SGBAU NEP 2020 DRAFT SYLLABUS
CIVIL ENGINEERING VI TH SEM 2025-26

Course Description:

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	6CE231PC	Structural Analysis	3	45	3 Hrs	60 Max Marks

Subject Code: 6CE231PC Structural Analysis is a compulsory Program core course for Third Year B.E. Civil Engineering.

Course Objective :

The objective of the course is to make student understand the action and corresponding displacement in various type of structural elements , statically determinate and indeterminate structures, analyze frames subjected to sway , To learn different analysis methods for analysis of beam and frames .

Course Outcomes (COs)

After completing the course students will be able to:

CO	Course Outcome
CO1	To decide what is required to be analyzed depending upon type of structural element.
CO2	To know about degree of freedom, Condition of equilibrium and determinacy of element.
CO3	To understand reason for failure and permissible limits for safety
CO4	To apply the knowledge of beam analysis for practical analysis and design purpose.
CO5	To make application of various analysis methods for actual structural member analysis and design.
CO6	To judge suitability of analysis method as per structure under consideration

Details of Syllabus :

UNIT I	1. Moment distribution method, application to portal frames with sway. Multi-bay, multi-storied, symmetrical frames subjected to symmetric loads only. 2. Slope deflection method: Application to portal frames with side sway.	8 Hrs
UNIT II	Kani's method: Continuous beams and single bay single storey portal frames with side sway. Multi- bay, multi storeyed frames subjected to symmetric loads.	8 Hrs
UNIT III	Castigliano's second theorem, principle of least work, Analysis of redundant frames. (up to two degree redundancy). Analysis of redundant trusses (up to second degree of redundancy).	8 Hrs
UNIT IV	Muller - Breslau's principle, Influence line diagrams for continuous beams, upto two span with simple end supports. Tension coefficient method & its applications to simple space trusses.	8 Hrs
UNIT V	Flexibility method, static redundancy, flexibility coefficients, compatibility condition application to beams.	8 Hrs
UNIT VI	Stiffness method, kinematic redundancy, stiffness coefficients, direct stiffness approach, application to continuous beams and single - bay, single - storey portal frame.	8 Hrs

BOOKS RECOMMENDED:

1. Meghre A.S. and Deshmukh S.K., Matrix Methods of Structural Analysis, Charotar Publishing, Anand, India 2003.
2. Junnarkar, S. B., Mechanics of Structure, Volume I and II, Charotar Publishing house Pvt. Ltd., 2017
3. Jain and Arya, Theory and Analysis of Structures, Nem Chand & Bros.
4. Reddy. C. S., Basic Structural Analysis, Tata McGraw Hill
5. Norris and Wilbur, Elementary Structural Analysis
6. Bhavikatti, S. S, Structural Analysis Vol I and II, Vikas Publishing
7. Ramamrutham., S and Narayan R., Theory of Structures 9th Edition, Dhanpat Rai Books

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	6CE231PC	Structural Analysis	3	45	3 Hrs.	60

Course Description:
Subject Code: 6CE231PC Structural Analysis is a compulsory Program core course for Second Year B.E. Civil Engineering.

Course Objectives:

Course Objective: Students are able to

1) Make the students familiar with the various Force and Displacement Methods of analysis of indeterminate structures.
2) Impart the students the ability to determine forces in trusses.
3) Impart the students the knowledge of Influence line diagram; Introduce to the students the matrix methods in structural analysis

Course Outcomes (COs)
After completing the course students will be able to:

CO	Course Outcome
CO1	Apply various theoretical concept of different methods of structural analysis
CO2	Analyse indeterminate using displacement method- slope and deflection method
CO3	Analyse indeterminate using displacement method- Moment distribution method
CO4	Analyze different types of structures like beam, parabolic arches, and trusses.
CO5	Analyze indeterminate beams and portal frames by using matrix method- Stiffness matrix method
CO6	Analyze indeterminate beams and portal frames by using matrix method- Flexibility matrix method

Details of Syllabus:

Unit I	**Introduction** **a)** Concept of degree of static and kinematic indeterminacy , Degree of freedom **b)** Introduction to fixed beam and Analysis of continuous beams by three moment theorem.	8 Hrs.
Unit II	**Slope Deflection Method** Analysis of continuous beams and simple portal frames without sway	7 Hrs.
Unit III	**Moment Distribution Method** Analysis of continuous beams and simple portal frames without sway, effect of sinking of support	8 Hrs.
Unit IV	**Influence Line Diagrams and Arches** a) Influence lines for reactions, bending moments and shear forces in simply supported beams, b) Analysis of Three hinged parabolic arches, shear force and Normal thrust	7 Hrs.
Unit V	**Stiffness method** Stiffness coefficient, development of stiffness matrix, Analysis of continuous beams and portal frame (Involving not more than two unknowns)	8 Hrs.
Unit VI	**Flexibility Method** Flexibility coefficient, development of Flexibility matrix, Analysis of continuous beams and portal frame (Involving not more than two unknowns	7 Hrs.

Text Book/s:

Sr. No.	Title / Edition	Author	Publisher
1	Structural Analysis	Pandit G.S and Gupta S.P	Tata McGraw-Hill Publishing company LTD, New Delhi

2	Theory of Structure	Timoshenko S.P. and D.H. Young	Tata McGraw Hill Publication, Delhi

Reference Book/s:

Sr. No.	Title / Edition	Author	Publisher
1	Matrix Methods of Structural Analysis	Meghre A.S. and Deshmukh S.K	Charotor publication
2	Mechanics of Structure, Volume I and II	Junnarkar, S. B.	Charotar Publishing House
3	Theory and Analysis of Structures	Jain and Arya	Nem Chand & Bros
4	Basic Structural Analysis	Reddy. C. S	Tata McGraw Hill Publication
5	Structural Analysis Vol I and II	Bhavikatti, S. S	Vikas Publishing
6	Theory of Structures	Ramamrutham., S and Narayan R	9th Edition, Dhanpat Rai Books

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Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	6CE232PC	Fluid Mechanics	3	45	3 Hrs.	60

Course Description:
Subject Code: 6CE232PC Fluid Mechanics is a core program Course for Third Year B.E. Civil Engineering.

Course Objectives:
1. To study the basic behavior of fluids and fluid system and the laws governing this behavior.
2. To understand and apply the basic concepts Mechanics to carry out professional engineering activities in the field of fluids.
3. To apply scientific strategies to analyze qualitatively and quantitatively the problems and give solutions.

