Savitribai Phule Pune University, Pune

Syllabus for BE Civil Engineering (2019 Pattern)

Implemented from Academic year 2022-23

Board of Studies in Civil Engineering

Faculty of Science and Technology

Savitribai Phule Pune University, Pune BE (Civil Engineering) 2019 Pattern (With effect from Academic Year 2022-23)																
SEMESTER: VII																
Course Code	**Course Name**	**Teaching Scheme (Hours/Week)**			**Examination Scheme and Marks**						**Credit**					
		Theory	**Practical**	**Tutorial**	**IN-Sem**	**End-Sem**	**TW**	**PR**	**OR**	**Total**	**TH**	**TW**	**PR**	**OR**	**TUT**	**Total**
401001	Foundation Engineering	03	--	--	30	70	--	--	--	100	03	--	--	--	--	03
401002	Transportation Engineering	03	--	--	30	70	--	--	--	100	03	--	--	--	--	03
401003	Elective III	03	--	--	30	70	--	--	--	100	03	--	--	--	--	03
401004	Elective IV	03	--	--	30	70	--	--	--	100	03	--	--	--	--	03
401005	Project Stage I	--	04	--	--	--	50	--	50	100	--	01	--	02	--	03
401006	Transportation Engineering **Lab**	--	02	--	--	--	--	--	50	50	--	--	--	01	--	01
401007	Elective III **Lab**	--	02	--	--	--	--	--	50	50	--	--	--	01	--	01
401008	Elective IV **Lab**	--	02	--	--	--	50	--	--	50	--	01	--	--	--	01
401009	Computer Programming in Civil Engineering	01	02	--	--	--	50	--	--	50	--	02	--	--	--	02
401010	Audit Course I **Stress Management by Yoga / Communication Etiquette in Workplaces**	--	--	01	--	GR	--	--	--	GR	--	--	--	--	--	--
	Total	**13**	**12**	**01**	**120**	**280**	**150**	**--**	**150**	**700**	**12**	**04**	**--**	**04**	**--**	**20**
Abbreviations: TH : Theory, TW: Term Work, PR : Practical, OR: Oral, TUT : Tutorial, GR: Grade																

Elective III and IV

S N	Course Code	Elective III: Course Name	Course Code	Elective IV: Course Name
01	401003 a	Coastal Engineering	401004 a	Air Pollution and Control
02	401003 b	Advanced Design of Concrete Structures	401004 b	Advanced Design of Steel Structures
03	401003 c	Integrated Water Resources Planning & Management	401004 c	Statistical Analysis and Computational Method
04	401003 d	Finite Element Method	401004 d	Airport and Bridge Engineering
05	401003 e	Data Analytics	401004 e	Design of Prestressed Concrete Structures
06	401003 f	Operation Research	401004 f	Formwork and Plumbing Engineering

SEMESTER-VIII																
Course Code	**Course Name**	**Teaching Scheme (Hours/Week)**			**Examination Scheme and Marks**						**Credit**					
		Theory	**Practical**	**Tutorial**	**IN-Sem**	**End-Sem**	**TW**	**PR**	**OR**	**Total**	**TH**	**TW**	**PR**	**OR**	**TUT**	**Total**
401011	Dams and Hydraulics Structures	03	--	--	30	70	--	--	--	100	03	--	--	--	--	03
401012	Quantity Surveying, Contracts and Tenders	03	--	--	30	70	--	--	--	100	03	--	--		--	03
401013	Elective V	03	--	--	30	70	--	--	--	100	03	--	--		--	03
401014	Elective VI	03	--	--	30	70	--	--	--	100	03	--	--		--	03
401015	Project Stage II	--	10	--	--	--	100	--	50	150	--	03	--	02	--	05
401016	Dams and Hydraulics Structures **Lab**	--	02	--	--	--	--	--	50	50	--		--	01	--	01
401017	Quantity Surveying, Contracts and Tenders **Lab**	--	02	--	--	--	--	--	50	50	--		--	01	--	01
401018	Elective V **Lab**	--	02	--	--	--	50	--	--	50	--	01	--	--	--	01
401019	Audit Course II **Social Responsibility / Human Rights**	--	--	01	--	GR	--	--	--	GR		--	--	--	--	--
	Total	**12**	**16**	**01**	**120**	**280**	**150**	--	**150**	**700**	**12**	**04**	--	**04**	--	**20**
Abbreviations: TH : Theory, TW: Term Work, PR : Practical, OR: Oral and TUT : Tutorial, GR: Grade																

Elective V and VI

S N	Course Code	Elective V: Course Name	Course Code	Elective VI: Course Name
01	401013 a	Earthquake Engineering	401014 a	TQM and MIS
02	401013 b	Structural Design of Bridges	401014 b	Advanced Transportation Engineering
03	401013 c	Irrigation and Drainage	401014 c	Geo Synthetic Engineering
04	401013 d	Design of Precast and Composite Structures	401014 d	Structural Design of Foundations
05	401013 e	Hydropower Engineering	401014 e	Green Structures and Smart Cities
06	401013 f	Structural Audit and Retrofitting of Structures	401014 f	Rural Water Supply and Sanitation

Programme Outcomes

S N	Programme Outcomes	Programme Outcomes Statement
01	Engineering Knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
02	Problem Analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
03	Design/Development of Solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
04	Conduct Investigations of Complex Problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
05	Modern Tool Usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
06	The Engineer and Society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
07	Environment and Sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
08	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
09	Individual and Team Work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project Management and Finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	Life-Long Learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401001: Foundation Engineering

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites

Engineering Mechanics and Soil Mechanics

Course objectives

01 To know various methods for subsurface investigations for foundations.
02 To learn to perform geotechnical design of shallow and deep foundations.
03 To study the problems related to foundations on expansive soil and ways to solve them.

Course outcomes

On successful completion of this course, the learner will be able to,
01 Perform subsurface investigations for foundations using different methods.
02 Estimate the bearing capacity of shallow foundations.
03 Calculate immediate and primary consolidation settlement of shallow foundations.
04 Decide the capacity of a pile and pile group.
05 Understand the steps in geotechnical design of shallow foundations and well foundations.
06 Analyze problems related to expansive soil and overcome them using design principles, construction techniques in black cotton soil.

Course Content

Unit 1: Subsurface Investigations for Foundations (06 hours)

Purpose and planning of subsurface exploration, methods of Investigation: trial pits, borings, depth & number of exploration holes, core recovery, RQD, core log, geophysical methods: seismic refraction and electrical resistivity method, disturbed and undisturbed sampling, types of samplers, degree of disturbance of a sampler, field tests- SPT, N value correction and significance, DCPT, SCPT and introduction of advanced testing techniques like pressure meter test, borelog, contents of sample soil investigation report.

Unit 2: Bearing Capacity (06 hours)

Basic definitions, modes of shear failure, bearing capacity analysis- Terzaghi's, Hanson's, Meyerhof's, Skempton's, Vesics equations and IS code method - rectangular and circular footings, bearing capacity evaluation: plate load test and SPT, Housel's perimeter shear concept, bearing capacity of layered soil, effect of water table on bearing capacity, effect of eccentricity, presumptive bearing capacity

Unit 3: Immediate and Consolidation Settlement (06 hours)

Immediate Settlement: introduction, causes of settlement, pressure bulb, contact pressure, significant depth of foundation, allowable settlement, differential settlement - I. S. criteria, components of settlement, use of plate load test and SPT in settlement analysis and allowable soil pressure.
Consolidation Settlement: introduction, spring analogy, Terzaghi's consolidation theory, laboratory consolidation test, determination of coefficient of consolidation- square root of time fitting method

and logarithm of time fitting method, time factor, rate of settlement and its applications in shallow foundations, introduction of normal consolidation, over consolidation and pre consolidation pressure.

Unit 4: Pile Foundations **(06 hours)**

Introduction: pile classification according to different criteria, pile installation - Cast in-situ, driven and bored pile, load carrying capacity of pile by static method, dynamic Methods: Engineering news formula, modified ENR formula and modified Hiley formula, pile load test and cyclic pile load test, group action: field rule, rigid block method, negative skin friction, settlement of pile group in cohesive soil by approximate method, uplift capacity of piles, micro piles.

Unit 5 Shallow foundations, Piers and Caissons **(06 hours)**

Shallow Foundations: types and applications, location and depth of footing, principles of design of footing, steps involved in proportioning of footing, proportioning of combined footings – rectangular, trapezoidal and strap footing, raft foundation- types, bearing capacity, floating raft, design of raft foundation- conventional (rigid) method and elastic (flexible) method (only design principles and steps, no numerical).

Piers and Caissons: definitions, types and uses, well foundation: components, sand island method, shapes of wells, tilts and shifts: precautionary and remedial measures, bearing capacity and depth of well foundation, forces acting on well foundations, lateral stability of well foundation – Terzaghi's method, IRC method, ultimate soil resistance method (only numerical on lateral stability analysis, no derivation for methods).

Unit 6: Cofferdams and Foundation on Black Cotton Soils **(06 hours)**

Cofferdams: types and applications, contiguous pile walls, RC Diaphragm wall method. Foundation on Black Cotton Soils: characteristics of black cotton soil, swelling potential and its evaluation methods, engineering problems, swelling pressure measurement, foundations on black cotton soil: design principles, construction techniques, under reamed piles: design principles and its construction techniques, stone columns, pre loading with prefabricated vertical drains/sand drains.

Text books

01 Foundation Engineering by P. C. Varghese, PHI Learning Pvt. Ltd.
02 Soil Mechanics and Foundation Engineering by A. K. Arora, Standard Publishers.
03 Soil Mechanics and Foundation Engineering by V. N. S Murthy, Marcel Dekker, Inc. New york.
04 Soil Mechanics and Foundation Engineering by B. C. Punmia, Laxmi Publicationselhi.

Reference books

01 Basic and Applied Soil Mechanics by Gopal Ranjan and A. S. Rao, New Age International Publishers.
02 Principles of Foundation Engineering, Braja M. Das, PWS Publishing Company.
03 Geotechnical Engineering by Shashi K. Gulati & Manoj Datta, Tata McGraw Hill.
04 Foundation Analysis and Design, J. E. Bowels, McGraw-Hill.
05 Geotechnical Engineering by Conduto, PHI, New Delhi.
06 Soil Mechanics & Foundation Engineering by Rao, Wiley

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401002: Transportation Engineering

Teaching scheme	Credits	Examination scheme
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Infrastructural Engineering and Construction Materials

Course objectives
01 To learn principles and practices of transportation planning
02 To describe traffic studies, their analysis and their interpretation.
03 To learn Geometric Design of Cross Sectional Elements of pavement.
04 To study characteristic, properties and testing procedures of highway materials.
05 To enumerate different types of pavements and design of flexible and rigid pavement
06 To understand the fundamentals of Bridge Engineering and Railway Engineering

Course outcomes
On successful completion of this course, the learner will be able to,
01 Understand principles and practices of transportation planning.
02 Demonstrate knowledge of traffic studies, analysis and their interpretation.
03 Design Geometric Elements of road pavement.
04 Evaluate properties of highway materials as a part of road pavement.
05 Appraise different types of pavements and their design.
06 Understand the fundamentals of Bridge Engineering and Railway Engineering

Course Content

Unit 1: Highway development and planning (06 hours)
History , development plans, classification of roads, road patterns, road development in India: vision 2021, rural road development vision 2025, current road projects in India, highway alignment, highway project report preparation, (planning surveys & master plans based on saturation system).problems based on saturation system.

Unit 2: Traffic Engineering and control (06 hours)
Traffic characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control devices (signs, signals, islands, road markings), accident studies, types of road intersections, parking studies; highway lighting, problems.

Unit 3: Geometric design of highways (06 hours)
Introduction, highway cross section elements, sight distance, design of horizontal alignment, problems of horizontal alignment, design of vertical alignment, design of intersections.

Unit 4: Pavement materials (06 hours)
Materials used in highway construction and related tests: soil subgrade and CBR Test, stone aggregates, bituminous binders, bituminous paving mixes, viscosity based gradation of bitumen, modified bitumen cutbacks, emulsions, crumbed rubber modified bitumen, polymer modified bitumen, foamed bitumen, Marshall stability mix design and test (All 5 test parameters).

.**Unit 5: Pavement Design** **(06 hours)**

Introduction to various types of pavement, flexible pavements: computation of design traffic (vehicle damage factor, lane distribution factor, and traffic growth rate), flexible pavements, computation of design traffic, problems, stresses in flexible pavements, design guidelines for flexible pavements as per IRC 37-2018 without numerical. Rigid pavements: components and functions, factors affecting design, ESWL, Stresses in rigid pavements, wheel load stresses and temperature stresses, design guidelines for concrete pavements as per IRC 58-2015 without numerical, Joints in CC pavements, problems, highway drainage: subsurface and surface drainage.

Unit 6: Bridge and railway Engineering **(06 hours)**

Bridge Engineering: classification of bridges, components of bridges, preliminary data to be collected during investigation of site for bridges, economical span, afflux, HFL, scour depth and clearance, locations of piers and abutments, factors influencing the choice of bridge super structure, approach roads. Loads on bridges: brief specifications of different loads, forces and stresses coming on bridges as per IRC, Substructure: abutment, piers, and wing walls with their types. Railway Engineering: role and necessity of railway, merits of railways with respect to roadways and waterways, permanent way, component parts of permanent way, requirements of an ideal permanent way, gauge: types of gauges and their suitability

Text books

01 Highway Engineering, S. K. Khanna, C. E. G. Justo and A. Veeraragavan, Nem Chand and Brothers.
02 Principles and Practices of Highway Engineering, Dr. L .R. Kadiyali, Khanna Publishers Delhi
03 Principles of Highway Engineering and Traffic Analysis (4th edition), F. L. Mannering and Scott S. Washburn, Wiley India.
04 Highway and Bridge Engineering, B. L. Gupta and Amit Gupta, Standard publishers Distributors.
05 Principles of Railway Engineering, Rangwala, Charotar publication.

Reference books

01 A Course in Highway Engineering, S. P. Bindra, Dhanpat Rai and Sons.
02 Principles of Transportation Engineering, G. V. Rao, Tata MacGraw Hill Publication
03 Highway Engineering, Rangawala, Charotar publishing House.
04 Principles of Transportation Engineering, Partha Chakraborty and Animesh Das, Prentice Hall of India Pvt. Ltd.
05 Railway Engineering, M M Agarwal

Indian Standards and Handbooks

01 IS 1201 to 1220 - 1978, IS 73, IS 2386 part I to V
02 IRC 58 - 2015, IRC37
03 Specifications for Road and Bridge works (MORTH) - IRC, New Delhi.
05 Specifications for Road and Bridge works (MORTH)-IRC, New Delhi.
06 Handbook of Road Technology, Lay M. G., Gorden Breach Science, Newyork
07 Civil Engineering Handbook, Khanna S. K.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401003 a Elective III: Coastal Engineering

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Fluid Mechanics, Mathematics and Statistics

Course objectives
01 To make students aware about basics of ocean waves
02 To introduce students to the wave properties and analysis
03 To impart knowledge about tides and it's dynamic theory
04 To introduce students to important aspects of longshore transport
05 To impart knowledge about to the coastal structures, shore protection
06 To impart knowledge about coastal management

Course outcomes
On successful completion of this course, the learner will be able to,
01 Understand basic of ocean waves including wave generation, classification, propagation, wave theories, wave diffraction, wave refection and wave breaking.
02 Understand and apply short term and long-term wave analysis.
03 Understand basic characteristics of tides, tide producing forces, dynamic theory of tides.
04 Understand coastal process of erosion/accretion due to waves, bed forms, long shore transport (Littoral drift) and estimation of wave induced sediment quantity.
05 Understand the coastal structures and shore protection methods.
06 Understand coastal zone management activities, issues related to integrated coastal zone management and regulation of coastal zone.

