No	Course Code	Course Title	Scheme of Instructions Hours per Week				Scheme of Examination Maximum Marks		
			L	T	P	C	I	E	Total
1	23HRCIV1	Soil Dynamics and Machine Foundation	3	-	-	3	30	70	100
2	23HRCIV2	Industrial Waste and Waste Water Management	3	-	-	3	30	70	100
3	23HRCIV3	Repair and Rehabilitation Of Structures	3	-	-	3	30	70	100
4	23HRCIV4	Design and Drawing of Irrigation Structures	3	-	-	3	30	70	100
5	23HRCIV5	Road Safety Engineering	3	-	-	3	30	70	100
6	23HRCIV6	NDT Lab	-	-	3	1.5	30	70	100
7	23HRCIV7	ETABS/SAP Lab	-	-	3	1.5	30	70	100

Course Code	SOIL DYNAMICS AND MACHINE FOUNDATION	L	T	P	C
23HRCIV1		3	0	0	3

Course Objectives :-

The objectives of this course are to:

1. Understand the fundamentals of vibration and response of single/multiple-degree-of-freedom systems. *(L3)*
2. Analyze the wave propagation in soil deposits and evaluate dynamic soil properties. *(L4)*
3. Perform vibration analyses for machine foundations, considering different loading conditions. *(L4)*
4. Design block foundations for reciprocating and impact machines based on codal provisions. *(L5)*
5. Analyze and design machine foundations on piles, considering different modes of vibration. *(L5)*

Course Outcomes :-

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

1. Explain the fundamentals of vibration and response of SDOF/MDOF systems. (L3)
2. Analyze seismic wave propagation and evaluate dynamic soil properties. (L4)
3. Perform vibration analyses of rigid foundation blocks using different models. (L4)
4. Design machine foundations for reciprocating and impact-type machines. (L5)
5. Analyze the response of pile-supported machine foundations and develop design solutions. (L5)

CO – PO Articulation Matrix

Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO -1	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO -2	3	3	3	2	2	-	-	-	-	-	-	1	3	2
CO -3	3	3	3	2	2	-	-	-	-	-	-	1	3	3
CO -4	3	3	3	3	2	-	-	-	-	-	-	1	3	3
CO -5	2	2	2	2	2	2	-	-	-	-	-	1	2	2

UNIT – I

Fundamentals Of Vibration: Definitions, Simple Harmonic Motion, Response Of SDOF Systems Of Free And Forced Vibrations With And Without Viscous Damping, Frequency Dependent Excitation, Systems Under Transient Loads, Rayleigh's Method Of Fundamental Frequency, Logarithmic Decrement, Determination Of Viscous Damping, Transmissibility, Systems With Two And Multiple Degrees Of Freedom, Vibration Measuring Instruments

UNIT – II

Wave Propagation and Dynamic Soil Properties: Propagation of seismic waves in soil deposits - Attenuation of stress waves, Stress-strain behaviour of cyclically loaded soils, Strength of cyclically loaded soils, Dynamic soil properties - Laboratory and field testing techniques, Elastic constants of soils, Correlations for shear modulus and damping ratio in sand, gravels, clays and lightly cemented sand. Liquefaction of soils: An introduction and evaluation using simple methods.

UNIT – III

Vibration Analyses: Types, General Requirements, Permissible amplitude, Allowable soil pressure, Modes of vibration of a rigid foundation block, Methods of analysis, Lumped Mass models, elastic half space method, elasto-dynamics, effect of footing shape on vibratory response, dynamic response of embedded block foundation, Vibration isolation