Course Outcomes (COs)
After completing the course students will be able to:

CO	Course Outcome
CO1	Describe basic properties of fluid flow.
CO2	Apply the knowledge to fluid flow problems.
CO3	Analyze the type of flow by using basic of mathematical principle.
CO4	Solve and modeling the pipe flow problems.
CO5	Able to design various types channel

Details of Syllabus:

Unit 1	Properties of fluids: Introduction, properties of fluids, viscosity, surface tension, & capillarity, related problems. Pressure and its measurement: Fluid pressure at a point, Pascal's Law, pressure variation in a fluid at rest, absolute gauge, atmospheric & vacuum pressures, measurement of pressure, simple manometers, differential manometers, related problems.	8 Hrs.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	6CE233PC	Design of Steel Structure	3	45	3 Hrs	60 Max Marks

Unit 2	Hydrostatic forces on surfaces: Introduction, total pressure & centre of pressure, vertical, horizontal plane surface submerged in liquid, related problems. Buoyancy & floatation: Introduction, buoyancy, center of buoyancy, metacentre, metacentric height, analytical method of metacentric height, conditions of equilibrium of a floating & submerged body, related problems.	7 Hrs.
Unit 3	Kinematics of flow: Introduction, methods of describing fluid motion, types of fluid flows, continuity equation in three dimensions, velocity & acceleration, velocity potential function & stream function, related problems. Dynamics of fluid flow: Introduction equation of motion, Euler's equation of motion, Bernoulli's equation from Euler's equation, its assumptions, related problems.	8 Hrs.
Unit 4	Measurement of fluid flow, Horizontal venturimeter, V and Rectangular Notches, Darcy's equation (no proof), major and minor losses in pipes, pipes in series and parallel, pipe network. Momentum equation and its application to horizontal pipe bends.	7 Hrs.
Unit 5	Dimensional Analysis; Buckingham's Pie theorem, it's application, similitude, Dimensionless numbers, Re, Fr, We, Predominant forces & their ratio, Model Analysis - Geometrically similar models, Reynolds law, Froudes law, Model study of spillways.	8 Hrs.
Unit 6	Uniform flow, Open channel flow, Types of flow, geometric elements of rectangular & trapezoidal sections, Chezy's &Mannings equations, most efficient rectangular & trapezoidal section, Energy & momentum principles, Normal & critical depth, specific energy diagram, discharge diagram.	7 Hrs.

Recommended Books:

1. Modi P.N. & Seth S.M.: Hydraulics & Fluid Mechanics, SI Edition, Standard book house.
2. Dr. Jain A.K.: Fluid Mechanics, Khanna publication.
3. Subramanya K.: Fluid Mechanics, Tata Mc-Graw Hill.
4. Streeter: Fluid Mechanics, Mc-Graw Hill.
5. Fluid mechanics by R.K.Bansal, Laxmi publication.
6. Garde & Mirajgaonkar: Fluid Mechanics, Scitech publication.

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Course Description:

Subject Code: 6CE233PC Design of Steel Structure is a compulsory Program core course for Third Year B.E. Civil Engineering.

Course Objective :

The objective of the course is to

Course Outcomes (COs)

After completing the course students will be able to:

CO	Course Outcome
CO1	To explain the methods of design of steel structure and design bolted and welded connection.
CO2	To design the Tension and compression member.
CO3	To analyse Industrial Shed
CO4	To design column and column bases
CO5	To design simple and compound beams

CO6	To analyse earthquake effect over steel structure and apply seismic resistive philosophy

Details of Syllabus :

UNIT I	Introduction to WSM, LSM . Introduction to Plastic analysis of steel structure, plastic hinge, plasticmoment capacity, shape factor, plastic section modulus. Design of bolted & welded connections subjected to axial and eccentric loading (In the plane of group of Bolts & Weld).	**8 Hrs**
UNIT II	Design of Compression & Tension member.	**7 Hrs**
UNIT III	Analysis of Industrial shed subjected to dead, live load and wind load	**8 Hrs**
UNIT IV	Design of simple & compound columns for axial loading. Design of column bases (Slab base & Gusseted base) subjected to axial load.	**7 Hrs**
UNIT V	Design of simple and compound Beams (laterally supported).	**8 Hrs**
UNIT VI	Introduction to earthquake resistant design of steel structures: Design philosophy & methodology, seismic analysis methods, seismic behaviour of steel structures , Seismic resistive philosophy (Numerical examples are not expected)	**7 Hrs**

Books Recommended:

1. Duggal, S. K., Design of Steel Structures, Tata McGraw Hill Pub. Company Ltd.
2. N. Subrramanyam, Design of Steel Structures, Oxford University Press, 2008.
3. V L Shah & Veena Gore: Limit State Design of steel structures IS 800-2007 4. M. R. Shiyekar, Limit state design in Structural Steel (Second Edition); PHI Learning Pvt. Ltd.
5. Bhavikatti, Design of Steel Structures: By Limit State Method as Per IS: 800 – 2007; I K International Publishing House Pvt. Ltd
6. M. L. Gambhir, Fundamentals of Structural Steel Design ; McGraw Hill Education

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	6CE234PE1	Advanced Construction Materials	3	45	3 Hrs.	60

Course Description:

Subject Code: 6CE234PE Advanced Construction Materials is a compulsory Program Elective Course-II for Third Year B.E. Civil Engineering.

Course Objectives:

The objective of course is to comprehend the various building materials and supplementary cementitious materials, metals and glass and glazing system. The course also seeks to the different different type of floor and wall finishes, composite materials and thermal, sound insulating materials, different types of construction chemicals and formwork material, smart & HVAC materials.

Course Outcomes (COs)

After completing the course students will be able to:

CO	Course Outcome
CO1	Identify various building materials and their uses.
CO2	Explain the properties & usage of steel and glazing system.
CO3	Classify and select the floor and wall finishes.
CO4	Demonstrate the properties of polymeric materials
CO5	Classify and select the construction chemicals and formwork materials.
CO6	Select the smart and HVAC materials.

Details of Syllabus:

Unit 1	**Construction Materials:**	8 Hrs.

	Introduction to construction materials, selection criteria of construction materials, Special Purpose Cement, Ground Granulated Blast Furnace Slag, micro silica -properties and their uses. Replacement of aggregates; stone dust, light weight aggregates, recycled aggregate.	
Unit 2	**Metal Alloys & Glazing System:** Steel and metal alloys: Carbon steel, alloy steel, cold form steel, corrosion risk, protection methods, maintenance for steel structure, tendons, Glass and glazing system, types of glasses, installation methods, maintenance techniques.	7 Hrs.
Unit 3	**Architectural Finishes:** Floor and Wall finishes: Factors affecting the selection of floor finishes, types of flooring and their uses. Requirements and uses of the following types of wall finishes. Materials: Wall papers, Cement mortar plaster, Tiles ,Gypsum plaster, Stucco plaster ,Special External Finishes for plaster surface • Rough cast • Smooth cast • Barium plaster.	8 Hrs.
Unit 4	**Polymer, Acoustic and Thermal Management:** Polymer and its composites, classification, types of fibers, polymer composite in construction. Acoustics and sound proofing methods and materials, Thermal performance of materials and insulating materials, GeoSynthetics, Geo-Membranes.	7 Hrs.
Unit 5	**Building Chemistry and Formwork:** Construction Chemicals , materials for repair and retrofitting, water proofing material and process of construction, Formwork, its classification, materials used for formwork, design aspects for formwork, mivan formwork and shuttering system, causes of Failure of Formwork.	8 Hrs.
Unit 6	**Smart Material and HVAC system:** Elementary Concept of Smart Material: Smart and Intelligent Materials-Piezoelectric Materials, shape memory alloys, Self-Healing Materials. Heating, Ventilation, and Air Conditioning (HVAC) Materials and Systems in building construction.	7 Hrs.