Course Content

Unit 1: Basics of Ocean Waves **(06 hours)**
Introduction to wind and waves, Sea and Swell, generation, classification of ocean waves, wave measurement, introduction to small amplitude wave theory, Linear (Airy) wave theory, use of wave tables, introduction to non-linear waves.

Unit 2: Wave Properties and Analysis **(06 hours)**
Basic understanding of wave mechanics including wave propagation, refraction, diffraction, breaking and shoaling, waves in shallow waters, introduction to waves of unusual character: currents, giant waves, tsunami etc, hindcasting and forecasting of waves, short term wave analysis, wave spectra and its utilities, long term wave analysis, statistical analysis of grouped wave data.

Unit 3: Tides **(06 hours)**
Definition and basic characteristics of tide, process of generation of tide, tide producing forces: earth moon and earth sun system, dynamic theory of tides- types of tides- tides and tidal current in shallow sea, storm surges, tides in rivers and estuaries, tidal power.

Unit 4: Coastal Processes **(06 hours)**

Coastal process: erosion/accretion due to waves, bed forms, long shore transport (Littoral drift) estimate of wave induced sediment, budget, tides, effect of tides, stability of inlets, effect of construction of coastal structures on stability of shoreline/beaches.

Unit 5: Coastal Structures and Shore Protection **(06 hours)**

Introduction to coastal structures and their types, concept of risk analysis and design waves along with the concept of break water, introduction and necessity of shore protection, methods of shore protection, groins, seal walls, offshore breakwaters, and artificial nourishment.

Unit 6: Coastal Management **(06 hours)**

Introduction to coastal zones: beach profile, surf zone, off shore zone etc, introduction to coastal waters, coastal sedimentation, estuaries, wet lands and lagoons, coastal dunes. pollution in coastal zone, disposal of waste/dredged spoils, oil spills and contaminants, coastal zone management: activities in coastal zone, CRZ, issues related to integrated coastal zone management, coastal regulation zone.

Text books

01 Coastal Hydrodynamics, J.S.Mani, PHI India Publications
02 Ocean wave Mechanics-Applications in Marine Structure, V.Sundar, Ane Books Pvt Ltd
03 Harbour and Coastal engineering Vol I & II, Ocean and Coastal Engineering Publication

Reference Books

01 Port planning, Qeen A. D. Mc Grow Hill Book Co. New York.
02 Coastal engineering, Vol-I-II, Silvester Richard, University of Western Australia.
03 Shore Protection Manual, U. S. Waterways Experiment Station Corps of Engineer.
04 Costal Engineering Research Center, Vickburg and USA1984,Coastal Protection Manual 2002.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 003 b Elective III: Advanced Design of Concrete Structures

Teaching scheme	Credits	Examination scheme
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Structural analysis and fundamentals of RC design.

Course objectives
01 To provide the students with advance design concepts of reinforced concrete structures.
02 To analyze, design and detail different types of reinforced concrete structures.

Course outcomes
On successful completion of this course, the learner will be able to,
01 Understand yield line theory and apply it to analyze and design slabs of different shapes having different edge conditions.
02 Understand the concepts of ductile detailing
03 Analyze and design of flat slab.
04 Analyze and design of retaining walls.
05 Analyze and design of liquid retaining structures.
06 Analyze and design of RC frames and shear walls.

Course Content

Unit 1: Flat Slabs **(06 hours)**
Flat slabs, types, design methods, proportioning of flat slab, design moments, direct design method, distribution of moments, design of an intermediate panel, design of end panel, detailing of flat slab.

Unit 2: Yield Line Analysis and Design of Slabs **(06 hours)**
Yield line theory, assumptions, yield line patterns, characteristics of yield lines, equilibrium and virtual work method of analysis, analysis of rectangular, triangular, circular slabs with various edge and loading conditions using the yield line theory.

Unit 3: Earth Retaining Structures **(06 hours)**
Types of retaining walls, various backfill conditions, design of cantilever type retaining walls for different backfill conditions.

Unit 4: Liquid Retaining Structures **(06 hours)**
Types of liquid retaining structures, code provisions, analysis by approximate method and by using IS code method, design of circular and rectangular water tanks resting on ground.

Unit 5: Design of Shear wall and Ductile Detailing **(06 hours)**
Functions of shear walls, types of shear wall, code provisions, design of shear wall for given lateral loads.

Unit 6: Analysis and Design of RC Frames **(06 hours)**

Seismic coefficient method, substitute frame analysis, analysis of frames subjected to a load combination of gravity and lateral loads. Design of all elements of a frame subjected to combined effect of gravity and lateral loads.

Textbooks

01 Advanced Reinforced Concrete Design, N Krishnaraju, CBS Publishers and Distributors
02 Reinforced Concrete Design, S Unnikrishna Pillai, Devdas Menon, McGraw Hill Publications
03 Reinforced Concrete design, Vol I and II, Dr .H. J. Shah, Charotar Publishing house.
04 Advance R. C. C. Design, S. S. Bhavikatti, New Age International Publishers
05 Reinforced Concrete Structures Vol. II, B.C. Punmia, Ashok K. Jain, Arun K. Jain, Laxmi Publications, New Delhi
06 Earthquake Resistant Design of Structures, Pankaj Agarwal and Manish Shrikhande, Prentice Hall India Learning Private Limited.

Reference books

01 Design of Reinforced Concrete Structures, by Ramamrutham S, Dhanpat Rai Publications
02 Advanced Reinforced Concrete Design, P. C. Varghese, Prentice Hall of India Pvt. Ltd., New Delhi
03 Fundamentals of Reinforced Concrete, N. C. Sinha, S.K. Roy, S. Chand & Co. Ltd, New Delhi

Indian Standards

01 IS 1893 (Part 1): 2016, Reaffirmed in 2021, Criteria for Earthquake Resistant Design of Structures - Part 1: General Provisions and Buildings, Bureau of Indian Standards, New Delhi.
02 IS 13920: 2016 Reaffirmed in 2021, Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces - Code of Practice (First Revision), Bureau of Indian Standards, New Delhi.
03 IS: 456-2000, Indian Standard code of practice for plain and reinforced concrete, Bureau of Indian Standards, New Delhi.
04 IS: 3370-2021, Indian Standard code of practice for concrete structures for storage of liquids, Bureau of Indian Standards, New Delhi

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 003 c Elective III: Integrated Water Resources Planning and Management

Teaching scheme	Credits	Examination scheme
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Basics of fluid mechanics, geology, geotechnical engineering, hydrology and surveying

Course objectives
01 To introduce connection of agriculture and water with IWRP & M and to make students aware about organizations like WALMI
02 To introduce the connection of IWRP & M with water
03 To impart knowledge of legal aspects

Course outcomes
On successful completion of this course, the learner will be able to,
01 Understand concerned organizations, IWRP & M objectives, principles, challenges, application & analysis of IWRP&M approaches & principles in a case study.
02 Understand PIM, WDS, WALMI, agriculture in the concept of integrated water resources, apply and analyse water requirements for food production
03 Understand assessment of surface and ground water quality, EIA, CPCB regulations, application & analysis of effluent quality standards as per CPCB
04 Understand water economics and funding, application & analysis of planning for a sustainable water future
05 Understand legal regulatory settings of IWRP & M, application & analysis of inter-basin water transfers and IWRP & M
06 Understand flood control & power generation for IWRP & M, application QIGIS for analysis of a basin for IWRP & M

Course Contents

Unit I: Introduction to IWRP & M (06 hours)
Concept, definitions, objectives, principles, challenges and needs, components, approaches of IWRP & M, water as a global issue, introduction of global water partnership (GWP), introduction of central water commission (CWC), national water policy (only introductory), discussion of one case study.

Unit 2: Agriculture & IWRP & M (06 hours)
Agriculture in the concept of integrated water resources, water requirement for food production (numerical to be covered), blue Vs green water disputes, global water security -virtual water trading, irrigation methods and efficiencies of these methods (numerical to be covered), current water pricing, ground water quality protection, sea water intrusion into fresh water aquifers due to human activities, ground water recharge (no numerical on ground water), participatory irrigation management (PIM), water distribution society's (WDS), introduction of water and land management institute (WALMI).

Unit 3: Considerations for Water Supply & Health (06 hours)

Importance of assessment of river water quality, prevention & control of surface & ground water pollution, cost effective water quality monitoring for basins, environmental impact assessment (EIA), central pollution control board (CPCB) regulations, need of training to water users for sustainability. application of polluters pays principle, need of treatment facilities for domestic sewage and industrial effluents, effluent quality standards as per CPCB and its strict implementation and monitoring, discussion of one case study.

Unit 4: Water Economics and IWRP & M (06 hours)

Water as economic good, economic value of water, water scarcity, importance of Water to the Indian economy, principles of planning and financing of water resources project: discussion on any two case studies, sustainability principles for water management, framework for planning a sustainable water future, economics and decision making.

Unit 5: Legal Regulatory Settings & IWRP&M (06 hours)

Global and national perspectives of water crisis, UN laws on non-navigable uses of international water courses, current water laws and regulation (national, state & local), water rights & priorities, CWC laws & guidelines, inter-basin water transfers and integrated water resources management, importance of arbitration in IWRM, Dublin Principles (1992), discussion of one case study.

Unit 6: Flood Control & Power Generation (06 hours)

Role of dams in flood control and power generation and its importance in IWRM, management of flood plains, flood risk mapping, flood forecasting and disaster relief, coordination between co-basins for flood management, use of QGIS for IWRM, effects of hydraulic structures on river surface profiles and sediment transport, hydro power generation, basic introduction of soft computing techniques for flood forecasting (only introductory).

Text Books

01 Integrated Water Resources Management: Water in South Asia Volume I, Peter P Mollinga, Ajaya Dixit and Kusum Athukorala, Sage Publications.

02 Ecosystem Principles and Sustainable Agriculture, Sithamparanathan, Rangasamy A. and Arunachalam, N, Scitech Publications (India) Pvt. Ltd, Chennai.

Reference Books

01 Water Resources System Planning & Management, M. C. Chaturvedi, Tata McGraw-Hill.

02 Water Resources Systems Engg, D. P. Loucks, Prentice Hall.

03 Economics of Water Recourses Planning, L. D. James & R. R. Lee, McGraw Hills, New York

04 Integrated Water Resources Management: Global Theory, Emerging Practice and Local Needs, Peter P Mollinga, SAGE Publication

05 Principles of Water Resources: History, Development, Management and Policy, Thomas V., John Wiley and Sons Inc., New York. 2003.

06 Watershed Management in India, Murthy, J. V. S., Wiley Eastern Ltd., New York, 1995.

07 Soil Conservation and Land Management, Dalte, S.J . C., International Book Distribution,

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 003 d: Elective III: Finite Element Method

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Basics of matrix and matrix operations

Course objectives
01 To learn basic principles of finite element analysis procedure.
02 To learn the theory and characteristics of finite elements that is used in the analysis of engineering structures.
03 To develop the knowledge and skills needed to analyze structural problems by using finite element method.

Course outcomes
On successful completion of this course, the learner will be able to,
01 To understand the basics of solid mechanics prior to learn finite element analysis.
02 Solve simple Engineering problems using 1D, 2D and 3D elements
03 Write shape functions of 1D, 2D and 3D elements
04 Determine the stresses in three dimensional finite elements using isoparametric formulation.
05 Analyze the truss and beam elements using stiffness matrix and finite element procedure.
06 Evaluate the forces and stresses in rigid jointed portal frame and grid elements using stiffness matrix and finite element procedure.

Course Content

Unit 1 **(06 hours)**
Theory of elasticity: strain-displacement relations, compatibility conditions in terms of strain, plane stress, plane strain and axisymmetric problems, differential equations of equilibrium, compatibility condition in terms of stresses, stress-strain relations in 2D and 3D problems and Airy's stress function.

Unit 2 **(06 hours)**
General steps of the finite element method, applications and advantages of FEM, concept of finite element for continuum problems, discretisation of continuum, use of polynomial displacement function, Pascal's triangle, convergence criteria, Stability and possible sources of errors, principle of minimum potential energy, formulation of stiffness matrix for truss element using variational principles.

Unit 3 **(06 hours)**
Displacement function for 2D triangular (CST and LST) and rectangular elements, use of shape functions, area co-ordinates for CST element, shape functions in Cartesian and natural coordinate systems, derivation of expressions for element stiffness matrix and element nodal load vector using

principle of stationary potential energy, shape functions for one dimensional element such as truss and beam, shape functions of 2D Lagrange and serendipity elements.

Unit 4 **(06 hours)**

Introduction to 3D elements such as tetrahedron and hexahedron, theory of isoparametric elements: isoparametric, sub parametric and super-parametric elements, characteristics of isoparametric quadrilateral elements, iso-parametric elements in 1D, 2D and 3D analysis, Jacobian matrix, formulation of stiffness matrix for 1D and 2D Isoparametric elements in plane elasticity problem.

Unit 5 **(06 hours)**

Formulation of stiffness matrix, analysis of spring/bar assemblage, member approach for truss and beam element, node numbering, assembly of element equations, formation of overall banded matrix equation, boundary conditions and solution for primary unknowns, element matrices, assembling of global stiffness matrix, solution for displacements, reactions, stresses, applications to truss and beam not involving unknowns more than three.

Unit 6 **(06 hours)**

Formulation of stiffness matrix using member approach for portal frame and grid elements, transformation matrix, element matrices, assembling of global stiffness matrix, solution for displacements, reactions, stresses, applications to frame and grid not involving unknowns more than three, introduction to computer program algorithm and flowchart.

Textbooks

01 Introduction to Finite Elements in Engineering, T. R. Chandrupatla and A. D. Belegundu, Prentice Hall Publication

02 A First Course in the Finite Element Method, D. L. Logan, Cengage Publications.

Reference books

01 Introduction to the Finite Element Method, Desai and Abel, CBS Publishers & Distributors, Delhi

02 Matrix, Finite Element, Computer and Structural Analysis, M. Mukhopadhyay, Oxford IBH Publishing Co. Pvt. Ltd.

03 Finite Element Analysis - Theory & Programming, C. S. Krishnmoorthy, TATA McGraw Hill Publishing Co. Ltd.

04 An Introduction to the Finite Element Method, J. N. Reddy, TATA Mc Graw Hill Publishing Co. Ltd.

05 Theory & Problems -Finite Element Analysis, G. R. Buchanan, Schaum's Outline series. TATA Mc Graw Hill Publishing Co. Ltd.

06 Finite Element Analysis, S. S. Bhavikatti, New Age International (P) Ltd.

07 The Finite Element Method, O. C. Zien kiewicz, TATA Mc Graw Hill Publishing Co. Ltd.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401003 e Elective: Data Analytics

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites

Engineering and discrete mathematics, basics of civil engineering

Course objectives

01 Impart knowledge and develop the ability of students to analyze the data for a given problem and represent in the mathematical and statistical form
02 Impart knowledge and develop the ability of students to systematically solve the problems using knowledge of probability, distributions, sampling and formulating hypothesis
03 Impart knowledge and develop the ability of students to carry out test of hypothesis, and apply the concept of correlation and regression.
04 Impart knowledge and develop the ability of students to understand concept of machine learning and apply Regression, classification and clustering techniques

Course outcomes

On successful completion of this course, the learner will be able to,

01 Understand the basic concepts of Statistics and its analysis and applications
02 Solve the problems related to probability and various probability distributions.
03 Apply the concept of sampling and distribution and interpret problems using correlation
04 Analyze and test of hypothesis
05 Examine and prepare the data and use develop regression
06 Understand and Apply machine learning algorithms for Regression, Classification and Clustering

Course Content

Unit 1: Data Analysis (06 hours)

Types of data, levels of data, types of variables, data science, data analytics, classification of data analytics, importance of data analytics, central tendency: mean mode, percentile, and dispersion: skewness, kurtosis, range, variance, and coefficient of variation, histogram, scattergram; uncertainty & outliers.