UNIT – IV		
Design of Machine Foundations: Analysis and design of block foundations for reciprocating engines, Dynamic analysis and design procedure for a hammer foundation, IS code of practice design procedure for foundations of reciprocating and impact type machines. Vibration isolation and absorption techniques		
UNIT – V		
Machine Foundations on Piles: Introduction, Analysis of piles under vertical vibrations, Analysis of piles under translation and rocking, Analysis of piles under torsion, Design procedure for a pile supported machine foundation.		
Text Books :-		
1. S. Prakash, *Soil Dynamics*, McGraw Hill, 1st Edition, 1981. 2. F. E. Richart, J. R. Hall, and R. D. Woods, *Vibrations of Soils and Foundations*, Prentice Hall Inc., 1st Edition, 1970.		
Reference Books:-		
1. I. Chowdhary and S. P. Dasgupta, *Dynamics of Structures and Foundation*, 1st Edition, 2009. 2. S. D. Arya, M. O'Neil, and G. Pincus, *Design of Structures and Foundations for Vibrating Machines*, Gulf Publishing Co., 1st Edition, 1979. 3. S. Prakash and V. K. Puri, *Foundation for Machines: Analysis and Design*, John Wiley & Sons, 1st Edition, 1998. 4. N. S. V. Kameswara Rao, *Vibration Analysis and Foundation Dynamics*, Wheeler Publishing Ltd., 1st Edition, 1998. 5. Swami Saran, *Soil Dynamics and Machine Foundation*, Galgotia Publishing, 1st Edition, 1999. 6. S. L. Kramer, *Geotechnical Earthquake Engineering*, Prentice Hall, 1st Edition, 1996.		
Online Resources :-		
https://nptel.ac.in/courses/105101005		

Course Code	INDUSTRIAL WASTE AND WASTE WATER MANAGEMENT	L	T	P	C
23HRCIV2		3	0	0	3

Course Objectives :-

The objectives of this course are to:

1. To understand the various sources and characteristics of industrial wastewater and its impacts on natural water bodies and sewer systems.(L2)
2. To explain and differentiate primary and preliminary treatment methods for industrial effluents.(L2)
3. To illustrate advanced treatment techniques including nutrient and heavy metal removal. (L3)
4. To examine and summarize the characteristics and treatment needs of effluents from major industries like sugar, steel, petroleum, textiles, and tanneries.(L4)
5. To develop awareness of common effluent treatment plants (CETPs), their design considerations, and operational challenges.(L5)

Course Outcomes :-

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

1. Identify sources and characteristics of industrial wastewaters, compare them with municipal wastewaters, and explain their effects on sewers and water bodies.(L2)
2. Apply suitable preliminary and primary treatment methods such as equalization, neutralization, and oil separation. (L3)
3. Analyze various waste treatment methods like nitrification, phosphorous and heavy metal removal, and evaluate their suitability. (L4)
4. Assess the composition of industrial effluents and recommend suitable treatment strategies. (L5)
5. Design components of CETPs and address operational and maintenance problems considering economic aspects. (L6)

CO – PO Articulation Matrix

CO \ PO/PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO1	2	2	–	–	–	2	2	–	–	–	–	1	3	2
CO2	2	3	2	2	2	–	–	–	–	–	–	–	3	2
CO3	2	3	2	3	2	–	2	–	–	–	–	1	3	3
CO4	2	3	3	3	2	–	2	–	–	–	–	1	3	3
CO5	2	2	3	2	3	2	3	–	1	2	2	1	3	3

UNIT – I

Sources of Pollution - Physical, Chemical, Organic & Biological properties of Industrial Wastes - Difference between industrial & municipal waste waters - Sources and Flow Rates of Municipal Wastewater - Characteristics of Municipal Wastewater - Effects of industrial effluents on sewers and Natural water Bodies.

UNIT – II

Pre & Primary Treatment - Equalization, Proportioning, Neutralization, Oil separation by Floating-Waste Reduction-Volume Reduction-Strength Reduction. Waste Treatment Methods - Nitrification and De-nitrification-Phosphorous removal -Heavy metal removal - Membrane Separation Process - Air Stripping and Absorption Processes - Special Treatment Methods - Disposal of Treated Waste Water.