Recommended Books:

1. P.C. Varghese., Building Materials, Prentice Hall of India, New Delhi.
2. G. Amarendra, Baldev Raj, M.H. Manghnan., Advances in Materials Characterization, CRC Press · Publication
3. Michael S. Mamlouk, John P. Zaniewski, Materials for Civil and Construction engineers, Pearson Publication
4. P.K. Mehta and P.J.M. Monteiro., Concrete: Microstructure properties and materials, McGraw Hill
5. W.D. Callister, Materials Science and Engineering: An introduction, John Wiley
6. V. Raghavan., Materials Science and Engineering, Prentice Hall

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	6CE234PE2	Solid Waste Management	3	45	3 Hrs.	60

Course Description:

Subject Code: 6CE234PE2 Solid Waste Management is a Professional Elective-II subject for Third Year Civil B.E. Engineering.

Course Objectives:

The objective of the course is to give comprehensive knowledge of solid waste sources, characteristics, collection, environmental impacts, treatment, disposal methods, and relevant legal frameworks for effective solid waste management.

Course Outcomes (COs)

After completing the course students will be able to:

CO	Course Outcome
CO1	Identify and classify various types and sources of solid wastes based on origin and characteristics.

CO2	Explain different methods of solid waste collection, segregation, storage, and transportation used in municipal and industrial systems.
CO3	Apply suitable methods for size reduction, handling, and separation of solid wastes in practical scenarios.
CO4	Analyze environmental, social, and aesthetic impacts arising from improper solid waste management.
CO5	Evaluate various biological and mechanical treatment methods, including composting, vermicomposting, and incineration techniques, for different waste types.
CO6	Interpret solid waste management rules and examine the role of regulatory authorities such as CPCB and MPCB in sustainable waste management.

Details of Syllabus:

Unit 1	**Sources and Classification of Solid Wastes:** Solid Waste definition and concept, Classification of Solid Wastes – Source based classification – Residential, Commercial, Institutional, Industrial, Agricultural, Hospital etc., Type based classification – Garbage, ashes and residues, Combustible and non-combustible wastes, Biodegradable and non-biodegradable wastes.	8 Hrs.
Unit 2	**Collection and Transportation of Solid Waste:** Collection Methods - Communal system, block Collection, kerbside/alley, door to door collection, Handling and segregation of solid waste at source, Methods of separation-Mechanical, magnetic and screening, Mode of Transportation of solid waste, Solid waste size reduction methods (compacting, shredding, pulping, granulating, etc.), Storage of solid waste (MSW/ Biomedical/Industrial).	7 Hrs.
Unit 3	**Effects of Solid Waste:** Factors influence the quantity of solid wastes generated: Geographic location, Season of the year, Collection frequency, Characteristics of population, Extent of salvaging and recycling, Public attitudes, Legislation, Environmental Impact of solid waste – Air pollution, contamination of surface water, Contamination of ground water, Land degradation, global warming, Ocean dumping of solid waste. Social and aesthetic impacts of solid waste.	8 Hrs.
Unit 4	**Treatment and disposal-I:** Solid waste management hierarchy and Solid waste prevention and reduction techniques, Concept, principal and Factors affecting composting of waste, Method of composting – Manual composting, Mechanical composting, Vermicomposting and Open dumping.	7 Hrs.
Unit 5	**Treatment and disposal-II:** Land fill method – Land fill, Sanitary- landfill, Trench method and Ramp method. Advantages and disadvantages of landfill method, Incineration and pyrolysis – Flash, Multiple chamber incinerators and pyrolysis- Advantages and disadvantages.	8 Hrs.
Unit 6	**Legal aspects of solid waste**: Solid waste management rule 2016, Role of Central Pollution Control Board and Maharashtra Pollution Control Board in Management of solid waste from various sources.	7 Hrs.

Textbooks:

1. George Techobanoglous, "Integrated Solid Waste Management", McGraw-Hill Publication, 1993
2. Bhide A.D., Solid Waste Management in developing countries.

Reference Books:

1. CPHEEO manual on MSW, GoI, New Delhi

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	6CE234PE3	Airport Planning & Design	3	45	3 Hrs.	60

Course Description:
Subject Code: 6CE234PE3 Airport Planning & Design is a Program Elective Course II for Third Year B.E. Civil Engineering.

Course Objectives:
The objective of course is to understand the fundamental principles of airport planning, design and study the geometric and structural design of runways, taxiways. The course also seeks to explore the materials and construction practices specific to airfields.

Course Outcomes (COs)
After completing the course students will be able to:

CO	Course Outcome
CO1	Explain airfield planning and layout principles.
CO2	Design airfield pavements and geometric elements per ICAO/FAA standards
CO3	Assess construction materials and lighting systems used in airfields.
CO4	Analyze maintenance and pavement evaluation techniques..

Details of Syllabus:

Unit 1	Introduction to Airfield Engineering: Role and importance of air transportation and components of an airfield like runway, taxiway, apron etc.	8 Hrs.
Unit 2	Airfield Planning and Layout: Concepts for site selection, zoning, and planning regulations and master planning, ICAO standards, environmental impact etc.	7 Hrs.
Unit 3	Airfield Design Aspects: Concepts of runway design (4 Lectures), taxiway and apron design, airfield pavement design. Runway orientation, length, and width requirements; Geometric design as per ICAO and FAA guidelines; layout and design criteria for taxiways; apron types and aircraft parking configurations; flexible and rigid pavements; load classification number (LCN) and pavement classification number (PCN); pavement design methods (FAA, CBR, layered theory); types of pavement distress; and maintenance techniques like overlays, patching, crack sealing etc.	8 Hrs.
Unit 4	Airfield Materials and Construction Practices: Materials used in airfield construction and quality control, construction techniques, challenges etc.	7 Hrs.
Unit 5	Airfield Lighting and Signage: Types of lighting systems in approach, runway, taxiway; and markings and visual aids to be provided at the airfields.	8 Hrs.
Unit 6	Drainage Systems in Airfields: Surface and subsurface drainage design and stormwater management ; Air Traffic Management: Navigational aids: ground based systems, satellite based systems – Air traffic control and surveillance facilities – Airfield lighting - air traffic management.	7 Hrs.