Unit 2: Probability Distribution (06 hours)

Introduction to probability and probability distribution, continuous probability distribution: probability density function; normal (Gaussian's) probability distribution; properties of normal curve; lognormal distributions; exponential distribution. Discrete probability distribution: binomial probability, Poisson probability; gamma distribution; case studies: use of dataset/ problems in the field of civil engineering

Unit 3: Sampling distribution and Correlation (06 hours)

Sample, Types of samples, sample mean, Concept of Sampling Distributions; Impact of Sample Size on Sampling Distribution; Sampling Distribution of the Mean and the Central Limit, sample

proportion, sample size determination, Correlation, coefficient of determination, correlation analysis, coefficient of correlation, Rank of correlation.

Unit 4: Hypothesis Testing **(06 hours)**

An estimator or point estimator, confidence interval; estimation of population mean, proportion, cd variance; student's t distribution; chi-square distribution. Confidence interval and hypothesis testing; null and alternative hypotheses; test statistics and rejection regions; critical values; one- or two-tailed test; introduction to type i and type ii errors, P value, F, chi- square, Z and T- test.

Unit 5: Prediction **(06 hours)**

Data analytics life cycle, data cleaning, data transformation, comparing reporting and analysis, analytical approaches: prediction, regression, general multiple regression model, computation of coefficients of the first order multiple regression model using least square method, non-linear regression, residual analysis.

Unit 6: Introduction to Machine learning **(06 hours)**

Introduction to machine learning introduction to machine learning and concepts, types of machine learning: supervised, unsupervised, reinforced learning, over fitting and train/test splits, regression: logistics regression, classification: decision trees, clustering: K means, support vector machines.

Text books

01 Statistical Methods, 43rd Edition, Gupta S. P, S. Chand Publication.
02 Higher Engineering Mathematics, 42nd edition, Grewal B. S, Khanna Publishers.
03 Probability and Statistics for Engineers: 9th edition, Johnson Richard A., Miller I., Freund J.E ,PHI publications.
04 Machine Learning: Jeeva Jose, Khanna Publishing House, Delhi.

Reference books

01. Probability and Statistics for Science and Engineering, Rao G. S, Universities press publication.
02. Applied statistics and probability for engineers, Montgomery, Douglas C. and George C. Runger, John Wiley & Sons.
03. Basic Engineering Data Collection and Analysis, Stephen B. Vardeman and J. Marcus Jobe, Duxbury Thomson Learning.
04. Machine Learning, Chopra Rajiv, Khanna Publishing House.
05. The elements of statistical learning, Hastie, Trevor et al., New York: Springer.
06. Machine Learning: An Artificial Intelligence Approach, Ryszard, S., Michalski, J. G. Carbonell and Tom M. Mitchell, Volume 1, Elsevier.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401003 f Elective III: Operation Research

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Engineering maths and project management

Course objectives
01 Engineers with the ability to analyse the data for a given problem and formulate mathematical model
02 Engineers with ability to optimize linear & non-linear programming problems
03 Engineers with the ability to apply the knowledge for optimisation for Civil Engineering Projects

Course outcomes
On successful completion of this course, the learner will be able to,
01 Ccorrelate applications of Operations Research in Civil Engineering field
02 Solve the problems related to stochastic programming
03 Optimize transportation and assignment problems
04 Optimize linear problems
05 Optimize non-linear problems
06 Suggest solution for the problems related to dynamic models, games theory and replacement of items

Course Content

Unit 1: Introduction of Operations Research **(06 hours)**
Introduction to operations research and optimization techniques, applications of operations research in civil engineering, introduction to linear and non-linear programming methods, formulation of linear optimization models for civil engineering applications (objective function, constraints), graphical solutions to L P problems, local & global optima, unimodal function, convex and concave function.

Unit 2: Stochastic Programming **(06 hours)**
Sequencing: n jobs through 2, 3 and M machines, queuing theory: elements of queuing system and its operating characteristics, waiting time and ideal time costs, Kendall‘s notation, classification of Queuing models, single channel Queuing theory: Model I (Single channel Poisson Arrival with exponential services times, Infinite population (M/M/1): (FCFS/ /), simulation: Monte Carlo simulation.

Unit 3: Linear programming **(06 hours)**
The transportation model and its variants, assignment model and its variants

Unit 4: Linear programming **(06 hours)**
The simplex method, method of big M, two phase method, duality

Unit 5: Nonlinear programming **(06 hours)**

Single variable unconstrained optimization: sequential search techniques-dichotomous, Fibonacci, golden section, multivariable optimization without constraints: the gradient vector and hessian matrix, gradient techniques, steepest ascent/decent technique, Newton's Method, Multivariable optimization with equality constraints: Lagrange multiplier technique

Unit 6: Dynamic programming, Games Theory and Replacement Model (06 hours)

Dynamic programming: multi stage decision processes, principle of optimality, recursive equation, applications, Games theory: 2 persons games theory, various definitions, application of games theory, replacement of items whose maintenance and repair cost increase with time ignoring time value of money

Text Books

01 Operations Research, Premkumar Gupta and D. S. Hira, S. Chand Publications.
02 Engineering Optimization: Methods and Application, A. Ravindran and K. M. Ragsdell, Wiley India.
03 Engineering Optimization, S. S. Rao, New Age International (P) Ltd.
04 Quantitative Techniques in Management, N.D. Vohra, Mc Graw Hill
05 Operations Research, Pannerselvam - PHI publications.

Reference Books

01 Topics in Management Science, Robert E. Markland, Wiley Publication
02 A System Approach to Civil Engineering Planning & Design, Thomas K. Jewell - Harper Row Publishers
03 Operations Research, Hamdy A. Taha, Pearson Publication
04 Introduction to game theory, Stef Tijs, Hindustan Book Agency, New Delhi
05 Dynamic programming and optimal control, P. Bertsekas, Athena Scientific, Belmont.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 004 a Elective IV: Air Pollution and Control

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Basic concepts of sciences, mathematics

Course objectives
01 Impart the knowledge and understanding of outdoor and indoor air pollution, its impact and existing legislation and regulation.
02 Make aware about the meteorology, measurement techniques, emission inventory and modeling aspects.
03 Provide the scientific and technical background of state of the art air pollution control technologies.

Course outcomes
On successful completion of this course, the learner will be able to,
01 Recall air pollution, legislation and regulations.
02 Evaluate air pollutant concentrations as a function of meteorology.
03 Interpret sampling results with prescribed standards.
04 Assess emission inventory and air quality models.
05 Compare the air pollution control equipments.
06 Infer indoor air pollution and its mitigation.

Course Content

Unit 1: Air Pollution, Legislations and Regulations (06 hours)
Air Pollution: Layers of atmosphere, Atmospheric temperature and altitude, Composition of air, Definition of air pollution, Air pollution episodes and accidents (Donora Pennsylvania 1948, Great London Smog 1952, Bhopal Gas Tragedy 1984), Classification of air pollutants (Based on sources, origin and state of matter), Criteria and hazardous air pollutants, Greenhouse gases, Sources of air pollution, Scales (micro, meso, macro), Processes and fates (Advection, convention, Diffusion, dispersion), Impact on human health and its valuation, Ozone depletion, Acid rain, Global warming, Climate change, Estimation of Carbon footprints (Numerical Included). Legislations and regulations: A case study (Air Act 1981, The Air Rules 1982, Central Motor Vehicles Act 1988, Environmental Protection Act 1986, National Environment Tribunal Act 1995, National Green Tribunal Act 2010, Draft Notice for e-Vehicles in National Capital Region 2022), Major Government Initiatives for managing ambient air quality (NAMP-National Air Quality Program, AQI-Air Quality Index (Significance, calculation method adopted by CPCB), NCAP-National Clean Air Program).

Unit 2: Meteorological Aspects (06 hours)
Meteorology, Meteorological parameters and measuring instruments, Wind rose diagram, Environmental lapse rate (ELR) and adiabatic lapse rate (ALR), Inversion and its types, Atmospheric stability, Pasquill-Gifford classification, Plume behaviour, Horizontal and vertical dispersion coefficients, mixing height, Determination of mixing height using radio-soundings and remote sounding system, Stack height determination (Numerical included), CPCB recommendations, Plume rise estimation using Brigg's formula (Numerical included), Gaussian dispersion equation for point source; assumptions, advantages and limitations (Numerical included).

Unit 3: Ambient Air Sampling, Analysis and Standards (06 hours)

Ambient Air sampling and Analysis: Air pollution survey, basis and statistical considerations of sampling sites, Conversion of $\mu g/m^3$ to ppm, devices and methods used for sampling of particulates and gaseous air pollutants. Use of aerosol spectrometer and sensors, Stack emission monitoring for particulate and gaseous air pollutants, isokinetic sampling, Air Quality and Emission Standards: Components of air quality standards (Indicator, averaging time, form, level), National Ambient Air Quality Standards (NAAQS) 2009 and Emission standards in India, WHO air quality guidelines 2021, Interpretation of sampling results with case study.

Unit 4: Emission Inventory and Air Quality Modeling (06 hours)

Emission inventory: Definition, Role in air quality management, Utilization, Development approach (Bottom-up, Top-down), Basic equation of emission estimation, Types (Annual average, seasonal, forecasted and gridded), Emission inventory framework developed by CPCB, Air Quality Modeling: Introduction, Basic components, Importance, classification (Based on time period, pollutant type, coordinate system, level of sophistication), Types of air quality models (Physical, statistical, deterministic), AERMOD model USEPA (Assumptions, strengths and limitations).

Unit 5: Control of Air Pollution (06 hours)

Natural self-cleansing properties (Dispersion, gravitational settling, absorption, rainout, adsorption), Objectives, Control by process modification, change of raw materials, fuels, process equipment and process operation, Control of particulates from stationary sources: Removal Mechanism, collection efficiency, control equipment as Settling chamber, inertial separators, cyclone, fabric filter and electro Static precipitator. Scrubbers, Factors affecting selection of device (Numerical included). Control of gaseous pollutants from stationary sources: Absorption, adsorption, incineration/ combustion, carbon sequestration for CO_2, Control of emissions from mobile sources: Emission sources, Control of emissions from each source.

Unit 6: Indoor Air Pollution (06 hours)

Causes, sources, health impacts, factors affecting indoor air quality, sick building syndrome, General aspects of exposure assessment, Sampling design, Active and Passive samplers, monitoring of ventilation rates, Mitigating technologies: Source control, Improved ventilation, air cleaning, Types of air cleaners, Air cleaning technologies, Practical considerations using portable and in-duct air cleaners, Use of plants for control, Radon removal technique, Sources and remedial measures for odour control.

Text books

01 Air Pollution: Its origin and control, 3rd Edition, Kenneth Wark, Cecil F. Warner, Wayne T. Davis, Addison-Wesley Longman. 1998.

02 Air Pollution: Health and Environmental Impacts, Gurjar, B.R., Molina, L., Ojha, C.S.P. (Eds.), CRC Press, 2010

Reference books

01 Air Pollution, M. N. Rao, H. V. N. Rao, McGraw Hill, 2004.

02 Air Pollution and Control, K.V.S.G. Murali Krishna, University Science Press, 2015.

03 Fundamentals of Air Pollution, Boubel, R.W., Fox, D.L., Turner, D.B., Stern, A.C., Academic Press, 2005.

04 Methods of Air Sampling and Analysis, Lodge, J.P. (Ed.), CRC Press, 1988.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 004 b Elective IV: Advanced Design of Steel Structures

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks
		End semester exam: 70 Marks

Prerequisites:
Basic concept of Structural Analysis, Mechanics of Materials and fundamentals of design of steel structures

Course Objectives:
1. To study design of member subjected to combined forces with its connections
2. To study the design of section other than hot rolled steel section
3. To study the design of components of industrial structures

Course Outcomes:
At the end of the course, the learners will be able to
1. Understand the behavior and design of members subjected to combined forces
2. Design moment resisting connection
3. Design component / structure using cold form light gauge section
4. Design members of truss and scaffolding using tubular section
5. Design castellated beam
6. Analyze and design components of industrial structure such as Portal frame and gable frame

Course contents

Unit 1: Design of members subjected to combined forces (06 hours)
Introduction, combined shear with bending, design of section subjected to high shear, combined axial force and bending moment, section strength and member strength, design of beam column

Unit 2: Design of moment resisting connection (06 hours)
Type of connections, Moment Resisting Connections, Beam to Beam and beam to column connection, design of web and flange splice using bolt and weld

Unit 3: Cold form light gauge section (06 hours)
Introduction, advantage, type of cross section, stiffened multiple stiffened and un-stiffened element, flat-width ratio, and effective design width, design of compression, tension and flexural members using cold form light gauge section

Unit 4: Tubular Structures (06 hours)
Introduction, design of tubular trusses and scaffoldings using circular and rectangular hollow sections as per code, detailing of joints and design of Connections

Unit 5: Design of Castellated beam (06 hours)

Concepts, fabrication of the castellated beam from rolled steel section, advantage, mode of failure, design of castellated beam for bending and shear as per codal provisions by limit state method

Unit 6: Portal and gable frame **(06 hours)**

Introduction, plastic analysis of portal and gable frame, design of portal and gable frame as per limit state method by limit state method

Text books

01 Limit state design of steel structures, S K Duggal, Tata McGraw Hill Education, New Delhi.
02 Design of steel Structures, Volume II, Ram Chandra, Standard Book House, New Delhi.

Reference Books

01 Design of Steel Structure, N Subramanian, Oxford University Press, New Delhi.
02 Limit state design in Structural Steel, M. R. Shiyekar, PHI, Delhi.
03 Fundamentals of structural steel design, M L Gambhir, Tata McGraw Hill Education Private Limited, New Delhi.
04 Limit state design of Steel Structure by V L Shah and Gore, Structures Publication, Pune
05 Punmia and Jain, Comprehensive Design of steel structure, Laxmi Publication, New Delhi

IS Codes

01 IS: 800-2007, Code of practice for General Construction in steel, Bureau of Indian Standard, New Delhi.
02 IS: 806- Code of practice for use of steel tubes in general building construction, Bureau of Indian Standard, New Delhi.
03 IS: 811, Specification for cold formed light gauge structural steel sections, Bureau of Indian Standard, New Delhi.
04 IS: 875 ((Part I to V) Code of practice for design loads for buildings and structures, Bureau of Indian Standard, New Delhi.
05 IS: 801 - 1975, Code of Practice for use of cold formed light gauge steel structural members' in general building construction, Bureau of Indian Standard, New Delhi.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 004 c Elective IV: Statistical Analysis and Computational Methods

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Engineering mathematics, ccollection, classification & representation of data, permutations and Combinations

Course objectives
01 Engineers with the ability to analyze the data for a given problem and represent in the mathematical and statistical form
02 Engineers with ability to systematically solve the problems using knowledge of probability, distributions, sampling and formulating hypothesis
03 Engineers with the ability to carry out test of hypothesis, and apply the concept of correlation and regression, goodness of fit and distributions

Course outcomes
On successful completion of this course, the learner will be able to,
01 Understand the basic concepts of Statistics and perform statistical data analysis
02 Understand the concept of probability and fit Binomial, or Poisson or Normal distribution to the given data
03 Understand concept of sampling and perform chi-square test, z test, Student T test
04 Perform hypothesis test
05 Carry out correlation and regression analysis for the given data
06 Calculate variance and perform K-S test for goodness of fit

Course Content

Unit 1: **Introduction to Statistics** **(06 hours)**
Statistical methods: introduction, collection, classification and representation of data, various databases related to civil engineering applications (like hydrological, structural audit, etc) measures of central value (mean, median, mode), measures of dispersion, skewness, moment, Kurtosis.