UNIT – III		
Manufacturing Process and liquid waste origin, Characteristics and Composition from Textiles, Paper and Pulp industries, Sugar Mills, Tanneries, Dairy and Oil Refineries		
UNIT – IV		
Manufacturing Process and liquid waste origin, Characteristics and Composition from Steel, Pharmaceutical Plants, Petroleum Refineries, Atomic Energy Plants and other Mineral Processing Industries		
UNIT – V		
Joint Treatment of Raw Industries waste water and Domestic Sewage – Common Effluent Treatment Plants(CETP) – Location, Design, Operation and Maintenance Problems – Economical aspects. Development of integrated treatment for waste water – zero polluting industry concept – Reuse and recycle of waste water.		
Text Books :-		
1. Rao, M.N. & Dutta, A.K. ―Waste Water Treatment‖, 3rd Edition, IBH Publishers, 2020. 2. Patwardhan-‖ Industrial Waste Water Treatment‖- PHI learning Pvt. Ltd, 2017		
Reference Books:-		
1. Metcalf, L., and Eddy, P. Wastewater Engineering; Treatment and Reuse. 5th Edition, Tata McGraw-Hill, New Delhi, 2013. 2. Arceivala, S. J. and Asolekar, S. R. Wastewater Treatment for Pollution Control. 3rd Edition, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2006. 3. Bureau of Indian Standards for analysis of water and wastewater (IS3025) 4. Anil K. De. Environmental Chemistry, New Age International Ltd., New Delhi, 2003 5. Hammer, Mark J. Water and Wastewater Technology, Prentice Hall, New Jercy, 2001		
Online Resources :-		
1. https://onlinecourses.nptel.ac.in/noc24_ce53/preview 2. https://onlinecourses.nptel.ac.in/noc21_ce25/preview		

Course Code	REPAIR & REHABILITATION OF STRUCTURES	L	T	P	C
23HRCIV3		3	0	0	3

Course Objectives :-

The objectives of this course are to enable the students to:

1. **Understand** the causes of deterioration and distress in concrete structures and the importance of rehabilitation. (L1)
2. **Familiarize** with condition/damage assessment and evaluation techniques using NDT and field/lab tests. (L2)
3. **Gain knowledge** on the selection and application of suitable materials and techniques for concrete repair. (L2)
4. **Learn** various rehabilitation and retrofitting methods including case studies and demolition techniques. (L3)
5. **Understand** the importance of protection, maintenance, and structural health monitoring (SHM) for ensuring long-term durability. (L1)

Course Outcomes :-

At the end of the course, the student will be able to:

1. **Identify** the causes and types of deterioration in structures and interpret the nature of cracks using IS 456 guidelines. (L1)
2. **Explain** the procedures for condition assessment and damage evaluation using both field and lab-based NDT techniques. (L2)
3. **Select** appropriate repair materials and techniques based on the type and severity of damage in concrete structures. (L3)
4. **Apply** suitable retrofitting and rehabilitation strategies, including engineered demolition methods, with reference to case studies. (L3)
5. **Analyze** the significance of corrosion mitigation, preventive maintenance, and SHM in enhancing the service life of structures. (L4)

CO – PO Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	–	2	2	1	–	–	–	1	3	2
CO2	3	3	2	3	2	1	–	–	–	–	–	2	3	2
CO3	3	2	3	2	2	–	2	2	–	–	1	1	3	3
CO4	2	2	3	2	2	–	1	1	1	2	2	2	2	3
CO5	2	2	2	2	2	2	3	2	–	–	1	3	2	3

UNIT – I

Introduction: Deterioration of structures with aging, Need for rehabilitation - Deterioration of concrete structures: Causes of distress Causes of distress in concrete structures, construction and design failures, Distress in concrete due to physical and chemical deterioration. Deterioration due to water leakage, fire – detection & mitigation of the same. Visual deterioration of structures- Types of cracks, causes & characteristics of cracking in various structural components. Measurement of cracks as per IS456 - interpretation of the cause of particular type of crack.