Text Books:
1. Khanna, S.K., Arora, M.G., and Jain, S.S. Airport Planning and Design, Nem Chand & Bros
2. Horonjeff, R., McKelvey, F.X. Planning and Design of Airports, McGraw-Hill.

Reference Book:
1. ICAO Annex 14 – Aerodrome
2. FAA Advisory Circulars on Airport Design

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	6CE235PE1	Advance Concrete Technology	3	45	3 Hrs.	60

Course Description:

Subject Code: 6CE234PE Advance Concrete Technology a compulsory Program Elective Course-II for Third Year B.E. Civil Engineering.

Course Objectives:

1) To introduce various admixtures and construction chemicals used to improve concrete performance.
2) To impart knowledge on factors influencing concrete durability.
3) To study the causes and effects of deformation and cracking in concrete under various environmental conditions.
4) To introduce special types of concrete and advanced concreting techniques.

Course Outcomes (COs)

After completing the course students will be able to:

CO	Course Outcome
CO1	Apply appropriate admixtures to enhance concrete properties and solve site-specific challenges.
CO2	Evaluate and apply durability principles and IS code guidelines to improve concrete lifespan.
CO3	Analyze deformation issues in concrete and suggest appropriate control and prevention measures.
CO4	Select and apply suitable special concretes and techniques based on specific project requirements.
CO5	Assess damage and implement appropriate repair and rehabilitation techniques for concrete structures.
CO6	Perform and interpret non-destructive tests to assess concrete quality and structural integrity.

Details of Syllabus:

Unit 1	Admixtures and construction chemicals: Introduction, admixtures, plasticizers (Water reducers), action of plasticizers, dispersion, retarding effect, superplasticizers (High range water reducers),site problems in the use of plasticizers, retarders, accelerators, air-entraining admixtures, pozzolanic or mineral admixtures, flyash, silica fume, rice husk ash, metakaolin, ground granulated blast furnace slag (GGBFS), damp and water proofing admixtures.	8 Hrs.
Unit 2	Durability of concrete: Introduction, strength and durability relationship, volume change in concrete, significance of durability, impact of water cement ratio on durability, factors affecting durability, methods of predicting durability, IS code provisions for durability of concrete.	7 Hrs.
Unit 3	Deformation in concrete: Introduction, deformation of concrete in Indian climate, permeability, factors contributing cracks in concrete, sulphate attack, alkali aggregate reaction, corrosion of embedded steel, controlling measures.	8 Hrs.
Unit 4	Special concrete and concreting techniques: Introduction to special concrete, Lightweight, aerated, no-fines, high density, fibre reinforced, polymer, prepacked concrete. Introduction to special concreting techniques; roller compacted concrete and ready mix concrete casting and applications.	7 Hrs.
Unit 5	Repairs and rehabilitations: Introduction, need for repairs, crack width, interaction between permeability, volume change and cracking, polymer modified mortar, bond aid for plasters, guniting aid, silicon based water repellent materials, protective and decorative coatings, injection grout for cracks, coatings to embedded reinforcement, concrete repair systems, stages of repair works.	8 Hrs.
Unit 6	Non-destructive testing of concrete: Introduction, rebound hammer, limitations, rebound number and strength of concrete, penetration technique, pullout test, resonant frequency, pulse velocity method, corrosion analyzer, rebar locators.	7 Hrs.

Recommended Books:

1. Shetty, M. S, Concrete Technology, S. Chand Publication
2. Gambhir, M. L, Concrete Technology, Dhanpat Rai and Sons Publication
3. Neville A. M, Properties of Concrete, Pitman Publishing Company
4. Neville, Brooks. Concrete Technology, ELBS
5. Lea F.M., The Chemistry of Cement and Concrete, Edward Arnold (Publishers) ltd.
6. Varshney, R. S. Concrete Technology, Oxford Pub. House

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	6CE235PE2	Ground Improvement Techniques	3	45	3 Hrs.	60

Course Description:
Subject Code: 6CE235PE Ground Improvement Techniques is a compulsory Program Elective Course-III for Third Year B.E. Civil Engineering.

Course Objectives:
The objective of course is to analyze various index/strength properties of soil and suggest suitable ground improvement method. The course also seeks to understand the use of Geosynthetics and reinforced soil as a ground improvement technique, general construction procedures and inspection items for ground improvement techniques.

Course Outcomes (COs)
After completing the course students will be able to:

CO	Course Outcome
CO1	Identify the mineral composition responsible for the weak soil deposits and problems associated with it.
CO2	Understand general construction procedures and inspection items for ground improvement techniques.
CO3	Analyze various index/strength properties of soil and suggest suitable ground improvement method.
CO4	Understand the use of Geosynthetics and reinforced soil as a ground improvement technique.
CO5	Understand the use of Grouting technology for ground improvement.
CO6	Understand the soil stabilization and other miscellaneous methods for ground improvement.

Details of Syllabus:

Unit 1	**INTRODUCTION** Ground Improvement: Definition, Objectives of soil improvement, Classification of ground improvement techniques, Factors to be considered in the selection of the best soil improvement technique. Weak Deposits: Identification, Problems associated with weak deposits. Mechanical Modification, Principle of modification for various types of soils. aggregate.	8 Hrs.
Unit 2	**DEEP GROUND IMPROVEMENT** Insitu compaction of cohesion less soil, Dynamic compaction & blasting, Vibroflotation, stone column, Encased stone column, stone column design as per codal provisions, strengthening of sub soil by stone column installation. Lime piles.	7 Hrs.
Unit 3	**HYDRAULIC MODIFICATION** Definition, aim, principle, techniques. Gravity drain, lowering of water table, multistage well point, vacuum dewatering. Discharge equations. Design of dewatering system including pipe line effects of dewatering, Preloading, vertical drains, sand drains. Assessment of ground condition for preloading, Electro kinetic dewatering.	8 Hrs.
Unit 4	**GEOSYNTHETICS AND REINFORCED SOIL** Types of geosynthetics like geotextiles, geogrids, geonets, geocells, geo-composites, their functions, applications and manufacturing methods. Index properties and Strength properties of Geosynthetics. Historical background of reinforced soil, Principles of reinforced soil. Concept of MSE (Mechanically Stabilized Earth) wall and Reinforced Soil slopes.	7 Hrs.
Unit 5	**GROUTING** Types of Grouts, Desirable characteristics of Grout, Grouting methods- Permeation grouting, displacement-compaction grouting, displacement-soil fracture grouting, Jet or Replacement-displacement grouting. Grouting pressure, Grouting technology.	8 Hrs.
Unit 6	**SOIL STABILIZATION & MISCELLANEOUS METHODS** Soil stabilization with admixtures like lime, flyash, cement etc, Properties of chemical components, reactions and effects. Bitumen, tar or asphalt in stabilization. Micro piles, Soil nailing, Ground Anchors, ground freezing and heating methods.	7 Hrs.