Unit 2: **Probability and Distributions** **(06 hours)**
Probability and probability distributions including binomial, Poisson, normal: examples based on each distribution preferably based on various civil engineering problems.

Unit 3: **Data Sampling** **(06 hours)**
Population, sampling: meaning, 4 types of sampling, importance of population sampling, sample size determination, Chi-square test, Z test, student T test, examples to be framed and solved based on various databases related to civil engineering applications (like hydrological, structural audit, etc)

Unit 4: **Test of Hypothesis** **(06 hours)**
Test of hypothesis: three parts of hypothesis, steps in hypothesis testing: assumptions, test statistics, rejection region, calculations and conclusions, characteristics and qualities of a good hypothesis, students may use hypothesis (if any) from their PBL topic from SE civil curriculum, or any other suitable hypothesis example pertaining to civil engineering applications.

Unit 5: **Correlation and Regression** **(06 hours)**

Correlation analysis, regression analysis, coefficient of correlation, probable error, single and multiple regression, sample examples to be developed through data collected in unit iii and carry out correlation regression analysis for the same.

Unit 6: **Variance and Fitness Test** **(06 hours)**

K-S test for goodness of fit and distribution, analysis of variance on way and two-way classification, examine data using suitable data and frame examples to carry out analysis of variance and use classification rules for the same.

Text Books

01 Statistical Methods , S. P. Gupta, Sultan and Chand Sons

02 Higher Engineering Mathematics, B. S. Grewal, Publisher: Khanna Publishing House.

Reference Books

01 Probability and Statistics for Engineers, Richard A Johnson

02 An Introduction to Statistical Methods and Data Analysis Student Solutions Manual, R. Lymann Ott and Michael Longnecker, Jackie Miller

03 Statistical Methods, Rudolf Freund William Wilson, Academic Press USA

04 Probability and Statistics for Science and Engineering, G Shankar Rao

05 Fundamentals of Statistics, S C Gupta, Himalaya Publishing House

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 004 d Elective IV: Airport and Bridge Engineering

Teaching scheme	Credits	Examination scheme
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Basic of computer, understanding of drawings and specifications

Course Objectives
01 Introduce the aspect of airport and bridge system.
02 Study plans, specifications for planning and design.
03 Involve in the planning and design of new runways and terminal buildings
04 Select and design the bridge that will meet the needs of the area

Course outcomes
On successful completion of this course, the learner will be able to,
01 Understand the fundamental of airport.
02 Understand and design the runway and taxiway and drainage systems.
03 Understand the BIM, AR and VR in airport planning and pavement design.
04 Plan the lighting and marking of airport and heliport.
05 Estimate various components of bridge and loads on bridges.
06 Study and design of bridge structures.

Course Content

Unit 1: Introduction and Classification of Airport (06 hours)
General, transportation systems, typical air trip, the air age, world civil air transport, geographic distribution of world air transport, air ports characteristics of good layout, runway configuration, airport obstruction, location of terminal buildings, aprons and hangers. zoning requirements regarding permissible heights of constructions and landing within the airport boundary, airport landslide planning, navigation and landing aids – ILS, air traffic control (ATC). Airport classification: community size and airport types, airport classification according to types of services, functional classification of airports, airport classification for the purpose of stipulating geometric standards, ICAO, FAA

Unit 2: Aircraft Characterizes and Geometric design (06 hours)
Introduction to Aircraft Characterizes: related to airport design characterizes of principle transport aircrafts, trends size, speed and productivity of transport aircraft, turning radii. airport planning, size and type of airport, selection of site for the airport. Geometric design: element of an airport, runway and taxi way width, runway profile and runway length, runway orientation, corrections and calculation, introduction to analytical methods for air travel demand for planning and casting, case study- airport master plan.

Unit 3: Airport Visualizing, Airport Capacity and Airport Pavements (06 hours)
Airports visualizing: introduction to visualizing airports in a virtual environment, building information modelling (BIM) for air ports, introduction to augmented reality (AR) and virtual reality (VR) in airport planning and design, Airport capacity: ultimate and practical runway capacity, runway

arrangement factors effecting runway capacity, practical annual capacity and practical hourly capacity, Airport pavements: comparison- highway and airfield pavement, design of rigid airport pavements, design of rigid pavement and design of flexible pavement, junction of flexible and rigid pavements, airport drainage.

Unit 4: Airport Marking and Lighting- Heliports (06 hours)

Airport Marking and lighting: the need for marking and lighting, runway lighting, runway marking , runway designation marking , runway center marking , threshold marking, fixed distance marking , touchdown zone marking , runway side strips marking, Heliports: helicopter characteristics, planning of heliports - site selection, size of landing area, orientation of landing area, heliport marking and lighting, vertical takeoff and landing (VTOL), short takeoff and landing (STOL).

Unit 5: Introduction to Bridges (06 hours)

Classification, selection of bridge site and preliminary and detailed survey work, computation of discharge, linear waterway, economic span, afflux, scour depth, effective width, introduction to design loads for bridges, IRC loading standards, load distribution theory, bridge slabs, substructure: abutment, piers, and wing walls with their types based on requirement and suitability.

Unit 6: Types of Bridges (06 hours)

Culvert: definition, location, waterway of culvert and types, design of pipe culverts, design of box culvert (Single vent only). Temporary bridges: definition, materials used, brief general ideas about timber, floating- pontoon bridges. (Introduction only), Movable bridges: bascule, cut boat, flying, swing, lift, transporter and transverse bridges, their requirement and suitability. (Introduction only), Fixed span bridges: simple, continuous, cantilever, arch, suspension, bowstring girder type and rigid frame and cable stayed bridges, materials for super structure. Bearing: definition, purpose and importance, types of bearings with their suitability (Introduction only).

Text books

01 Airport Engineering, by Saxena S.C., CBS Publishers & Distributors
02 Airport planning and design – S.K. Khanna , M.G. Arora , S.S. Jain, Nem Chand and Brothers, Roorkee
03 Bridge Engineering by Rangwala, Charotar Publication
04 Aiport Engineering by Rangwala, Charotar Publication

Reference books

01 Ashford, N., and P. H. Wright. 1992. Airport Engineering, 3rd ed. New York: John Wiley & Sons
02 Essentials of Bridge Engineering – D. Johnson and Victor, Oxford and IBH publishing Co. Pvt. Ltd. , New Delhi.

Handbooks and Manuals

01 Airport Planning Manual, Part 2 Land Use and Environmental Control, Doc 9184 AN/902
02 Airport Planning and Development Handbook, Paul Stephen Dempsey, Paul Dempsey, McGraw Hill Professional, 2000
03 https:///panchayatrajengineers.wordpress.com/2019/01/27/irc-codes-for-roads-and-bridges-direct-download-links-from-panchayatraj-engineers-blog
04 Indian Road Congress (IRC) – Standard Specifications and code of practice for bridges.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401004 e Elective IV: Design of Prestressed Concrete Structures

Teaching scheme	Credits	Examination scheme
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Structural Mechanics, Structural Design: Concrete or equivalent course

Course objectives
01 To introduce the students to the basic concepts and principles of prestressed concrete structures.
02 Develop an insight into the behavior of prestressed concrete structural members both at service loads and overloads.
03 To explain fundamentals of prestressed concrete design.
04 To understand the applications of precast prestressed components in civil infrastructure.

Course outcomes
On successful completion of this course, the learner will be able to,
01 Know the prestressed members.
02 Determining the stresses and various losses in prestressed concrete members.
03 Design the prestressed concrete structures
04 Design the prestressed concrete slab
05 Design the prestressed concrete flat slab
06 Analysis and design the prestressed continuous beams

Course Content

Unit 1: Prestressing Systems, Material Properties and Composite Sections (06 hours)
Basic concept, early attempts of prestressing, brief history, development of building materials, definitions, advantages of prestressing, limitations of prestressing, types of prestressing, prestressing systems and devices, introduction of composite sections of prestressed concrete beam and cast in-situ RC slab.

Unit 2: Analysis of Prestressed Members and Losses in Prestress (06 hours)
Analysis of prestressed concrete member, stress calculations and concept of cable profile and losses in prestressed concrete

Unit 3: Design of Determinate Beam (06 hours)
Design of post tensioned prestressed concrete simply supported rectangular and flanged sections for flexure and shear including end block.

Unit 4: Design of Slab (06 hours)
Design of one way and two way post tensioned slabs.

Unit 5: Design of Flat Slab (06 hours)
Introduction to flat slab, design of prestressed two way flat slab by direct design method

Unit 6: Statically Indeterminate PSC Beams **(06 hours)**

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

Text books

01 Advanced Design of Structures, Krishnaraju, Mc Graw Hill.
02 Prestressed Concrete, N. Krishna Raju, Tata Mc Graw Hill Publication Co.
03 Earthquake Resistant Design of Structures, Agarwal and Shrikhande, PHI learning.

Reference books

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

Indian Standards

01 IS: 1343: Indian Standard Code of Practice for Prestressed Concrete, Bureau of Indian Standard, New Delhi.
02 IS: 456: Indian Standard Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standard, New Delhi.
03 IS: 1893: Indian Standard Code of Practice for Criteria for Earthquake Resistant Design ff Structures, Bureau of Indian Standard, New Delhi.
04 IS 13920: 2016 Reaffirmed in 2021, Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces - Code of Practice (First Revision), Bureau of Indian Standards, New Delhi.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401004 f Elective IV: Formwork and Plumbing Engineering

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites

Structural analysis, concrete technology, building technology

Course objectives

01 Exposure to formwork procedures in construction practice
02 Study different types of formwork, analysis and design of formwork
03 Exposure of type and components of plumbing.
04 Study different provision for the design of plumbing system.

Course outcomes

On successful completion of this course, the learner will be able to,
01 Select appropriate material and type of formwork
02 Analyze the formwork for various loadings.
03 Illustrate the design aspects of formwork under various requirements.
04 Understand requirement of plumbing in a building.
05 Understand plumbing hydraulics and its components in plumbing system.
06 Illustrate the design aspects as per the requirement of Indian Standards.

Course contents

Unit 1: Formwork Introduction **(06 hours)**

Introduction to formwork as a temporary structure, formwork requirements, selection, classification (types) of formwork; Conventional formwork material like timber, plywood, steel; Advanced formwork material like aluminium, plastic, fibre reinforced polymer (FRP) composite materials; Accessories; Economy in formwork; Planning for formwork.

Unit 2: Formwork Analysis **(06 hours)**

Typical illustrative forms for walls, beams, column and slab with detailing, loads on formwork: dead loads, live loads, lateral pressure due to fresh concrete as per IS 14687: concrete density, height of discharge, temperature, rate of placing, consistency of concrete, vibration, hydrostatic pressure and pressure distribution, examples, design considerations, allowable stresses, deflection limits, common deficiencies in design.

Unit 3: Formwork Design **(06 hours)**

Formwork design concepts for slab, beams, columns and footing, design of formwork for slabs and wall, illustration of formwork system for beams and, columns

Unit 4: Introduction to Plumbing in Buildings **(06 hours)**

Water borne disease, importance of premise plumbing, history of plumbing, codes on plumbing, organizations and institutes in plumbing across India and the world, need for sustainable practices in

plumbing, role of plumbing designer, role of plumber, plumbing system installations, future challenges in plumbing.

Unit 5: Plumbing Hydraulics and components of the plumbing system (06 hours)

Frictional losses in pipes, minor losses in pipes, common plumbing fixtures, water efficient fixtures, pipe materials and roughness coefficients, types of fittings, types of valves, types of traps, equivalent lengths for fittings and valves as per standards, water demand in different types of buildings as per standards, components of water supply systems in buildings, types of water supply systems in buildings, types of drainage systems in buildings.

Unit 6: Plumbing system design (06 hours)

Code provisions on pressure and velocity in plumbing systems, simultaneous demand, different methods of pipe sizing in building (fixture unit, water demand calculator, fixture value method, etc.), fixture unit method of pipe sizing in building, water supply fixture units and drainage fixture units for different plumbing fixtures, sizing pipes of 3- storey building using segmented loss method, the layout of plumbing fixtures in a toilet, plumbing plans of buildings.

Text Books

01 Modern Practices in Formwork for Civil Engineering Construction Works, Dr. Janardan Jha & Prof. S. K. Sinha, University Science Press (An Imprint of Laxmi Publications Pvt. Ltd.

02 Formwork for Concrete Structures, Robert L. Peurifoy and Garold D. Oberlender, McGrawhill Publication.

03 Plumbing: Design and Practice, Deolalikar S. G., Tata Mcgraw-Hill Publication.

04 Water Supply and Sanitary Installation (Within Building), Design, Construction and Maintenance Panchdhari A. C., New Age International publishers.

Reference Books

01 Formwork by Michael P. Hurst, Addison-Wesley Longman Ltd; First Edition (June 1, 1983).

02 Formwork for Concrete, Hurd, M.K., Special Publication No.4, American Concrete Institute, Detroit; Fifth edition

03 Design and Construction of Formwork for Concrete Structures by A.E. Wynn, George Philip Manning, Cement & Concrete Association.

04 Austin C.K., Formwork for Concrete, Cleaver-Hume Press Ltd., London, 1996.

Indian Standards

01 IS 6461: Part V: 1972, Reaffirmed 2002; Glossary of terms relating to cement concrete: Formwork for concrete, Bureau of Indian Standard, New Delhi.

02 IS 14687: 1999, Falsework for Concrete Structures – guidelines, Bureau of Indian Standard, New Delhi.

03 IS 12183-1-1987, Code of practice for plumbing in multi-storeyed buildings (Part 1 water supply), Bureau of Indian Standards, New Delhi, India.

04 Uniform Illustrated Plumbing Code - India 2018, International Association of Plumbing and Mechanical Officials India.

05 International Plumbing Code - 2018, Appendix E, International Code Council, USA.

06 National Building Code of India - 2016, Vol. 2, Part 9, Bureau of Indian Standards, New Delhi, India.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 005: Project Stage I

Teaching scheme	**Credits**	**Examination scheme**
Practical: 04 Hours/week	01	Term Work: 50 Marks
	02	Oral: 50 Marks

Pre-requisites
Fundamentals of Civil Engineering

Course objectives
01 Identify latest technical/practical problems in the field of Civil Engineering.
02 Inculcate the ability to describe, interpret and analyze technical content.
03 Develop competence in preparing report which will enhance critical thinking and develop the skill of technical writing along with presentation.

Course outcomes
On successful completion of this course, the learner will be able to:
01 Appraise the current Civil Engineering research/techniques/developments/interdisciplinary areas.
02 Review and organize literature survey utilizing technical resources, journals etc.
03 Evaluate and draw conclusions related to technical content studied.
04 Demonstrate the ability to perform critical writing by preparing a technical report.
05 Develop technical writing and presentation skills.

Term Work

The Project Stage I report should contain the following. Internal guides may prepare a continuous evaluation sheet of each individual and refer as continuous assessment for term work marks. Project group must comprise of minimum two and maximum five students.

01 Introduction of the topic, its relevance to civil engineering, need for the study, aims and objective, limitations.
02 Literature review from reference books, journals, conference proceedings, published reports/articles/documents with conclusion. The literature review should be from published literature in the last five years.
03 Problem statement and methodology
03 Theoretical contents related to the chosen topic or case studies if applicable.
04 Concluding remarks or summary.
05 References

Oral Examination: The students must prepare presentation on Project Stage I and present in presence of pair of examiners through a viva-voce examination.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401006: Transportation Engineering Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Oral: 50 Marks

Term Work

Term work consists of the following. Oral examination based on term work.