UNIT – II

Conditional/damage assessment & Evaluation of structures: Condition assessment and distress-diagnostic techniques, Field & laboratory testing procedures for evaluating the structure for strength, corrosion activity, performance & integrity, durability by use of NDT equipments

UNIT – III

Materials for Repair materials - Criteria for durable concrete repair, Methodology, selection of repair

materials, Preparatory stage of repairs, Different types of repair materials & their application, types of repair techniques . Corrosion damage of reinforced concrete - repair and prevention measures - Surface deterioration, Efflorescence, causes, prevention and protection Surface coatings and painting - Water proofing		
UNIT – IV		
Rehabilitation methods Retrofitting, RCC Jacketing, Fibre wrapping, Building and restoration of earthquake damaged masonry structure, Method for foundation rehabilitation; Case studies - Demolition techniques : Engineered demolition techniques for Dilapidated structures – case studies.		
UNIT – V		
Protection & maintenance of structures - Deterioration due to ageing, inadequate maintenance Facets of Maintenance, importance of Maintenance various aspects of Inspection. Corrosion mitigation techniques to protect the structure from corrosion. Long term health monitoring / Structural health monitoring (SHM)– Definition maintenance of structures and motivation for SHM, Basic components of SHM and its working mechanism.		
Text Books :-		
1. B. Bhattacharjee, Concrete Structures-Repair, Rehabilitation and Retrofitting, CBS Publishers and Distributors Pvt Ltd, 2017 2. R. Dodge Woodson, Concrete Structures-Protection, Repair and Rehabilitation, Elsevier, 2009.		
Reference Books:-		
1. CPWD, Handbook on Repair and Rehabilitation of RCC Buildings, Govt of India Press, New Delhi, 2014. 2. Allen, Harold Roper, and Denison Campbell, Concrete Structures: Materials, Maintenance and Repair, Longman Scientific and Technical, UK, 1st Edition, 1991. 3. R. Dodge Woodson, Concrete Structures: Protection, Repair and Rehabilitation, Elsevier, 1st Edition, 2009. 4. Kenneth and Carper, Forensic Engineering, CRC Press, 1st Edition, 2000. 5. W. H. Ranson, Building Failures – Diagnosis and Avoidance, E. & F.N. Spon, 1st Edition, 1981. 6. R. Holland, Appraisal and Repair of Reinforced Concrete, Thomas Telford Ltd., Edition and Year not specified.		
Online Resources :-		
https://onlinecourses.nptel.ac.in/noc20_ce26/preview		

Course Code	DESIGN AND DRAWING OF IRRIGATION STRUCTURES	L	T	P	C
23HRCIV4		3	0	0	3

Course Objectives :-

The objectives of this course are to:

1. **Impart fundamental knowledge** on various irrigation systems, soil moisture concepts, and canal design principles. (L1)
2. **Provide an understanding** of the design aspects of diversion head works and their components. (L2)
3. **Introduce** the functional and structural design of canal structures and cross-drainage works. (L2)
4. **Develop analytical skills** in assessing the design and safety of storage head works, including gravity and earth dams. (L3)
5. **Explain** the importance and design aspects of spillways and energy dissipation arrangements in hydraulic structures. (L2)

Course Outcomes :-

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

1. **Explain** the principles and practices of various irrigation systems, soil moisture concepts, irrigation efficiencies, and canal design methods including silt and tractive force theories. (L2)
2. **Describe** the components and layout of diversion head works and apply design principles for weirs and silt control systems. (L2)
3. **Design** canal structures such as canal regulators, Sarda-type falls, and cross-drainage works for effective water conveyance. (L3)
4. **Analyze** the structural stability and seepage characteristics of gravity dams and earth dams using appropriate design considerations. (L4)
5. **Apply** the principles of spillway hydraulics and energy dissipation mechanisms in the design of spillway systems. (L3)