Recommended Books:

1. Purushothama Raj. P, “Ground Improvement Techniques”, Firewall Media, 2005.
2. Koerner, R.M. “Construction and Geotechnical Methods in Foundation Engineering”
3. Ground Imrovement by M.P.Mosely, CRC Press, Inc
4. N. V. Nayak, Foundation Design Manual, Dhanpat Rai and Sons, Delhi.
5. G. V. Rao and G. V. S. Rao, Text Book on Engineering with Geotextiles, Tata McGraw Hill
6. Hausmann M.R. “Engineering Principles of Ground Modification” McGraw Hill
7. Publishing Company, New York, 2013
8. Koerner, R.M. "Designing with Geosynthetics", Prentice Hall, New Jersey, USA, 6th
9. edition, 2012.
10. 8. Jie H., " Principles and Practice of Ground Improvement, Wiley India, 2018 4. Patra N. H., “Ground Improvement Techniques”, Vikas publishing house Pvt. Ltd., 2013.
11. 9. Chu, Jian; Indraratna, B; Rujikiatkamjorn, C, " Ground improvement case histories:
12. compaction, grouting, and geosynthetics", Butterworth Heinemann - Elsevier, 2015
13. 10. Design guidelines from IS code, FHWA, BS and other codal organizations

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	6CE235PE3	Solid and Hazardous Waste Management	3	45	3 Hrs.	60

Course Description:

Subject Code: 6CE235PE3 Solid and Hazardous Waste Management is a Professional Elective-III subject for Third Year Civil B.E. Engineering.

Course Objectives:

The objective of the course is to give comprehensive knowledge of solid waste and hazardous waste sources, characteristics, collection, treatment, disposal methods, and Implement effective e-waste management systems

Course Outcomes (COs)

After completing the course students will be able to:

CO	Course Outcome
CO1	Analyze municipal solid waste characteristics, including sources, composition, and properties, to design effective management and transformation strategies.
CO2	Estimate solid waste generation rates, quantities, and collection methods, considering influencing factors and recovery potential.
CO3	Design effective handling, separation, and storage systems for solid waste at source and facility levels using various technologies.
CO4	Evaluate and design municipal solid waste disposal systems, including combustion, landfilling, and biochemical processes, considering environmental impacts.
CO5	Analyze hazardous solid waste characteristics, classification, and management strategies for safe handling, storage, transportation, and disposal.
CO6	Implement effective e-waste management systems, considering hazards, regulations, and environmental impacts, as per E-Waste (Management) Rules, 2022.

Details of Syllabus:

Unit 1	**Sources, Classification & Properties of Solid Wastes:** Introduction, Sources of solid waste, Types of solid waste, Composition of solid waste and its determination, Municipal solid waste Sources, Types of materials recovered from MSW, Physical, Chemical & Biological properties of Municipal Solid Waste, Transformation of Municipal Solid Waste.	8 Hrs.
Unit 2	**Solid Waste Generation and Collection:** Quantities of Solid Waste, Measurements and methods to measure solid waste quantities, Solid waste generation and collection, Factors affecting solid waste generation rate, Quantities of materials recovered from MSW.	7 Hrs.

Unit 3	**Handling, Separation and Storage of Solid Waste:** Handling and separation of solid waste on site, Material separation by pick in screens, floating and separator magnets and electromechanical separator and other advance devices for material separation, Waste handling and separation at Commercial and industrial facilities, Storage of solid waste at the sources.	8 Hrs.
Unit 4	**Disposal of Municipal Solid Waste:** Combustion and energy recovery of municipal solid waste, effects of combustion, undesirable effects of Combustion, Landfill: Classification, planning, sitting, permitting, landfill processes, landfill design, landfill operation, use of old landfill, Differentiate sanitary land fill and incineration as final disposal system for solid waste, Biochemical processes: Methane generation by anaerobic digestion, composting and other biochemical Processes.	7 Hrs.
Unit 5	**Hazardous Solid Waste:** Definition, identification and classification of hazardous solid waste, Characteristics Hazardous waste toxicity, reactivity, infectiousness, flammability, radioactivity, corrosiveness, irritation, bio-concentration, genetic activity, explosiveness, Bio-medical waste, its sources, generation, storage, transportation and Disposal.	8 Hrs.
Unit 6	**E-Waste Management**: E- waste; composition and generation. Global context in e- waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E- waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E waste management, Component of E waste management. E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2022 - Salient Features and its implications.	7 Hrs.

Textbooks:

3. George Techobanoglous, "Integrated Solid Waste Management", McGraw-Hill Publication, 1993
4. Hester R.E., and Harrison R.M, Electronic Waste Management. Science, 2009.
5. Hazardous Waste Management, Volume I, Sukalyan Sengupta, Momentum Press
6. Bhide A.D., Solid Waste Management in developing countries.

Reference Books:

2. P. Meenakshi, "Elements of Environmental Science and Engineering", Prentice Hall of India Private Limited, New Delhi,
3. CPHEEO manual on MSW, GoI, New Delhi

5.5	VI	6CE239MD	Advance Building Material	2	30	2 Hrs.	30

Course Description:

Subject Code 6CE239MD Advance Building Material is a (Multidisciplinary Minor-V) is a course for minor in Civil Engineering for Third Year B.E.

Course Objective:

The Objective of this course is to introduce advanced, sustainable, and innovative building materials, emphasizing properties, performance, applications, and selection for modern civil engineering projects.

Course Outcomes (COs)

After completing the course students will be able to:

CO	Course Outcome
CO1	Apply properties of advanced cementitious materials for appropriate concrete selection.
CO2	Analyze advanced and sustainable building materials for environmental and structural suitability.
CO3	Apply material selection criteria for real-world civil engineering applications.

Details of Syllabus:

Unit 1	**Advanced Cementitious and Concrete Materials** Conventional building materials and need for advanced materials, Characteristics, applications of : High Performance Concrete, Self-Compacting Concrete, Fiber Reinforced Concrete, lightweight concrete, polymer concrete; Geopolymer Concrete: materials, production, advantages and limitations	8 Hrs.