A. Practical

I. Tests on Aggregate (Any Five)

1 Aggregate Impact Value Test
2 Aggregate Crushing Strength Test
3 Los Angeles Abrasion Test
4 Shape Test (Flakiness Index and Elongation Index)
5 Specific Gravity and Water Absorption Test by basket method
6 Stripping Value Test
7 Soundness Test

II. Tests on Bitumen (Any Five)

1 Penetration Test
2 Ductility Test
3 Softening Point Test
4 Flash Point & Fire Point Test
5 Bitumen Extraction Test (compulsory)
6 Viscosity Test (Tar Viscometer)
7 Specific Gravity Test

III. Tests on Aggregate Bitumen Combined: (Compulsory)

1 Marshall Stability Test

B. Technical visits

1. Road Construction and/or RAP Site
2. Hot mix Plant with detailed report

C. Mandatory Assignments

1. Construction process of GSB, WBM, WMM; Cemented base, Introduction to bituminous works such as prime coat, tack coat, seal coat

2. Built-up Spray Grout (BSG), Asphaltic Concrete (AC) or Bituminous Concrete (BC), Bituminous Macadam (BM), Dense Bituminous Macadam (DBM) and premix carpet, Dry lean Concrete (DLC), Pavement Quality Concrete (PQC)

3. Mastic Asphalt, Cold Mix Asphalt Technology, Warm Mix Asphalt Technology, Recycled/Reclaimed Asphalt Pavement (RAP) (Manual Series - 2), Concept of Super pave Mix Design (Super pave Series 2), Non-Destructive Evaluation of Pavements (Falling Weight Deflect meter FWD)

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401007 a Elective III: Coastal Engineering Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Oral: 50 Marks

Term Work

Term work will consist of the following. Oral examination based on the term work.

01 Assignment on Linear (Airy) wave theory
02 Assignment on calculation of wave refraction, diffraction, wave breaking and shoaling
03 Assignment on hindcasting of waves / short term wave analysis
04 Assignment on long term wave analysis/ statistical analysis of wave data.
05 Assignment on dynamic theory of tides.
06 Assignment on Coastal process of erosion/accretion due to waves / bed forms.
07 Assignment on long shore transport (Littoral drift) / estimation of wave induced sediment, budget.
08 Assignment on effect of construction of coastal structures on stability of shoreline / beaches (case studies)
09 Assignment on methods of shore protection /groins, seal walls, offshore breakwaters/ artificial nourishment (case studies)
10 Assignment on pollution in coastal zone/ disposal of waste/dredged spoils (case studies)
11 Assignment on coastal zone management: activities in coastal zone, CRZ, Issues related to Integrated coastal zone management / Coastal regulation zone (case studies)
12 Site visit to actual port / port models and preparing the report

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 007 b Elective III: Advanced Design of Concrete Structures Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Oral: 50 Marks

Term Work

Term work will consist of the following. Oral examination based on the term work.

01 Assignment on analysis of slab using yield line theory
02 Design and detailing of flat slab
03 Design and detailing of retaining wall.
04 Design and detailing of ground resting water tank
05 Design and detailing of RC frame
06 Design and detailing of shear wall
07 Report on a site visit of ongoing construction of any structure mentioned in the syllabus
08 The drawings shall be prepared on full imperial drawing sheets. Detailing of reinforcement should be as per latest provisions of code.

Note: For term work, the group size should not be more than five students and each group should have different design data.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 007 c Elective III: Integrated Water Resources Planning and Management Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Oral: 50 Marks

Term Work

Term work will consist of the following. Oral examination based on the term work.

01 Detail report on components and approaches of IWRP & M
02 Detail report on national water policy
03 Detail report on participatory irrigation management and water distribution societies
04 Detail report on effluent quality standards as per CPCB
05 Detail report on economics in IWRP & M and decision making
06 Detail report on Dublin Principles (1992)
07 Detail report on water laws (National, State & Local)
08 Detail report on global water partnership (GWP)
09 Application of soft computing tool for flood forecasting
10 Application of QGIS for IWRM

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 007 d Elective III: Finite Element Method Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Oral: 50 Marks

Term Work

Term work will consist of the following. Oral examination based on the term work.

01 At least one assignment on each unit consisting minimum five numericals/theory questions.

02 One assignment based on FEM by using coding tools with program algorithm and flowchart for the following.
a) Formulation of stiffness matrix for any 1-D element.
b) Formulation of stiffness matrix for any 2-D element using isoparametric formulation.

03 Finite Element Method: Software applications of any one cases using suitable standard available software.
a) Truss/grid/beam/frame problem.
b) Plane stress/plane strain problem.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401007 e Elective III: Data Analytics Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Oral: 50 Marks

Term Work

Term work consists of the following assignments, out of twelve 2, 4, 6, 8, 10 & 12 are compulsory and any 4 out of remaining 6. Oral examination based on the term work

01 Determine mean, mode, kurtosis, coefficient of variation etc.
02 Determine measures of central tendency for a Civil Engineering dataset using Microsoft Excel/Python/Matlab/SPSS or any other suitable platforms.
03 Assignment on continuous probability distribution and discrete probability distribution.
04 Assignment on Probability distribution for a Civil Engineering dataset using Microsoft Excel/Python/Matlab/SPSS or any other suitable platforms.
05 Assignment on Sampling distribution, sample size determination and coefficient of correlation.
06 Assignment on Sampling distribution and Correlation for a a Civil Engineering dataset using Microsoft Excel/Python/Matlab/SPSS or any other suitable platforms.
07 Assignment on test of hypothesis.
08 Assignment on test of hypothesis for a Civil Engineering dataset using Microsoft Excel/Python/Matlab/SPSS or any other suitable platforms.
09 Assignment on Regression.
10 Assignment on Regression for a Civil Engineering dataset using Microsoft Excel/Python/Matlab/SPSS or any other suitable platforms.
11 Assignment on introduction to machine learning
12 Assignment on Logistic regression, Decision Trees, K means or Support Vector Machine (any two) for a Civil Engineering dataset using Microsoft Excel/Python/Matlab/SPSS or any other suitable platforms.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401007 f Elective III: Operation Research Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Oral: 50 Marks

Term Work

Term work consists of the following. Oral examination based on term work.

01 One exercise/assignment on each unit.
02 Out of this any one exercise/assignment to be solved using Computer programming/ Software
03 One exercise on formulation of a problem applicable to any field of Civil Engineering, requiring use of LP/ NLP/ DP. Formulation of objective function and constraints (No solution)
04 One exercise on analysis and solution using any of the above methods for data collected from Government Sources.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 008 a Elective IV: Air Pollution and Control Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work consists of the following. Term work marks will be based on continuous assessment.

A. Experimental Performance and Demonstration (S. N. 1 and 2 Compulsory and any 02 out of S. N. 3, 4 and 5)

01 Sampling and analysis of PM_{10} and $PM_{2.5}$ using (High Volume Sampler/ Fine Dust Sampler) in Ambient Air.
02 Sampling and analysis of SO_2 and NO_2 (High Volume Sampler/ Fine Dust Sampler) in Ambient Air.
03 Demonstration and report of Sampling and Analysis of PM_{10} & $PM_{2.5}$ using portable aerosol Spectrometer with the help of information and communication technology (ICT).
04 Demonstration and report of Stack Emission Monitoring (Isokinetic Sampling) with the help of information and communication technology (ICT).
05 Demonstration and report of Indoor Air Quality Assessment using Multi Gas Monitor with the help of information and communication technology (ICT)

B. Visits and Interactive Sessions (S. N. 4 is compulsory and any 01 out of S. N. 01, 02 and 03)

01 Visit to India Meteorological Department with reference to monitoring of meteorological parameters and its report.
02 Visit to air quality monitoring station and its report.
03 Visit to industry (sugar/cement/steel/thermal power plant/rubber/dairy) with reference to air pollution control device(s) and its report.
04 An interactive session with experts from Indian Institute of Tropical Meteorology/ Central Pollution Control Board/ State Pollution control board/ Municipal corporation or Nagar Panchayat/ smart city centers/ National Environmental Engineering Research Institute (NEERI)/any authority with reference to air quality and its report.

C. Reports and Case Studies (Any 03 of the following)

01 A report on "Application of remote sensing and satellite-based data in air quality management".
02 A report on "International Environmental Treaties to Reduce Air Pollution and GHG Emissions".
03 A report on "Impact of Lockdown on air quality".
04 A Report on "Sector Wise (Transportation/ Thermal Power plants/ Industries/ Domestic/ Agriculture) Mitigation Measures to Control Air Pollution".
05 A report on "Challenges and the Way forward to mitigate Air Pollution".
06 A case study report on "Ozone layer depletion/ Global warming/ Climate change/ acid rain".
07 A case study report on "Wind rose diagram construction and application using freeware".
08 A report on "Status of Air Quality Status of any city".
09 A report on any model (Screen3/ ISC/ CALINE4/ HIWAY2/ CAR-FMI/ OSPM/ CALPUFF/ AERMOD/ ADMS).

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 008 b Elective IV: Advanced Design of Steel Structures Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work consists of the following. Term work marks will be based on continuous assessment.

A. One assignment on each unit

01 Design of Beam Column
02 Design of beam to beam or beam to column connections
03 Design of cold form flexural member (Preferably purlin on sloping roof)
04 Design of rafter using tubular cross section with design of Connections showing detailing of joints
05 Design of castellated beam
06 Design of portal / gable frame

B. Two site visit cold formed light gauge section/tubular structure and gable frame

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 008 c Elective IV: Statistical Analysis and Computational Methods Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work consists of the following. Term work marks will be based on continuous assessment.

01 Exercise/Assignment on Introduction to Statistics
02 Exercise/Assignment on probability and distributions
03 Exercise/Assignment on data sampling
04 Exercise/Assignment on test of hypothesis
05 Exercise/Assignment on correlation and regression
06 Exercise/Assignment on variance and fitness test
07 Out of above at least two exercise/assignment to be solved using Excel or SPSS or Any other software suitable for statistical analysis

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 008 d Elective IV: Airport and Bridge Engineering Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work consists of the following. Term work marks will be based on continuous assessment.

A. Compulsory assignment

01 Runway design for length and related corrections, and sketches of essential runway markings.
02 Design of pipe culverts and design of box culvert (Single vent only) one each.
03 Structural design of flexible or rigid runway

B. Any six from the following

01 Report on study of recent trends in airport planning and design.
02 Selection of bridge site, alignment and collection of design data.
03 Site visit to bridge site or airport site (report on visit)
04 Seminar on one topic of building information modeling (BIM) system.
05 Report on guest lecture in applications of AR and VR in Airport or bridge engineering.
06 Prepare the drawing/plate (A3)/PPTs on airport marking and lighting (describing importance)
07 Collection of information and preparation of PPTs on Heliports.
08 Prepare report on movable bridges/ temporary bridges/bearing.
09 Power point presentation on bridge substructure.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 008 e Elective IV: Design of Prestressed Concrete Structures Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work consists of the following. Term work marks will be based on continuous assessment.

A. Compulsory assignment /design

01 Assignment on introduction, prestressing systems and material properties, composite sections
02 Assignment on calculation of losses in prestress and stress calculation
03 Design and detailing of design of prestressed concrete determinate beam
04 Design and detailing of prestressed concrete slab
05 Design and detailing of prestressed concrete flat slab.
06 Design and detailing statically indeterminate PSC beams
07 One site visit reports, on prestressed concrete structure.
08 Minimum Two full imperial sheets based on two projects on design of prestressed concrete structural elements.

Note: Should be separate design problem statement for a group of students not exceeding five.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 008 f Elective IV: Formwork and Plumbing Engineering Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work consists of the following. Term work marks will be based on continuous assessment.

01 Assignment on design of timber/steel formwork for slab. (Group of maximum Five students)
02 Assignment on design of timber/steel formwork for wall. (Group of maximum Five students)
03 Prototype model of any formwork (Group of maximum Five students)
04 Analysis and design of any formwork using suitable software.
05 Prototype model of plumbing for G + 2 building (Group of maximum Five students)
06 Assignment on design of plumbing
07 Assignment on plumbing system installation as Indian Standard.
08 Assignment on plumbing hydraulics and plumbing components
09 Reports of two site visits.
i. One site visit to observe conventional formwork and formwork for special structure or special formwork.
ii. One site visit to industrial plumbing system

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 009: Computer Programming in Civil Engineering

Teaching scheme	Credits	Examination scheme
Theory: 01 Hours/week	02	In semester Exam: NA
		End semester Exam: NA
Practical: 02 Hours/week		Term Work: 50 Marks

Prerequisites
Basic knowledge of computer programming, Civil Engineering

Course Objectives
01 To understand the basics of python programming.
02 To develop Python programs for civil engineering problems

Course Outcomes
At the end of course the learner will be able to,
01 Understand basics of Python Programming
02 Write Python codes for variety of problems in civil Engineering

Course Content

Unit I: Introduction to Python (06 hours)
Introduction of programming, introduction of python and its programming cycle, python interpreter and interactive mode, introduction of python integrated development environment (IDE), variables and identifiers, arithmetic operators, values and types, statements, operators, boolean values, operator precedence, expression, conditionals: if - else constructions. Loops: purpose and working of loops, do-while loop, for loop, nested loops, break and continue.

Unit II: Functions and Data Structures in Python (06 hours)
Function: parts of a function, execution of a function, keyword and default arguments, scope rules. Strings: length of the string and perform concatenation and repeat operations in it, indexing and slicing of strings, python data structure: tuples, unpacking sequences, lists, mutable sequences, list comprehension, sets. Dictionaries higher order functions: treat functions as first class objects, lambda expressions, introduction to python related libraries like NumPy, Matplotlib, seaborn and applications Keras and Tensor Flow.

Reference Books

01 Learning Python, Romano Fabrizio, Packt Publishing Limited.
02 Head First Python- A Brain Friendly Guide, Paul Barry, SPD O'Reilly, 2nd Edition.
03 Python: The Complete Reference, Martin C. Brown, McGraw Hill Education.

Term Work

Term work consists of any 10 mandatory laboratory assignments from the following. Students should complete these assignments by their developing/writing their own codes. Term work marks will be based on continuous assessment.

01 Application of python for **Open Channel Flow** (Analysis of rrectangular/triangular/trapezoidal channel)

02 Application of python for **Hydrology** (Determine the infiltration capacity and infiltration indices)

03 Application of python for **Groundwater Engineering** (Determine the discharge of a steady flow in a confined aquifer using Dupuit's equation)

04 Application of python for **Transportation Engineering** (Design the plain cement concrete pavement for two lane highway based on given conditions)

05 Application of python for **Infrastructure Engineering** (Estimation of productivity of construction equipment's like earthwork equipment)

06 Application of python for **Concrete Technology** (Estimation of strength of concrete or any mix design problem as per IS :10262-2019)

07 Application of python for **Structural Engineering** (Determine main steel for simply supported one way slab. Effective depth of slab is 125 mm and maximum moment in a slab is 22 kN.m, M25 grade of concrete and Fe 500 grade of steel)

08 Application of python for **Structural Engineering** (Determine the magnitude and nature of forces in members of statically determinate pin jointed truss by method of section)

09 Application of python for **Solid Waste Engineering** (Determine the settling velocity of suspended solids)

10 Application of python for **Environmental Engineering** (To find out the residual chlorine from given water with specifically mentioned doses of chlorine)

11 Application of python for **Soil Mechanics** (Find out the stress distribution in a soil using Boussinesq's equation)

12 Application of python for **Foundation Engineering** (Find out the shear strength of a soil with given data)

13 Application of python for **Quantity Analysis** (Determine the total volume of concrete in the trapezoidal footing)

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Savitribai Phule Pune University, Pune
B E Civil (2019 Pattern) w. e. f. July 2022
401010 Audit Course I a: Stress Management by Yoga

Teaching scheme	Credit	Examination scheme
Tutorial: 01 Hours/week	--	Grade

Pre-requisites
None

Course objectives
01 Understanding concept of Yoga and its benefits
02 Learn different types of Yogasans
03 Develop an understanding and stress importance of Meditation
04 Learn different techniques of Pranayam

Course outcomes
On successful completion of this course, the learner will be able to:
01 Develop understanding of Yoga and its impact on human body and mind.
02 Learn different Yogasans
03 Develop an understanding of meditation through pranayama
04 Learn different techniques of Pranayam

Course Contents

Unit I: Yoga: Sukshma (subtle) yoga techniques, difference between physical exercises and yogasans, impact of yogasans on human body, benefits of yogasans, patanjali yoga sutras, technique of different yogasans like, Trikonasan, Ardhachandrasan, Padmasan, Akarnadhanurasan, Ardhamatsendrasan, Vajrasan, Pachhimottanasan, Bhujangasan, Shalbhasan, Dhanurasan, Naukasan, Makrasan, Pawanmuktasan, Halasan, Sarvangasan, Shavasan, Suryanamaskar(Sun Salutation), yoga and food.