CO – PO Articulation Matrix

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	–	–	2	1	–	–	–	–	1	3	2
CO2	3	2	3	2	–	1	–	–	–	–	–	1	3	2
CO3	3	2	3	2	2	–	–	–	–	–	–	1	3	3
CO4	3	3	2	3	2	–	2	–	–	–	–	2	3	3
CO5	2	2	2	2	2	–	2	–	–	–	–	2	2	3

UNIT – I

Irrigation Systems: Types of irrigation systems, Soil moisture, Irrigation water requirements, Irrigation efficiencies, Methods of application of irrigation water, Water logging – Causes and remedial measures - Canal Systems: Types of canals, Principles of design of stable irrigation canals, Silt theories, Tractive force theory, Design of lined canal, Design of longitudinal section.

UNIT – II

Design of diversion head works: Types of hydraulic structures, Layout of a diversion head work, Design of vertical drop weir, Silt control in head works

UNIT – III		
Design of Canal Structures: Canal regulators, Types of canal falls, Design of Sarda type fall, Types of cross drainage works.		
UNIT – IV		
Storage head works: Types of storage head works, Forces acting on gravity dams, Analysis of gravity dams, Profile of a gravity dam Earth dams: Types of earth dams, Causes of failure of earth dams, Seepage analysis, Seepage control, Stability analysis		
UNIT – V		
Spillways and energy dissipation systems: Types of spillways, Ogee spillway, Principles of energy dissipators		
Text Books :-		
1. Modi, P. M., 2000, Irrigation Water Resources and Hydropower Engineering, Standard Book Publishing Company, New Delhi. 2. Asawa, G. L., 1996, Irrigation Engineering, New Age International Publishing Company, New Delhi		
Reference Books:-		
1. Arora, K. L., 1996, Irrigation Water Resources Engineering, Standard Book Publishing Company, New Delhi. 2. Murthy, C. S. N., 2002, Water Resources Engineering – Principles and Practice, New Age International Publishing Company, New Delhi 3. C. Satyanarayana Murthy, *Design of Minor Irrigation and Canal Structures*, Wiley Eastern Ltd.,		
Online Resources :-		
https://www.udemy.com/course/irrigation-structures/?couponCode=LEARNNOWPLANS		

Course Code	ROAD SAFETY ENGINEERING	L	T	P	C
23HRCIV5		3	0	0	3

Course Objectives :-

The objectives of this course are to:

1. Provide foundational knowledge about the causes and trends of road accidents and the impact of human, vehicle, and roadway factors on highway safety. (L1)
2. Introduce statistical tools and procedures for interpreting and analyzing crash data including black spot and hotspot investigations. (L2)
3. Explain the principles and components of road safety management systems and the role of audits and crash investigations. (L2)
4. Impart understanding of crash reconstruction techniques using physical evidence, kinematic principles, and accident scenarios. (L3)
5. Promote awareness of safety improvement measures in highway planning, design, operation, and enforcement including policy and stakeholder roles. (L2)

Course Outcomes :-

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

1. Explain road accident trends, human and vehicle factors affecting highway safety, and the Indian scenario of road safety. (L2)
2. Apply statistical methods for crash data analysis and conduct black spot and hotspot identification with case-based insights. (L3)
3. Describe the structure of a road safety management system, road safety audit process, and the data needs for improving intersection and vehicle safety. (L2)
4. Analyze crash reconstruction cases using physical evidence and calculate speed, drag, and impact forces for different accident types. (L4)
5. Evaluate and recommend mitigation measures such as forgiving road design, road signs, public transport safety strategies, and road safety law enforcement. (L5)

CO – PO Articulation Matrix

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	–	–	–	3	2	2	–	–	–	1	2	2
CO2	3	3	2	3	2	–	–	–	–	–	–	2	3	3
CO3	3	2	2	2	2	2	2	2	–	–	–	2	2	3
CO4	3	3	3	3	2	–	–	–	–	–	–	2	3	3
CO5	2	2	3	2	2	3	3	3	2	2	2	3	2	3

UNIT – I

Basics of Road Safety: Road accidents, Trends, Global and Indian level, Crash Causation, Collision diagrams; Highway safety; Human factors and road user limitations; Speed and its effect on road safety; Vehicle factors; Highway safety in India.