Unit 2	**Building Materials and Sustainable Alternatives** AAC blocks, fly ash bricks, stabilized mud blocks, Composite materials: FRP, GFRP, CFRP, Smart materials: shape memory alloys, piezoelectric materials, self-healing materials, Glass, plastics, and polymer-based building materials, Green and sustainable materials: recycled aggregates, industrial by-products, bio-based materials	10 Hrs.
Unit 3	**Performance Evaluation, Durability and Applications** Durability of advanced building materials: corrosion, chemical attack, fire resistance, Testing and characterization of advanced materials (mechanical, thermal, durability tests), Selection criteria for advanced materials in buildings and infrastructure, Applications in high-rise buildings, bridges, pavements, and retrofitting	12 Hrs.

Recommended Books:

1. R. Vasudevan, Advanced Building Materials, New Age International Publishers, New Delhi.
2. P. C. Varghese, Advanced Construction Techniques, PHI Learning Pvt. Ltd., New Delhi.
3. M. S. Shetty, Concrete Technology: Theory and Practice, S. Chand & Company Ltd., New Delhi.
4. A. M. Neville, Properties of Concrete, Pearson Education, India.
5. P. Kumar Mehta and Paulo J. M. Monteiro, Concrete: Microstructure, Properties and Materials, McGraw Hill Education.
6. K. K. Chitkara, Construction Materials: Properties and Applications, Tata McGraw Hill Publishing Company.

Course Description:

Subject Code 6CE240VS Non-destructive testing method is Civil Engineering vocational Skill enhancement course for Third Year.

Course Objectives:

Students will be able to:

- Understand deterioration mechanisms of RCC structures
- Perform major NDT tests on concrete and steel
- Interpret test data for structural condition assessment
- Use NDT for safety, repair and service life evaluation

Course Outcomes:

After completing the course students will be able to:

Level	Semester	Course Code	Course Name	Credits	Practical Hours	Exam Duration	Maximum Marks
5.5	VI	6CE240VS	Non-destructive testing method	2 (1T, 1P)	15 hours theory, 2 hours/week	-	50

CO	Course Outcome
CO1	- Identify types of defects and deterioration in RCC structures
CO2	Perform basic NDT tests on concrete and steel
CO3	Interpret NDT data and assess structural condition and Recommend repair or strengthening based on test results

Details of Syllabus:

Unit	Description	Duration (Hrs)
1	**1 – Introduction to NDT** • Need of NDT in civil engineering • Difference between Destructive Test and Non Destructive Test • Deterioration of RCC: corrosion, cracks, carbonation, sulphate attack Role of NDT in structural audit, repair and rehabilitation	5 Hrs

2	**Rebound Hammer & UPV** • Schmidt Rebound Hammer: principle, procedure, limitations • Ultrasonic Pulse Velocity (UPV): direct, indirect, semi-direct method • IS 13311 (Part-1 & 2) • Quality grading of concrete using UPV	5 Hrs
3	**– Corrosion Related Tests** • Half-Cell Potential (HCP) • Concrete resistivity • Carbonation depth • Chloride contamination • Interpretation of corrosion risk **– Advanced & Field NDT** • Cover meter and rebar locator • Crack width measurement • Basics of GPR, Impact Echo	5 Hrs

PRACTICAL SYLLABUS

Minimum four Practical on Non destructive testing method

Practical No.	Experiment
1	Visual inspection and mapping of cracks
2	Rebound hammer test on concrete
3	UPV test on concrete specimen
4	Half-cell potential measurement
5	Carbonation depth measurement
6	Cover meter test
7	Concrete resistivity test
8	Field visit – NDT on existing structure
9	Preparation of structural condition report
10	Mini project on real building

Text Books

1. Malhotra & Carino – Handbook on NDT of Concrete
2. Bungey, Millard – Testing of Concrete in Structures

Standards

- IS 13311 (Part 1 & 2)
- ASTM C876
- RILEM Recommendation

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	7CE310EC	Estimation & Costing	4	60	3 Hrs.	60

Course Description:

Subject Code: 7CE310EC Estimating & Costing is a Multiple entry/exit subject for Third Year Civil B.E. Engineering.

Course Objectives:

The objective of the course is to estimate the quantities of various items, preparation of detailed estimate, knowledge of execution of construction projects as per the contract documents.

Course Outcomes (COs)

After completing the course students will be able to:

CO	Course Outcome

CO1	Estimate approximate cost estimates for civil engineering projects using standard methods and schedules.
CO2	Prepare detailed quantity estimates for load-bearing and R.C.C. structures up to plinth using P.W.D. and center-line methods.
CO3	Analyze and determine property values, including fair market, book, salvage, distressed, and sentimental, considering depreciation and obsolescence.
CO4	Prepare detailed specifications and perform rate analysis for major construction items, incorporating material, labour, and overhead factors.
CO5	Apply tendering procedures and PWD work execution methods to manage construction projects from invitation to completion efficiently.
CO6	Analyze and apply Indian Contract Act principles to prepare, evaluate, and manage construction contracts with key clauses and payment terms.

Details of Syllabus:

Unit 1	**Introduction and Approximate Estimates:** Definitions of estimation and valuation, Purpose of estimation. Type of estimates, data required for estimation as a prerequisite. Units of measurement. Mode of measurement of building items/works. Introduction to components of estimates: face sheet, abstract sheet (BOQ), measurement sheet, Rate Analysis, lead statement. Provisional sum & prime cost items, contingencies, work charge establishment. Introduction to D. S. R Approximate Estimates: Meaning, purpose, methods of approximate estimation of building & other civil engineering projects like roads, irrigation/ water supply, sanitary engineering, electrical works.	10 Hrs.
Unit 2	**Taking out quantities & Detailed Estimate up to plinth:** Methods of estimating-P.W.D. and center-line methods of working out quantities. Calculation of quantities for Load bearing and R.C.C framed structures up to plinth level. Detailed estimates, Factors to be considered while Preparing Detailed Estimate, Detailed estimates of Load Bearing and R.C.C framed structures up to plinth level.	10 Hrs.
Unit 3	**Detailed Estimation for super structure & Valuation:** Calculation of quantities and detailed estimate for Load bearing and framed structures above plinth (super structure). Deduction rules for different items of work as per IS: 1200. Valuation: Purpose of valuation. Meaning of price, cost and value. Factors affecting 'value'. Types of value: only Fair Market Value, Book Value, Salvage/ Scrap Value, Distressed Value and Sentimental Value. Concept of free hold and lease hold property. Estimation versus valuation. Meanings of depreciation & obsolescence.	10 Hrs.
Unit 4	**Specifications and Rate Analysis:** Specifications: Meaning & purpose, types. Drafting detailed specifications for materials, quality, workmanship, method of execution, mode of measurement and payment for major items like, excavation, stone/ brick masonry, plastering, ceramic tile flooring, R.C.C. work. Rate Analysis: Meaning and factors affecting rate of an item of work, materials, sundries, labour, tools & plant, overheads & profit. Working out Rate Analysis for the items mentioned in specifications above. Task work or out turn, factors effecting task work.	10 Hrs.
Unit 5	**Tendering & Execution of Works:** Tenders: Definition. Methods of inviting tenders, tender notice, tendering procedure, Pre and post qualification of contractors, tender documents. 3 bid/ 2 bid or single bid system. Qualitative and quantitative evaluation of tenders. Comparative statement, Pre-bid conference, acceptance/rejection of tenders. Various forms of BOT & Global Tendering, E-tendering. Executing Works: PWD procedure of work execution, administrative approval, budget provision, technical sanction. Methods of execution of minor works in PWD.	10 Hrs.
Unit 6	**Contracts**: Contracts: Definition, objectives & essentials of a valid contract as per Indian Contract Act (1872), termination of contract. Types of contracts: only lump sum, item rate, cost plus. Conditions of contract: General and Specific conditions. Conditions regarding EM, SD, and time as an essence of contract, conditions for addition, alteration, extra items,	10 Hrs.