Unit II: Meditation: breathing technique, pranayam, benefits of pranayam, precautions for pranayam, Kumbhak, Bandh (Locks), Chakras, Mudra, technique of pranayam, Anulom-Vilom Pranayam, Ujjayi Pranayam, Bhramari Pranayam, Bhastrika Pranayam, Agnisa rPranayam, Kapalbhati Pranayam, Meditation (Dhyan).

Reference books

01 Light on Yoga, B. K .S. Iyengar, Harper Collins Publishers India
02 Light on Pranayama, B. K. S. Iyengar, Harper Collins Publishers India
03 Yoga for Dummies, Georg Feuerstein and larry Payne, Wiley India publishing
04 Yoga, Pilates, Meditation & Stress Relief, Parragon Books Ltd

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Savitribai Phule Pune University, Pune
B E Civil (2019 Pattern) w. e. f. July 2022
401010 Audit Course I b: Communication Etiquette in Workplaces

Teaching scheme	Credit	Examination scheme
Tutorial: 01 Hours/week	--	Grade

Pre-requisites
None

Course objectives
01 Develop an understanding of workplace codes, professionalism at workplace
02 Understand the workplace ethics
03 Develop an understanding of Business ethics, workplace privacy and ethics
04 Learn teamwork at workplace

Course outcome
On successful completion of this course, the learner will be able to,
01 Develop an understanding of workplace codes, professionalism at workplace
02 Learn the workplace ethics
03 Develop an understanding of Business ethics, workplace privacy and ethics
04 Learn teamwork at workplace

Course Content

Unit I: Ethics in engineering profession and roles of engineers, ethical codes and its need, codes from other profession, advertising standards of India, corporate codes, knowledge of ethical codes. Workplace ethics: needs, principles, development of personal ethics, workplace ethics for employees- ethical behaviour in workplace- professionalism, ethical violations by employees, employee attitude and ethics, employee etiquettes. Benefits of ethics in workplace employee commitment, investor loyalty, customer satisfaction, profits professionalism at workplace: unethical conduct for employees and employers. Factors leading to unethical behaviours, different unethical behaviours, measures to control unethical behaviours, rewarding ethical behaviour

Unit II: Business ethics: overview of business ethics, corporate governance, ethical issues in human resource management- the principal of ethical hiring, firing, worker safety, whistle blowing, equality of opportunity, discrimination, ethics and remuneration, ethics in retrenchment. Ethical dilemmas at workplace, ethical issues in global business, corporate responsibility of employers, workplace privacy & ethics: privacy at workplace, hardware, software and spyware, plagiarism and computer crimes, convenience and death of privacy, defence of employee privacy rights. Teamwork at workplace: teams, elements of team, stages of team development, team meetings, team rules, and teams work and professional responsibility, rules of professional responsibility, ASME code of ethics, discrimination, sexual harassment, creating awareness about workplace harassment, compulsory workplace guidelines, ethics of managing change in workshop.

Reference Books

01 Business Ethics, Kurt Stanberry and Stephen M. Byars, Tata Mc Graw Hill Publisher.

02 A Guide to Corporate Business Etiquette, How to Maintain Effective Communication at Work Paperback, Satish Babu Bachu, 4th Edition, 17 July 2014.

03 The Essentials of Business Etiquette and workplace through ethics, Barbara Pachter, 5th Edition, 2018.

04 The Etiquette Advantage in Business, Personal Skills for Professional Success, Daniel Post Senning, Peter Post, Anna Post, Lizzie Post, Peggy Post, 3rd Edition.

05 Subramanian Business Etiquette: 101 Ways to Conduct Business with Charm & Savvy, Ann Sabath.

06 The Unwritten Rules of Professional Etiquette, Ryan Sharma, 4th Edition.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401011: Dams and Hydraulics Structures

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Prerequisites
Basic knowledge of Fluid Mechanics and Geotechnical Engineering

Course Objectives
01 To study different types of dams and instrumentation
02 To study the stability analysis of Gravity Dam
03 To study the spillways and design philosophy of Ogee spillway.
04 To study the failures and stability analysis of an earthen dam
05 To study design of canals and types of canal structures
06 Analysis of design of diversion headwork and of Cross drainage work

Course Outcomes
At the end of course the learner will be able to,
01 Understand types of dams and instrumentation working
02 Execute stability analysis of Gravity Dam
03 Understand types of spillways & Design of Ogee spillway
04 Illustrate the failures and analyze stability of earthen dam
05 Design Canals and understand the canal structures
06 Analysis of the Diversion headwork and Cross Drainage work

Course Content

Unit 1: Introduction to dam **(06 hours)**
Introduction, historical development of dams, different terms related to dams, selection of site of dam, factors governing selection of type of dam, classifications of dam, classification based on purpose, classification based on material, classification based on size of project, classification based on hydraulic action, classification based on structural action, introduction of arch dam and buttress dam including classification, advantages and limitations. Significance of Instrumentation: introduction, objectives of dam safety and instrumentation. Working principles and functions of instruments: piezometer, porous tube piezometer, pneumatic piezometer, vibrating wire piezometer, vibrating wire settlement cell, inclinometer, joint meter, pendulums, inverted pendulum, hanging pendulum, automatic pendulum coordinator, vibrating wire pressure cell, extensometer, embedment strain gauge, temperature gauge, distributed fiber optics temperature tool, seismograph.

Unit 2: Gravity Dam **(06 hours)**
Introduction, components of gravity dam, conditions favoring gravity dam, forces acting on gravity dam, combination of loading for design, seismic analysis of dam, terms related to seismic analysis, determination of seismic forces (Zangger's method), effect of horizontal earthquake acceleration, effect of vertical earthquake acceleration, stress analysis in gravity dam (only concept no derivation),vertical or normal stress, principal stresses, shear stresses, middle third rule, modes of failure of gravity dam, elementary profile of gravity dam, concept of high and low gravity dam, various design methods of gravity dam (introduction only), details of gravity method or 2 D method,

construction of gravity dam, colgrout masonry, roller compacted concrete (R.C.C), temperature controlling in mass concreting, crack formation in gravity dam, control of crack formation in dam, construction joints, keys, water seal, retrofitting.

UNIT 3: Spillway **(06 hours)**

Introduction, location of spillway, different key levels and heads in spillway, spillway capacity, components of spillway, approach channel, control structure, discharge channel, energy dissipation, energy dissipation device, tail channel, classification of spillway, classification based on operation, main or service spillway, auxiliary spillway, emergency spillway, classification based on gates, gated spillway, ungated spillway, classification based on features, straight drop spillway (free overflow spillway), saddle spillway, side channel spillway, overflow or ogee spillway, chute or open channel or trough spillway, shaft or morning glory spillway, siphon spillway, conduit or tunnel spillway, stepped spillway. Design of ogee spillway or overflow spillway, shape of crest, equations for spillway profile on upstream and downstream, energy dissipation below spillway, classification of energy dissipation devices, stilling basin, components of stilling basin, types of stilling basins, Indian Standard stilling basin, correlation between jump height and tail water depth, methods of energy dissipation for stilling basin, design of roller bucket and ski-jump bucket, introduction to orifice type of spillway and spillway gates.

Unit 4: Earthen dam **(06 Hours)**

Introduction, conditions favoring on earth dam, limitations of earth dam, classification of earth dam, classification based on materials, methods of construction, height; selection of type of earth dam, components of earth dam, requirements for safe design of earth dam, hydraulic (seepage) analysis, plotting of phreatic (seepage) line, homogeneous earth dam with horizontal drainage blanket, determination of seepage discharge using flow net. Composite earth dam with casing and hearting, properties of phreatic line, determination of seepage discharge through earth dam using flow net, structural stability analysis of homogeneous and zoned earth dam, forces acting on earth dam, method of stability analysis of an earth dam, procedure of analysis by Swedish slip circle method, fellenius method of locating center of critical slip circle, stability analysis for foundation, failure of earth dam, classification of failure of earth dams, hydraulic failure, seepage failure, structural failure, seepage control in earth dams, causes of seepage, seepage control measures, construction of earth dam.

Unit 5: Canals **(06 Hours)**

Introduction, classification of canals, classification based on alignment, classification based on soil, classification based on source of supply, classification based on discharge, classification based on lining, classification based on excavation, components of canal, data required for canal design, selection of canal alignment, design of stable canal in alluvial beds, Kennedy's theory, design of canal by Kennedy's theory, limitations of Kennedy's theory, Lacey's regime theory, design of canal by Lacey's theory, design of lined canal, canal lining, necessity of canal lining, requirement of lining material and types of lining. Canal Structures: canal falls, canal outlets, canal escapes, canal regulators.

Unit 6: Diversion head works **(06 Hours)**

Introduction, function of diversion head works, selection of sites for diversion head works, components of diversion head works, design of weir on permeable foundation, criteria for safe design of weir floor, brief introduction to Bligh and Lane's theory, Khosla's theory based on potential theory approach, Khosla's theory on independent variables, design of weirs on permeable foundations.

C. D. Works: Introduction, Necessity of Cross Drainage works, Selection of site for Cross Drainage work, Selection of suitable type of C. D. works, data required for design of cross drainage work, classification of cross drainage works. Drain over canal: siphon, super passage. Canal over drain: aqueduct, siphon aqueduct**.** Canal and drain water meeting at same level: level crossing, inlet and outlet, design considerations for cross drainage works.

Text books

01 Irrigation and Water Resources Engineering, Asawa G. L., New Age International (P) Ltd.
02 Irrigation Engineering and Hydraulic Structures, Garg S. K, Khanna Publication.
03 Irrigation Water Power Engineering, Punmia B. C., Laxmi Publication.

Reference Books

01 Design of Small Dams, United States Department of the Interior, Bureau of Reclamation revised reprint 1974, Oxford and IBH Publishing Co.
02 Design Textbook in Civil Engineering, Volume Six, Leliavsky, Serge-Oxford and IBH Publishing Co.Pvt. Ltd.
03 Irrigation, Water Resources and Water Power Engineering, Modi P. N., Standard Book House, New Delhi.

Indian Standards

01 IS 8605: 1977 (Reaffirmed 1998), Code of practice for construction of masonry in dams, Third reprint, July 1999, Bureau of Indian Standards, New Delhi.
02 IS 6512: 1984 (Reaffirmed 1998), Criteria for design of solid gravity dams, first revision, First reprint, September, 1998, Bureau of Indian Standards, New Delhi.
03 IS 457: 1957 (Reaffirmed 2005), Code of practice for general construction of plain and Reinforcement concrete for dam and other massive structures, sixth reprint, January 1987, Bureau of Indian Standards, New Delhi.
04 IS 1013: 1985, Code of practice for drainage system for gravity dams, their foundations and abutments, first revision, Bureau of Indian Standards, New Delhi.
05 IS 14591: 1999, Temperature control mass concrete for dams - guidelines, Bureau of Indian Standards, New Delhi.
06 IS 11223: 1985, (Reaffirmed 2004), Guidelines for fixing Spillway capacity, edition 1.2 (1991-09), Bureau of Indian Standards, New Delhi.
07 IS 6934: 1998 (Reaffirmed 2003), Hydraulic design of high ogee overflow spillways-Recommendation, First revision, Bureau of Indian Standards, New Delhi.
08 IS 11155: 1994, Construction of spillways and similar overflow structures- Code of practice, Bureau of Indian Standards, New Delhi.
09 IS 5186: 1994, Design of Chute and side channel spillway-criteria, first revision, Bureau of Indian Standards, New Delhi.
10 IS 5186: 1994, Design of Chute and side channel spillway-criteria, first revision, Bureau of Indian Standards, New Delhi.
11 IS 10317: 1982 (Reaffirmed 2004), Guidelines for selection of spillways and energy dissipaters, Bureau of Indian Standards, New Delhi.
12 IS 4997: 1968 (Reaffirmed 1995), Criteria for design of hydraulic jump type stilling basins with horizontal and sloping apron, sixth reprint, January, Bureau of Indian Standards, New Delhi.
13 IS 7365: 1985, Criteria for hydraulic design of bucket type energy dissipaters, first revision, Bureau of Indian Standards, New Delhi.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401012: Quantity Surveying, Contracts and Tenders

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Knowledge of building planning, roads and its structural components, construction materials

Course Objectives
01 Impart knowledge to prepare approximate and detailed estimate of Civil Engineering works
02 To teach concepts of tendering process, contract document & Arbitration
03 To draft detailed specification and work out rate analysis according to material, labor requirements as per specified norms.
04 Impart knowledge of valuation, depreciation to carry out valuation of properties

Course Outcomes
On successful completion of this course, the learner will be able to,
01 Understand concept of estimates and prepare approximate estimate for various for Civil Engineering works.
02 Describe tendering process, construction contracts, and aspects of Arbitration and prepare tender documents**.**
03 Prepare detailed estimate of various items of work by different methods and calculate quantity of steel from Bar bending schedule.
04 Apply engineering knowledge to prepare estimate for roads, culverts, and water tank (Elevated storage tank)
05 Apply concepts of specification to draft brief specification, detailed specification and prepare detailed rate analysis report.
06 Evaluate depreciation and valuation of property on the basis of present condition, specifications and market trend.

Course Content

Unit 1: Introduction and Approximate Estimates (06 hours)
Definition of estimation, valuation, purpose, and data required for estimation, types, concept of item of work, different items of work of buildings, units and mode of measurement for different items of work, measurement form and abstract form (Bill of Quantities). Administrative approval and technical sanction, prime cost, provisional sum and provisional quantities, contingencies, rate analysis, lead statement, work charge establishment, centage charges, , contents of S. S. R. Approximate estimate: Methods of approximate estimate of Civil Engineering works: like building, roads, irrigation, water supply & sanitary works with numerical.

Unit-2: Tenders, Contracts and Arbitration (06 hours)
Tenders: Definition, detailed tendering process and procedure, conditions regarding earnest money, security deposit, retention money, pre and post qualification of contractors, 3 bid, 2 bid and single bid system, qualitative and quantitative evaluation of tenders, comparative statement, pre-bid conference, acceptance/ rejection of tenders, BOT & Global Tendering, E-tendering. PWD procedure for executing, works piecework, rate list and daily labor, introduction to registration as a contractor in PWD.

Contracts: definition, objectives & essentials of a valid contract as per Indian Contract Act (1872), types of contracts, conditions of contract- defective work, subletting, etc. termination of contract, defect liability period, liquidated damages, interim payment or running account bills, advance payment, secured advance, final bill. Arbitration: Introduction to arbitrations as per Indian Arbitration & Conciliation Act (1996) - meaning and need of arbitration, qualities and powers of an arbitrator.

Unit 3: Taking out quantities & Detailed estimate (06 Hours)

Detailed estimates: factors to be considered while preparing detailed estimate, methods of detailed estimate-PWD and Centre line method, taking out quantities for load bearing and R.C.C framed structures as per IS 1200, bill of quantities. Bar Bending Schedule: introduction to bar bending schedule and its importance, preparing bar bending schedule for RCC members of building.