UNIT – II

Statistical Interpretation and Analysis of Crash Data: Before-after methods in crash analysis, Recording of crash data; Accident Investigation and Analysis; Statistical testing and the role of chance; Black Spot Identification and Investigations, Hot spot analysis, Case Studies

UNIT – III

Road Safety Management System: Multi-causal dynamic systems approach to safety; Crash Vs.

Accident; Road safety improvement strategies; Elements of a road safety plan, Speed management, Safety data Needs; Intersection Safety, Safe vehicle design. Road Safety Audits: Key elements of a road safety audit, Road Safety Audits & Investigations, Work zone safety audit; Crash investigation and analysis, Methods for identifying hazardous road locations, Case Studies		
UNIT – IV		
Crash Reconstruction: Describe the basic information that can be obtained from the roadway surface, Basic physics related to crash reconstruction, speed for a various skid, friction, drag, and acceleration scenarios, variables involved in jump and flip crashes, variables involved in pedestrian crashes, Case Studies.		
UNIT – V		
Mitigation Measures: Accident prevention by better planning, Accident prevention by better design of roads, Crash Countermeasures, Highway operation, and accident control measures, Highway Safety Measures during construction, Highway geometry, and safety; Design of Forgiving roads and self-explaining roads, Effective Road Signs and Street Lighting, Safety in urban areas; Public transport and safety; Road safety policy-making, Stakeholders involvement; Road safety law.		
Text Books :-		
1. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997 (Reprinted 2002). 2. M. Ohidul Haque, Road Safety: Data Collection, Analysis, Monitoring, And Countermeasure Evaluations with Cases, University Press of America, 2008.		
Reference Books:-		
1. IRC: SP: 88-2019 Manual on Road Safety Audit 2. Geetam Tiwari and Dinesh Mohan, Transport Planning and Traffic Safety: Making Cities, Roads, and Vehicles Safer, CRC Press, 1st Edition, 2016. 3. Rune Elvik, Alena Hoye, and Truls Vaa, The Handbook of Road Safety Measures, Emerald Group Publishing, 2nd Edition, Sept 2009. 4. R. P. Roess, E. S. Prassa, and W. R. Mcshane, Traffic Engineering, Prentice Hall, 2011.		
Online Resources :-		
https://ebrdelearning.com/road-safety-engineering-e-learning-course		

Course Code	NDT LAB	L	T	P	C
23HRCIV6		0	0	4	2

Course Objectives :-

The objectives of this course are to enable the student to:

1. Understand the fundamental principles and significance of non-destructive testing (NDT) in concrete structures. **(L2)**
2. Apply various NDT techniques to evaluate the structural integrity and quality of concrete. **(L3)**
3. Analyze data from NDT methods to detect cracks, voids, rebar position, corrosion, and other defects. **(L4)**
4. Evaluate the durability and in-situ strength characteristics of concrete using advanced testing techniques. **(L5)**
5. Develop competence in interpreting NDT results for effective decision-making in structural health monitoring. **(L5)**

Course Outcomes :-

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

1. Apply Rebound Hammer and Ultrasonic Pulse Velocity tests to assess surface hardness and detect internal concrete defects. **(L3)**
2. Analyze corrosion risk and carbonation depth using Half-Cell Potential and Carbonation Depth tests. **(L4)**
3. Evaluate compressive strength and integrity of concrete using Penetration Resistance and Impact Echo methods. **(L5)**
4. Detect reinforcement layout, cover, and subsurface anomalies using Rebar Locator and Ground Penetrating Radar. **(L4)**
5. Interpret results from advanced methods like Acoustic Emission and core testing for structural damage diagnosis. **(L5)**