	testing of materials, defective work, subletting, etc. Defect liability period, liquidated damages, retention money, interim payment or running account bills, advance payment, secured advance, final bill.	

Textbooks:

1. Estimating and Costing in Civil Engineering: Theory and Practice: B.N Dutta - S. Dutta & Company, Lucknow.
2. Estimating, Costing Specifications & valuation in Civil Engineering: M. Chakraborty.
3. Estimating and Costing: R. C. Rangwala - Charotar Publ. House, Anand
4. Theory and Practice of Valuation: Dr. RoshanNamavati, Lakhani Publications.
5. Valuation Principles and Procedures: Ashok Nain, Dewpoint Publication.

Reference Books:

1. Standard Contract Clauses for Domestic Bidding Contracts: Ministry of Statistics and Programme Implementation, Government of India.
2. Indian Practical Civil Engineers' Handbook: P. N. Khanna, UBS Publi. Distri. Pvt. Ltd.
3. D. S. R. (District Schedule of Rates) for current year

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	7CE311EC	Sustainable Construction Methods	4	60	3 Hrs.	60

Course Description:

Subject Code: 7CE311EC Sustainable Construction Methods — National Education Policy (NEP) 2020 is a compulsory Program Exit Course for Third Year B.E. Civil Engineering. The course credit is 4 (4 hours per week, 56 hours total)

Course Objectives:

1. Understand environmental impacts of construction: Describe how the built environment affects natural systems, including urban heat islands, storm-water run-off and carbon emissions.
2. Select and apply sustainable materials: Explain the properties of sustainable alternatives to conventional cement, steel and wood; evaluate recycled materials, bio-based products and smart materials such as permeable or ultra-high-performance concrete.
3. Analyse energy and life-cycle impacts: Evaluate embodied and operational energy in buildings, conduct life-cycle assessments and propose design strategies to reduce energy consumption.
4. Manage indoor environmental quality: Assess indoor air quality issues arising from paints, adhesives and VOCs and recommend measures for occupant health.
5. Integrate green building practices: Apply ecological design concepts, develop waste and water management strategies, and navigate rating systems such as LEED and GRIHA.
6. Develop hands-on skills and professional awareness: Gain experience through site visits, workshops and case studies; understand certification frameworks and contracting requirements for green projects

Course Outcomes (COs)

After completing the course students will be able to:

CO	Course Outcome
CO1	Conduct site assessments and recommend sustainable site planning measures to mitigate environmental impacts.
CO2	Evaluate sustainable materials and methods for concrete, steel and building blocks; design for deconstruction and recycling.
CO3	Perform basic life-cycle and energy analyses to inform material selection and design.
CO4	Develop waste management and water conservation plans for construction projects.
CO5	Navigate green building rating systems and prepare documentation for certifications such as LEED or GRIHA.
CO6	Demonstrate professional and ethical responsibility in sustainable construction, aligning with industry standards and policies.

Details of Syllabus:

Unit 1	**Introduction & Site Sustainability** Definitions of sustainability in construction; impacts of the built environment (urban heat island, storm-water run-off, carbon emissions); principles of sustainable site development—site selection, vegetation, public transport, solar reflectance index; regulations and guidelines; introduction to green building rating systems and professional bodies (LEED, GRIHA, CaGBC).	10 Hrs.
Unit 2	**Sustainable Materials & Methods** Sustainable building materials: recycled aggregates, low-carbon cement, supplementary cementitious materials; high-performance and smart materials (permeable concrete, cool concrete, UHPC, phase-change materials); sustainable alternatives for steel and timber (recycled steel, engineered lumber, wood-plastic composites); evaluation of material properties, IS codes and certification standards; design for deconstruction and reuse.	10 Hrs.
Unit 3	**Energy & Life-Cycle Assessment** Concepts of embodied energy, operational energy and life-cycle energy; methods for life-cycle costing (LCC) and impact assessment (LCIA); software tools and case studies; building energy design strategies and passive design principles; integration of renewable energy and net-zero concepts.	10 Hrs.
Unit 4	**Waste, Water & Indoor Environmental Quality** Construction and demolition waste management: segregation, recycling, reduction and reuse; development of waste management plans; indoor air quality—sources of VOCs (paints, adhesives, sealants) and mitigation measures; hydrologic cycle impacts, water conservation and recycling strategies (rainwater harvesting, grey-water recycling); storm-water management techniques; health and safety considerations.	10 Hrs.
Unit 5	**Integrated Green Building Design & Professional Practice** Ecological design concepts and integrated design process; phases of green building project management and documentation; green procurement and contracting—overview of regulatory frameworks and ethical practices; site visits, hands-on workshops and case studies as emphasised in SPA New Delhi's curriculum; introduction to building services for sustainability—energy-efficient HVAC, lighting, and water systems; preparation for LEED/Griha documentation.	10 Hrs.
Unit 6	**Field Project / Mini-Project** Students work in groups to conduct a field study or mini-project on a nearby building or college facility. Tasks include: site assessment, material audit, energy and water evaluation, waste management plan, and sustainability enhancement proposals. Reports and presentations are assessed as part of continuous evaluation.	10 Hrs.

Recommended Books:

1. Sustainable Building Design Manual—Volume II, TERI Publications (2009).
2. Kibert, C. J., Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, 2016.
3. Sabnis, G. M., Green Building with Concrete: Sustainable Design and Construction, CRC Press, 2015.
4. Sandy Halliday, Sustainable Construction, Routledge, 2013.
5. Dejan Mumovic & Mat Santamouris (eds.), Handbook of Sustainable Building Design and Engineering, CRC Press, 2018.
6. Osman Attmann, Green Architecture: Advanced Technologies and Materials, McGraw Hill, 2010.
7. Canada Green Building Council (CaGBC) and USGBC resources on LEED and Net-Zero rating systems.
8. Relevant IS codes and the National Building Code for sustainable materials and building practices

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	6CE248DH1	Green Technology	4	60	3 Hrs.	60

Course Description:

Subject Code: 6CE248DH1 Green technology is a Double Minor for Third Year All branches excluding Civil Engineering and Honors Course for Third Year Civil B.E. Engineering.