Unit 4: Estimates of other construction works (06 Hours)

Earthwork for road construction, estimate of road/highway works, estimate of steel roof truss, estimate of a culvert, water tank (elevated storage tank).

Unit 5: Specifications and Rate Analysis (06 Hours)

Necessity of specifications, purpose, types, drafting detailed specifications for major items of Civil Engineering works like earthwork, PCC, Masonry (stone & brick), RCC, Plastering, flooring, painting and road, Rate Analysis: purpose, importance, factors affecting rate of an item of work, overheads, task-work, procedure for rate analysis, rate analysis for major items of civil engineering works- like earthwork, PCC, masonry-stone & brick, RCC structural elements, plastering, flooring.

Unit 6: Valuation (06 Hours)

Introduction, valuation- purpose, types of property-real property and personal property, meaning of price, cost and value, factors affecting value, gross income, net income, outgoings, various forms of values. concept of free hold and lease hold property, depreciation, methods of calculating depreciation, obsolescence, sinking fund, years purchase, annuity. Methods of valuation of land and building: rental basis, direct comparison method, profit based method, development method, and rent fixation for building. Methods of Valuation of land: belting method of land valuation and other methods.

Text books

01 A Textbook of Estimating and Costing (Civil), D D Kohli and R C Kohli, S. Chand & company, New Delhi.

02 Civil Engineering Contracts and Estimates, B. S. Patil, Universities press

03 A Text Book of Estimating and Costing for Civil Engineering, G.S. Birdie, Dhanpat Rai Publishing Company

Reference Books

01 Estimating and Costing in Civil Engineering: Theory and Practice, B. N Dutta and S. Dutta , 28th revised edition, CBS Publishers and distributors.

02 Estimating, Costing Specifications & valuation in Civil Engineering, M. Chakraborty.

03 Estimating and Costing, R. C. Rangwala, Charotar Publishing House Pvt Ltd, Anand.

04 Theory and Practice of Valuation, Dr. Roshan Namavati, Lakhani Publications.

05 Valuation Principles and Procedures, Ashok Nain, Dewpoint Publication.

06 Laws for Engineers, Dr. Vandana Bhat and Priyanka Vyas, ProCare.

Hand books and Indian Standards

01 Standard contract clauses for domestic bidding contracts: ministry of statistics and program implementation, Government of India.

02 Document: Federation International Des Ingenieurs Conseils (FIDIC) i.e. International Federation of Consulting Civil Engineers, Geneva, Switzerland.

03 Indian Practical Civil Engineers Handbook: P. N. Khanna, UBS Publication Distri. Pvt. Ltd.

04 Quantity Surveyor's Pocket Book by Duncan Cartlidge.

05 IS 1200: --- (Part 1 to 25): Methods of Measurement of Building & Civil Engineering Works, Bureau of Indian Standards, New Delhi.

06 IS 3861:1966, Method of measurement of areas and cubical contents of buildings, Bureau of Indian Standards, New Delhi.

07 D. S. R. (District Schedule of Rates) for current year.

08 PWD Redbooks, Vol 1 & 2.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 013 a Elective V: Earthquake Engineering

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites

Engineering Mechanics, Engineering Geology, Structural design, Geotechnical Engineering, Engineering Mathematics

Course objectives

01 Introduce the aspect of earthquakes and vibrations.
02 Model real and physical dynamic problems.
03 Solve equations of motions for various oscillatory systems.
04 Perform static and dynamic seismic analysis for buildings.

Course outcomes

On successful completion of this course, the learner will be able to,
01 Define the concepts of earthquakes, seismology and vibrations.
02 Model physical structures and develop equations of motion.
03 Solve the equations of motion for SDOF systems.
04 Solve the equations of motion for MDOF systems.
05 Perform static seismic analysis for buildings.
06 Perform dynamic seismic analysis for buildings.

Course Content

Unit 1: Earthquake and Seismology **(06 hours)**

Causes of earthquakes, seismic waves, magnitude and intensity of earthquakes, seismographs, accelerometers, ground motion parameters, peak acceleration, peak velocity, peak displacement, ground motion spectra

Unit 2: Vibration Analysis: SDOF Systems **(06 hours)**

Types of vibrations, dynamic equilibrium, mathematical modelling, stiffness, damping, types of damping, single degree of freedom (SDOF) systems, and solution to SDOF systems subjected to free and forced vibrations.

Unit 3: Vibration Analysis: MDOF Systems **(06 hours)**

Modeling of multi degree of freedom (MDOF) systems, solution to MDOF systems, Eigen values and Eigen vectors

Unit 4: Seismic Analysis: Static Approach **(06 hours)**

Types of seismic analysis, IS 1893 code provisions, equivalent static analysis.

Unit 5: Seismic Analysis: Dynamic Approach **(06 hours)**

Dynamic analysis, IS 1893-2016 code provisions, response spectrum analysis

Unit 6: Seismic Design **(06 hours)**

Seismic design factors – building configuration, damping, torsion, ductility. Lateral load resisting

systems, moment resisting frames, shear walls, diaphragms, braced frames, IS: 1893 code provisions. Strength and ductility of steel and concrete structures, ductile detailing of steel and concrete structures, IS 13920 provisions.

Text books

01 Structural Dynamics: Theory and Computation, Mario Paz & William Leigh, Springer Publications

02 Earthquake Resistant Design of Structures, S. K. Duggal, Oxford Publications

03 Earthquake Resistant Design of Structures, Pankaj Agarwal and Manish Shrikhande, Prentice Hall India Learning Private Limited.

Reference book

01 Dynamics of Structures, A. K. Chopra, Pearson Education India.

Indian Standards

01 IS 1893 (Part 1): 2016 Reaffirmed in 2021, Criteria for Earthquake Resistant Design of Structures - Part 1: General Provisions and Buildings, Bureau of Indian Standards, New Delhi. India.

02 IS 13920: 2016 Reaffirmed in 2021, Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces - Code of Practice (First Revision), Bureau of Indian Standards, New Delhi. India.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401013 b Elective V: Structural Design of Bridges

Teaching scheme	Credits	Examination scheme
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Concepts of structural analysis, Concept of structural steel design, Concept of reinforced concrete structural design, Concept of prestressed concrete

Course objectives
01 Know about various types of bridge structures.
02 Selection of appropriate bridge structures for given site conditions.
03 Analyze and design reinforced concrete, steel and prestressed concrete superstructures.

Course outcomes
On successful completion of this course, the learner will be able to,
01 Identify loads on bridges and selection of type of bridge for the site condition as per Indian standards.
02 Design the reinforced concrete deck slab, culvert slab and T beam deck slab for highway bridges.
03 Analysis and design of reinforced concrete and post tension prestressed concrete girders.
04 Classify the types of rail bridges and design the plate girder steel bridges
05 Analyse and design the steel trussed bridges.
06 Study different types of bearing and thereby design the bearings for reinforced concrete highway bridges.

Course Content

Unit 1: Introduction to Highway and Railway Bridges (06 hours)
Types of bridges, classification, IRC loading standard for RC highway bridges, IRC loading standard for railway steel bridges, impact factors for moving loads as per IRC, concept of ILD/moving load and equivalent uniformly distributed load (EUDL).

Unit 2: RC Slab Bridge Deck for Highways (06 hours)
Analysis of slab decks considering cases solid slab spanning in one direction, solid slabs in spanning two direction and solid cantilever slab, design Aids and Tables of RC deck bridge slab as per Pigeaud‘s method, design of slab culvert, Design of RC slabs supported on all sides for T-beam and slab deck.

Unit 3: RC Bridge Girders and Post Tensioned Prestressed Girders (06 hours)
Load distribution on longitudinal and cross girders, methods of analysis, analysis and design of longitudinal and cross girders as per Courbon’s theory, design of post tensioned prestressed concrete T beam bridge deck and girders.

Unit 4: Railway Plate Girder Bridges (06 hours)
Railroad bridge philosophy, railroad bridge types, elements of plate girder and their design such as web, flange, vertical stiffeners, end bearing stiffeners, intermediate stiffeners, and lateral bracing for plate girders.

Unit 5: Railway Truss Girder Bridges **(06 hours)**

Types and components, Structural configurations, loads and load combinations, analysis and design of truss elements, longitudinal and cross-girders, bracing systems.

Unit 6: Bridge Bearings **(06 hours)**

General features and function of bearings, types of bearings, design of steel rocker and roller bearings, design of elastomeric pad bearing.

Text books

01 Design of Bridges, N. Krishna Raju, Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.
02 Design of Bridge Structures, T. R. Jagdish and M. A. Jayaram, Prentice-Hall of India Pvt. Limited., New Delhi.
03 Prestressed Concrete, N. Krishna Raju, Tata-McGraw Hill International.

Reference Books

01 Essentials of Bridge Engineering, Johnson Vector D, Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.
02 Bridge Engineering Handbook, Wai-Fah Chen and Lian Duan, CRC Press Pvt. Ltd.
03 Bridge Engineering, Ponnuswamy S., Tata McGraw-Hill, New Delhi.
04 Design of Steel Structures, Ramachandra, Standard Publications New-Delhi.
05 Bridge Superstructure, Rajagopalan. N., Alpha Science International, New Delhi.
06 Plain and Reinforced Concrete, Vol.2., Jain and Jaikrishna, Nem Chand Brothers, New Delhi

Indian Standards

01 IS 456:2000, Code of practice for Plain and Reinforced Concrete, BIS, Bureau of Indian Standards, New Delhi.
02 Indian Railway Standard Code of practice for the design of steel and wrought iron bridges carrying rail, Govt of India, Ministry of Railways, 1962.
03 Standard specifications and code of practice for road bridges, IRC section I, II, III, V, VI. VII, and IX.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401013 c Elective V: Irrigation and Drainage

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Prerequisites
Basic knowledge of fluid mechanics, geotechnical engineering, and hydrology and water resources engineering

Course Objectives
01 To study different irrigation and drainage systems.
02 To introduce students about basic concepts of water, plant, and their interactions.
03 To calculate evapotranspiration and crop water requirement.
04 To develop analytical skills relevant to the design of irrigation and drainage projects, planning and management.

Course Outcomes
On successful completion of this course, the learner will be able to:
01 Summarize types of irrigation methods.
02 Estimate evapotranspiration and crop-water requirement.
03 Understand component parts and their design considerations of lift irrigation system.
04 Design drip and sprinkler irrigation systems.
05 Understand basics of salt affected soils and estimate leaching requirement.
06 Design surface and subsurface drainage systems.

Course Contents

Unit 1: Introduction (06 hours)
Definition, necessity of irrigation, benefits of irrigation, ill effects of irrigation, crop pattern, irrigation efficiency, cropping intensity, water use efficiency, canal and pipe distribution system, types of irrigation systems, techniques of water distribution in the farm, factors affecting the choice of irrigation methods, quality of irrigation water. Surface and subsurface irrigation methods, concept of deficit irrigation, micro irrigation (theory only), application of AI in irrigation and drainage.

Unit 2: Soil Moisture and Evapotranspiration (06 hours)
Soil Moisture: soil texture, soil structure, soil groups of India, field capacity, wilting point, maximum allowable deficiency (MAD), kinds of soil water, soil moisture tension, root zone, soil profile, soil-water relationships, soil-moisture characteristic curve, measurement of soil moisture, tensiometer.
Evapotranspiration (consumptive use): direct measurement of evapotranspiration: Lysimeters, field plots; evapotranspiration equations – Penman's equation, FAO Penman - Monteith equation, Blaney-Criddle formula, Thornthwaite formula, reference crop evapotranspiration, procedure to estimate actual evapotranspiration, frequency of irrigation, crop water requirement in peak fortnight, design discharge for canal and pipe distribution system. (**No** numerical should be asked on Penman's and FAO Penman - Monteith equation in theory exam).

Unit 3: Lift Irrigation and Drip Irrigation **(06 hours)**

Centrifugal pump (CP): working, component parts, heads of CP, NPSH, computation of power requirement, characteristic curves of CP. Lift Irrigation: general concepts, advantages, disadvantages, elements of lift Irrigation schemes, design considerations involved in intake well, jack well, rising main, distribution systems. Drip Irrigation: definition and functions, advantages and disadvantages of drip irrigation systems, suitability of drip irrigation system, wetting pattern (width and depth of wetting front), components of drip irrigation system, planning and design of drip irrigation systems, installation and maintenance of drip assembly.

Unit 4: Sprinkler Irrigation **(06 hours)**

Introduction of sprinkler irrigation, advantages and limitations of Sprinkler Irrigation, types of sprinkler systems, components of sprinkler Irrigation system (Pumping set, main and lateral pipe lines, sprinkler heads, perforated pipes, debris screen and desilting basin, booster pumps, take off valves and flow control valves, fertilizer applicators), moisture distribution patterns and uniformity of coverage, uniformity coefficient. Design of sprinkler irrigation systems (inventory of resources and conditions, criteria for system layout, selection of sprinkler and its spacing, discharge capacity of the pump, hydraulic design of sprinkler systems- (discharge of sprinkler nozzle, main and lateral pipe sizes, pumps and power units), cost estimation, operation and maintenance.

Unit 5: Management of Salt Affected Soil **(06 hours)**

Salinity, salinity units, electrical conductivity, pH, quality of irrigation water, sodium adsorption ratio (SAR) and exchangeable sodium percentage (ESP), classification of saline and alkaline soils, osmotic potential, salinity stress coefficient, water stress coefficient, yield reduction, salt balance (mass balance) at farm level. Reclamation of saline soils: leaching requirement (LR) - Rhoades equation, requirement of irrigation water to meet crop demand and LR. Reclamation of alkali soils: Gypsum requirement.

Unit 6: Drainage of Irrigated Land **(06 hours)**

Definition and objectives of drainage, water logging, definition, classification and impact; types of drainage systems, surface, subsurface, vertical or tube well. Surface drainage system: design considerations for land drainage; design considerations for land grading/leveling, design consideration for field drains and field laterals; layout and design considerations of field drains and laterals - random field drain system, bedding field drain system, parallel field drain system; design of surface drainage channel (computation of design discharge only). Subsurface drainage systems: purpose and benefits; location and alignment of drains pipes; sub surface drainage system layouts- random system, parallel grid system, herringbone system, combined system; drain pipe envelope; structures of pipe drainage system- outlet of a pipe drain into a ditch or canal, junctions and inspection chamber, surface water inlets, bedding; drainage coefficient; drain spacing design – steady state formula (Hooghoudt formula), unsteady state formula (Glover-Dumm equation); design of drain pipe diameter; materials for drain pipe – clay, concrete, plastic, drainage wells. (No derivation of Hooghoudt and Glover-Dumm formulae).

Text Books

01 Irrigation Engineering and Hydraulic Structures, Garg, S. K., Khanna Publishers, New Delhi.

02 Irrigation, Theory and Practice, A. M. Michael, Vikas Publishing House Pvt. Ltd. New Delhi.

03 Irrigation Engineering and Hydraulic Structures, S. R. Sahasrabudhe, Kataria & Sons, New Delhi.

04 Engineering Hydrology, K Subramanya, McGraw Hill Education (India) Pv. Ltd.

Reference books

01 Drip and Sprinkler Irrigation, R. K. Biswas, New India Publishing Agency, New Delhi.
02 Land Drainage, Battacharaya A. K. & Michael A. M., Vikas Publ.
03 An introduction to Drip Irrigation Systems, Ajai Singh, New Delhi Publishers.
04 Irrigation Engineering, H. M. Raghunath, Wiley India.
05 Irrigation and Drainage Engineering, Peter Waller and Muluneh Yitayew, Springer.
06 Trickle Irrigation for Crop Production, F. S. Nakayama and D. A. Bucks, Elsevier.
07 Urban Drainage, David Butler and John W. Davies, Taylor & Francis.
08. Guidelines for Planning and Design of Piped Irrigation Network, Central Water Commission, Ministry of Water Resources, River Development & Ganga Rejuvenation, Govt. of India, New Delhi.
09 Pipe Distribution Network for Irrigation", WRD Handbook-Chapter 4 (Vol I, 2019), Water Resources Department, Govt. of Maharashtra.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401013 d Elective V: Design of Precast and Composite Structures

Teaching scheme	Credits	Examination scheme
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Fundamentals of Engineering Mechanics, Mechanics of Materials, Structural Analysis, Design of Steel and Concrete Structures

Course objectives
01 Learn the concepts and techniques of precast and composite construction.