CO – PO Articulation Matrix

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	2	2	1	2	3	–	–	–	1	1	–	2	3	2
CO2	2	3	1	2	3	3	2	2	–	1	–	1	2	3
CO3	3	3	2	2	3	–	–	–	–	1	–	1	3	2
CO4	3	2	2	3	3	–	2	–	–	1	–	2	3	2
CO5	3	3	2	3	3	2	1	1	1	2	1	3	3	3

1. To assess the surface hardness and compressive strength of concrete by using Rebound Hammer Test
2. To determine the quality, uniformity, and presence of cracks or voids in concrete by Ultrasonic Pulse Velocity Test
3. To evaluate the compressive strength of hardened concrete using probe penetration by Penetration Resistance Test
4. To measure the depth of carbonation in concrete this leads to corrosion of reinforcement by Carbonation Depth Test
5. To assess the **corrosion potential** of reinforcing steel in concrete by Half-Cell Potential Test
6. To detect **reinforcement position**, **diameter**, and **concrete cover** over rebars by Rebar Locator
7. To detect **subsurface features**, **rebar locations**, and **voids** in concrete structures by Ground Penetrating Radar
8. To monitor **crack propagation** and **damage activity** in structural components by Acoustic Emission Technique
9. To extract cores for testing and conduct **visual and microscopic analysis** of concrete quality.

10. To evaluate **thickness**, **delaminations**, and **voids** in concrete slabs or pavements by Impact Echo Test
11. To measure **strain**, **temperature**, or **crack growth** in structural components using embedded optical fibers.
12. To identify **surface-**breaking defects **in non-porous materials BY Dye Penetrant Testing**

Course Code	ETABS/SAP LAB	L	T	P	C
23HRCIV7		0	0	4	2

Course Objectives :-

1. To understand the interface, tools, and modeling environment of ETABS and SAP2000 for structural design.(L2)
2. To develop and analyze multi-storey buildings, shear walls, and frames under various loads using ETABS and SAP2000.(L3)
3. To perform structural modeling, assign loads, and interpret analysis results for real-world building and infrastructure systems.(L4)
4. To evaluate performance-based seismic behavior and nonlinear analysis techniques using advanced structural software.(L5)
5. To design and optimize structural components like water tanks and bridges using advanced modeling tools.(L6)

Course Outcomes :-

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

1. Understand and operate the ETABS and SAP2000 interface for modeling structural systems.(L2)
2. Apply ETABS for analysis of multi-story buildings and shear wall systems under lateral and gravity loads.(L3)
3. Analyze and interpret the behavior of structural models including performance-based and nonlinear seismic analysis.(L4)
4. Evaluate the design of structural elements such as frames, water tanks, and bridges using SAP2000.(L5)
5. Create detailed structural models and conduct advanced simulations to support safe and economical design decisions.(L6)

CO – PO Articulation Matrix

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	–	–	2	–	–	–	–	–	–	2	3	2
CO2	3	3	2	2	3	–	–	–	–	–	–	2	3	3
CO3	3	3	3	2	3	–	–	–	–	–	–	2	3	3
CO4	3	3	3	3	3	–	–	–	–	–	–	3	3	3
CO5	3	2	3	3	3	–	–	–	–	–	–	3	3	3

1. Determination of ETABS Interface and Structural Modeling Techniques
2. Analysis of a Multi-Story Building under Lateral Loads in ETABS
3. Development of Structural Analysis for a Shear Wall System in ETABS
4. Application of Performance-Based Seismic Analysis in ETABS
5. Determination of Structural Analysis of a Simple Frame using SAP2000
6. Development of a Bridge Model and Load Analysis in SAP2000
7. Analysis and Design of an Elevated Water Tank using SAP2000
8. Application of Nonlinear Analysis for a Structural System using SAP2000