Course Objectives:

The objective of the course is to give comprehensive knowledge of solid waste sources, characteristics, collection, environmental impacts, treatment, disposal methods, and relevant legal frameworks for effective solid waste management.

Course Outcomes (COs)

After completing the course students will be able to:

CO	Course Outcome
CO1	Understand the nexus between energy, environment and sustainable development
CO2	Appreciate energy ecosystems and its impact on environment
CO3	Learn basics of solar energy as a renewable and clean energy technology.
CO4	To acquire knowledge on solar radiation and its characteristics.
CO5	Learn basics of wind, ocean and bioenergy as a renewable and clean energy technology.
CO6	Understand energy and economics and environmental sustainability.

Details of Syllabus:

Unit 1	**Energy:** Introduction to the nexus between energy, environment and sustainable development, Energy sources overview and classification, sun as the source of energy, fossil fuel reserves and resources - overview of global/ India's energy scenario. Energy consumption models – Specific Energy Consumption.	10 Hrs.
Unit 2	**Ecology and Environment:** Concept and theories of ecosystems, - energy flow in major man-made ecosystems-agricultural, industrial and urban ecosystems - sources of pollution from energy technologies and its impact on atmosphere - air, water, soil, and the environment - environmental laws on pollution control, The environmental protection act: Effluent standards and ambient air quality, innovation and sustainability.	10 Hrs.
Unit 3	**Solar Energy:** Solar Energy: Solar radiation: measurements and prediction. Indian's solar energy potential and challenges, solar energy conversion principles and technologies Photosynthesis, Photovoltaic conversion and Photo thermal energy conversion.	10 Hrs.
Unit 4	**Solar Radiation Geometry:** Solar angles; the earth and solar constant; day length; angle of incidence on the tilted surface, variation of extraterrestrial radiation; solar radiation at the earth's surface, sunrise, sunset and day length local apparent time	10 Hrs.
Unit 5	**Wind, Ocean & Bio Energy:** Wind Energy: Atmospheric circulations, atmospheric boundary layers, classification, factors influencing wind, wind shear, turbulence, wind energy basics and power Content, wind speed monitoring, Betz limit, wind energy conversion system: classification, characteristics and applications. Ocean Energy: Ocean energy resources-ocean energy conversion principles and technologies: ocean thermal, ocean wave & ocean tide. Bioenergy: resources and types.	10 Hrs.
Unit 6	**Energy and Economy**: Energy and Economics: gross domestic product (GDP) and energy– energy market and society – energy efficiency – energy – energy and economics – energy: security – equity – environmental sustainability index and global measure	10 Hrs.

Textbooks:

7. Energy and Environment Set: Mathematics of Decision Making, Loulou, Richard; Waaub, Jean-Philippe; Zaccour, Georges (Eds.), 2005.
8. Energy and the Environment, Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A., 2nd Edition, John Wiley, 2006
9. Zaccour, Georges (Eds.), 2005.

References Book :

1. Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N York, 2000.
2. Solar Energy: principles of Thermal Collection and Storage, S.P. Sukhatme, Tata McGraw-Hill (1984).
3. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.
4. Wind Energy Conversion Systems, L.L. Freris, Prentice Hal 1990..

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	6CE248DH2	Sustainable and green construction	4	60	3 Hrs.	60

Course Description:

Subject Code 6CE248DH2 Sustainable and Green construction is a Double Minor/Honours Course in Sustainable Engineering for second Year B.E.

Course Objective:

The Objective of this course to develop interdisciplinary understanding of sustainable and green construction practices, materials, energy efficiency, and environmental responsibility in modern infrastructure development.

Course Outcomes (COs)

After completing the course students will be able to:

CO	Course Outcome
CO1	Apply sustainability principles to assess environmental impacts of construction activities.
CO2	Analyze green building rating systems and certification criteria applicable in India.
CO3	Analyze sustainable material options based on performance, cost, and environmental impact.
CO4	Apply energy and water efficiency strategies to improve sustainability of built systems.
CO5	Apply sustainable construction practices to minimize waste and environmental degradation.
CO6	Analyze life-cycle impacts and emerging trends in sustainable and green construction.

Details of Syllabus:

Unit 1	**Introduction to Sustainability and Green Construction** Concept of sustainability and sustainable development, Environmental impacts of construction industry, Principles of green construction and sustainable infrastructure, Triple bottom line: environmental, economic, and social sustainability, Role of engineers from different disciplines in sustainable development	10 Hrs.
Unit 2	**Green Building Concepts and Rating Systems** Green building fundamentals and objectives, green building rating systems: LEED, IGBC, GRIHA, BREEAM, ECBC and National Building Code provisions related to sustainability, Certification process, documentation, and benefits	10 Hrs.
Unit 3	**Sustainable Building Materials and Resources** Sustainable and alternative building materials, fly ash, GGBS, silica fume, Recycled and renewable materials in construction, Low embodied energy materials and material selection criteria, Resource efficiency and circular economy concepts	10 Hrs.
Unit 4	**Energy and Water Efficiency in Construction** Energy use in buildings and infrastructure, Passive design strategies and climate-responsive construction, Energy-efficient systems: lighting, HVAC, building envelope, Renewable energy integration in buildings, Water conservation techniques: rainwater harvesting, wastewater reuse	10 Hrs.
Unit 5	**Sustainable Construction Practices** Sustainable construction planning and execution, Construction and demolition waste management, Reduce, reuse, recycle concepts in construction, Lean construction and green procurement, Occupational health, safety, and environmental management	10 Hrs.
Unit 6	**Life Cycle Assessment and Emerging Trends** Life Cycle Assessment (LCA) of buildings and infrastructure, Embodied energy and carbon footprint analysis, Sustainable urban development and smart cities, Net-zero energy buildings and carbon-neutral construction, Future trends and interdisciplinary role of engineers in sustainability	10 Hrs.

Reference Books:

1. Charles J. Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons.
2. TERI, Sustainable Building Design Manual – Volume II, The Energy and Resources Institute (TERI), New Delhi.
3. Francis D. K. Ching and Ian M. Shapiro, Green Building Illustrated, John Wiley & Sons.
4. Steven V. Szokolay, Introduction to Architectural Science – The Basis of Sustainable Design, Routledge.
5. Sandy Halliday, Sustainable Construction, Routledge (Taylor & Francis Group).
6. BIS Publications, National Building Code, ECBC and Sustainability-related IS Codes, Bureau of Indian Standards, New Delhi.