Course outcomes
On successful completion of this course, the learner will be able to,
01 Achieve knowledge of design and development of problem solving skills.
02 Explore the concept of precast construction.
03 Learn the principles and design of precast structures
04 Understand the need, advantages and limitations of composite material.
05 Apply basic mechanical principles in analysis of composite structures like beams, columns, floors, shear connectors.
06 Understand and apply various provisions as per Indian standards in design of structural components using composite materials.

Course Content

Unit 1: Introduction to Precast Concrete Construction (06 hours)
General principles of fabrication, need for prefabrication, comparison with monolithic construction, types of prefabrication, site and plant prefabrication, economy of prefabrication, modular coordination, standardization, materials, modular coordination, systems, production, transportation, erection.

Unit 2: Production and Fabrication (06 hours)
Production technology, choice of production setup, manufacturing methods, stationary and mobile production, planning of production setup, storage of precast elements, dimensional tolerances, acceleration of concrete hardening, hoisting technology, equipment for hoisting and erection, techniques for erection of different types of members like beams, slabs, wall panels and columns, vacuum lifting pads.

Unit 3: Design of Precast Concrete Elements (06 hours)
Prefabricated load carrying members: types of beams, design of simple rectangular beams and I-beams, handling and erection stresses, elimination of erection stresses in beams, types of Slabs: construction of roof and floor slabs, design of hollow core slab, columns: construction and design principles of column, study of IS: 15916 and their applications.

Unit 4: Introduction to Composite Construction (06 hours)

Introduction to composite construction, basic concepts, types of composite constructions, Steel concrete composite, analysis and design of simply supported composite beams with solid steel beams.

Unit 5: Design of Shear Connectors **(06 hours)**

Types of shear connectors and its function, analysis and design of shear connection between concrete slab and beam**.**

Unit 6: Design of Composite Columns **(06 hours)**

Design of steel concrete composite columns, columns subjected to axial loads and moments, encased composite construction of beams and columns, concepts and design, introduction to of IS: 11384 and their applications.

Text Books

01 Design and Construction of Precast Concrete Structures, Ramachandra Murthy D. S., 1st Edition, Dipti Press OPC Private Limited, Chennai.

02 Precast Concrete Structures, Hubert Bachmann and Alfred Steinle, Earns and Sohn.

03 Steel-concrete Composite Structures, Narayanan R, Vol. 7, CRC Press.

Reference Books

01 Handbook of Composite Construction Engineering, Gajanan M. Sabnis and Van Nostrand Reinhold Inc., U.S.

02 Composite Structures of Steel and Concrete: Beams, Slabs, Columns and Frames for Buildings, Roger P. Johnson, 4th Kindle Edition.

03 The Institute for Steel Development & Growth (INSDAG) course Material.

Indian Standards

01 IS 15916: 2010, Code of Practice for Building Design and Erection using Prefabricated Concrete, Bureau of Indian Standards, New Delhi.

02 IS 11384: 1985, Code of Practice for Composite Construction in Structural Steel and Concrete, Bureau of Indian Standards, New Delhi

03 IS 3935: 1966, Code of practice for composite construction, Bureau of Indian Standards, New Delhi.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401013 e Elective V: Hydropower Engineering

Teaching scheme	Credits	Examination scheme
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Basics of fluid mechanics, hydrology

Course objectives
01 Introduce the energy resources planning and potential concept.
02 Estimate the load factor and study the power house components and layout.
03 Understand the design of hydraulic turbines and study the economic consideration of hydroelectric power.

Course outcomes
On successful completion of this course, the learner will be able to,
01 Understand the classification of power resources & trends in energy use patterns.
02 Identify the components of hydro power plant.
03 Analyze the load assessment for turbines.
04 Prepare the layout of power house based on the various structures need for it.
05 Design the turbines and surge tanks.
06 Understand the laws and regulatory aspects of hydroelectric power.

Course Content

Unit 1: Hydropower Plants & Its Classification (06 hours)
Introduction: sources and forms of energy, types of power plants, and elements of hydropower scheme, hydropower development in India. Power house structures-substructure and superstructure layout and dimensions, deign considerations. Hydropower plants classification: surface and underground power stations, low medium-high head plants-layout and components, pumped storage plants, tidal power plants, micro tidal units.

Unit 2: Energy Resources and Load Assessment (06 hours)
Estimation of electrical load on turbines, load factor, plant factor, peak demand and utilization factor, load curve, load duration curve, prediction of load, tariffs, hydro-thermal mix, combined efficiency of hydro-thermal-nuclear power plants.

Unit 3: Power and Energy Potential study (06 hours)
Processing of hydrological data, use of extreme and long term hydrological data, mass and elevation volume curves, flow duration curves, gross and net head and estimation, reservoirs and their regulation, need for flow regulation, source of sediment, sediment yield in rivers, life of the reservoirs, methods of fixing installed capacity of a hydropower plant, estimation of power and energy potential, mean and peak load, load curve, load factor.

Unit 4: Water Conductor System and Powerhouse (06 hours)
Water conductor system, alignment, intake structures, location and types, trash rack, penstock and pressure shaft, types of powerhouses, typical layout of powerhouse, components, power plant equipment's, instrumentation and control.

Unit 5: Design of Hydraulic Turbines **(06 hours)**

Components of hydraulic turbines, standardization and selection of turbine, Pelton turbine design, Francis turbine runner design, design of axial turbine runner including bulb turbine, draft tube theory, standardization and applications draft tube. Water hammer and surge tanks: rigid and elastic water column theories, water hammer pressure, behavior of surge tanks, types of surge tanks, hydraulic design, design of simple surge tank-stability

Unit 6: Economics of Hydroelectric Power: **(06 hours)**

Hydropower, economic value and cost and total annual cost. economic considerations – pricing of electricity, laws and regulatory aspects, policies, electricity act- 2003, investment in the power sector, carbon credits, participation of private sector.

Text Books

01 Water Power Engineering, Dandekar and Sharma, Vikas Publishin house, New Delhi
02 Water Power Engineering, R. K. Sharma and T. K. Sharma, S. Chand and Co. Ltd.
03 Irrigation Engineering and Hydraulic Structures, Garg , S. K. Khanna Publishers, New Delhi
04 Water Power Engineering, P. K. Bhattacharya, Khanna Pub., Delhi.
05 Water Power Engineering, M. M. Deshmukh, Dhanpat Rai Pub.

Reference Books

01 Handbook of Hydroelectric Engineering, P. S. Nigam
02 Modern Power System Planning, Wang.
03 Hydropower Resources in India, CBIP
04 Hydro Power Structures, R. S. Varshney.
05 Water Power Development. E. Mosonvi, Vol. I & II.
06 Hydro-electric Engineering Practice, G. Brown, Vol. I, II & III.
07 Hydro – Electric Hand Book, Creager and Justin.
08 Centrifugal and axial flow Pump, A. J. Stephenoff, Krieger Publishing Company.
09 Hydraulic Structures, Novak, P. et al., Taylor and Francis, London.
10 Water Power Development, Volume 1: Low-head Hydropower Plants, Mosonyi, E., Academia Kiado, Budapest.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401013 f Elective V: Structural Audit and Retrofitting of Structures

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Structural analysis and structural design

Course objectives
01 To introduce Structural Audit: its necessity, procedure involved and report writing.
02 To introduce Retrofitting of structures: its necessity, materials & methods for retrofitting, retrofitting of RC, Steel & Masonry structures.
03 To make learners enable to design of retrofitting for RC beams and columns using FRP.

Course outcomes
On successful completion of this course, the learner will be able to,
01 Identify causes of deterioration in RC and steel structures.
02 Explore entire process of structural audit.
03 Explore necessity and methods of structural health monitoring.
04 Explain method of retrofitting for RC, steel and historical structures.
05 Design retrofitting using FRP for RC column.
06 Design retrofitting using FRP for RC beams.

Course Content

Unit 1: Introduction **(06 hours)**
Causes of structural damages: mechanical actions, chemical attacks, earthquake, fire, damage to steel structures due to corrosion, damage to RC structures due to corrosion: corrosion induced by carbonation of concrete, chloride induced corrosion and corrosion induced by leaching of concrete. Introduction to structural audit, its necessity, introduction to retrofitting of structures, its necessity, repairs, difference between repairs and retrofitting

Unit 2: Structural Audit **(06 hours)**
Structural audit, assessment of health of structure, study of structural drawings, visual observations, nature of distress, collapse and investigation, limitations on investigator, tools for investigation, various NDT methods for assessing strength of distressed materials, concrete endoscopy. Investigation management, review of assimilated information, interviews and statements, evaluation and reporting, presentation of report, role of client, architect, consulting engineer and contractor

Unit 3: Structural Health Monitoring (SHM) **(06 hours)**
Introduction to SHM, Local and Global techniques for SHM, short and long-term monitoring, active and passive monitoring, remote and wireless SHM Techniques. Instrumentation, data acquisition, data processing for SHM, Artificial Intelligence in SHM

Unit 4: Retrofitting of Structures **(06 hours)**
Methods of retrofitting: moisture barrier systems, mass reduction technique, jacketing, shortcreting, Ferro cement mesh, inserting new member, base isolation. Suitability of various retrofitting

techniques for RC structures, steel structures and masonry structures and introduction to retrofitting of Historical Structures

Unit 5: FRP and Retrofitting of RC Columns (06 hours)

Fiber Reinforced Polymer (FRP), Types of FRP and their properties, advantages of FRP retrofitting, FRP retrofitting using FRP plates, FRP wrapping, FRP bars, National and International code provisions. Retrofitting of RC columns using FRP for axial confinement as per provisions of ACI 440

Unit 6: Retrofitting of RC Beams using FRP (06 hours)

Analysis and design of RC beam using FRP, Retrofitting of RC Beams using FRP for flexural strengthening, shear strengthening, Provisions of ACI 440.

Text books

01 Concrete Repair and Maintenance, P. H. Emmons and G M Sabnis, Galgotia Publication.
02 Repairs and Rehabilitation, Compilation from Indian Concrete Journals
03 Building: Structural Audit, Repairs and Restoration, Arun Kelkar, Majestic Publishing House.
04 Concrete Building Pathology, Susan Macdonald, Blackwell Publishing
05 Diagnosis and treatment of structures in Distress, R. N. Raikar, R & D Centre, (SDCPL).
06 A Handy Guide to Repairs, Rehabilitation and Waterproofing of RCC Building (Structures), Jayakumar J. Shah.

Reference books

01 ACI 440.2R-08, Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures, American Concrete Institute.
02 Xilin lu (2010), Retrofitting Design of Building Structures, Science Press, New York.
03 Strengthening and Rehabilitation of Civil Infrastructures Using Fibre-Reinforced Polymer (FRP) Composites, L. C. Hollaway and J. G. Teng, Woodhead Publishing Series in Civil and Structural Engineering
04 Maintenance, Repair & Rehabilitation & Minor Works of Building, by P C Varghese, PHI
05 Management of Deteriorating Concrete Structures, George Somerville, Taylor and Francis, Publication.
06 Durability of Cement and Cement Composites, C. L. Page, M M Page, Wood Head, Publishing.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401014 a Elective VI: TQM and MIS

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Project management & engineering economics, construction management

Course objectives
01 Engineers with the ability to propose total quality management system in the construction projects
02 Engineers with the ability to appraise quality system standards in the construction projects
03 Engineers with the ability to choose MIS for a construction organizations

Course outcomes
On successful completion of this course, the learner will be able to,
01 Recognize quality and contribution of quality gurus for evaluation of best practices
02 Relate the functioning and application of TQM & Six Sigma in the domain of construction sector
03 Recommend ISO 9001 principles in preparation of quality manual to construction business
04 Apply management control & certification systems for construction industry
05 Choose TQM process implementation and various quality awards for construction sector
06 Propose MIS for allied fields in construction sector

Course Content

Unit 1: Construction Quality **(06 hours)**
Quality: various definitions and interpretation, importance of quality on a project in the context of global challenges, factors affecting quality of construction, reasons for poor quality & measures to overcome, Contribution of various quality gurus (Juran, Deming, Crossby, Ishikawa). Evolution of TQM-QC, TQC, QA, QMS, TQM, PDCA cycle

Unit 2: TQM and Six Sigma **(06 hours)**
TQM: Necessity, advantages, old and new 7 QC tools, quality function deployment (QFD), Six sigma: iimportance, levels, run chart and case study. Defects & it's classification in construction, measures to prevent and rectify defects and case study.

Unit 3: ISO and Quality Manual **(06 hours)**
Study of ISO 9001:2015 principles. Quality manual: importance, contents, documentation, importance of check-lists in achieving quality, typical checklist for concreting activity, formwork activity, steel reinforcement activity. Corrective and preventive actions, conformity and NC reports

Unit 4: Management Control and Certifications **(06 hours)**
Benchmarking in TQM, quality circle, categories of cost of quality, CONQAS, CIDC-CQRA certifications

Unit 5: Techniques in TQM Implementation and Awards **(06 hours)**

Five S techniques, failure mode effect analysis (FMEA), zero defects, Japanses tools and practices: JIT, KAIZEN, KANBAN, total productive maintenance, National & International quality awards- Rajeev Gandhi Award, Jamunalal Bajaj Award, Golden Peacock Award, Deming Prize, Malcolm Baldrize award

Unit 6: MIS **(06 hours)**

Introduction to management information systems (MIS), overview, definition, MIS and decision support systems, information resources, management subsystems of MIS, MIS based on management activity whether for operational control, management control, strategic control. Study of an MIS for a construction organization associated with building works.

Text Books

01 Total Quality Management, Dr. Gunmala Suri and Dr. Puja Chhabra Sharma, Biztantra
02 Quality Control and Total Quality Management, P. L. Jain- Tata McGraw Hill Publ. Company.
03 Total Quality Management, Dr. S.Rajaram and Dr. M. Sivakumar, Biztantra.
04 Total Engineering Quality Management, Sunil Sharma, Macmillan India Ltd. Publishing
05 Management Information System, James O'Brien, Tata McGraw Hill Publishing

Reference Books

01 Importance of quality on a project in the context of global challenges. Importance of quality on a project in the context of global challenges, Juran's Quality Handbook, Juran Publication.
02 Management: Principle, process and practices, by Bhat, Oxford University Press.
03 Juran's Quality Planning & Analysis, Frank Gryna, Richard Chua, Joseph Defeo, McGraw Hill Publishing.
04 Management Information Systems, Gordon B. Davis, Margrethe H. Olson, Tata McGraw Hill Publishing.
05 Total Project Management: The Indian Context, P. K. Joy, Macmillan India Ltd Publishing.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401014 b Elective VI: Advanced Transportation Engineering

Teaching scheme	Credits	Examination scheme
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Surveying and leveling, concrete technology and infrastructure engineering

Course objectives
01 To develop an analytical approach to urban transportation system.
02 To impart knowledge of sustainable transportation system with emphasis on non-motorized mode of transport.
03 To enable the students to design efficient pavement structure.

Course outcomes
On successful completion of this course, the learner will be able to,
01 Analyze travel demand model and forecasting.
02 Evaluate relative importance of various modes and their capacities.
03 Design facilities required for non-motorized transportation and pedestrians.
04 Estimate basic characteristics of traffic stream and signal design.
05 Design flexible pavements.
06 Design rigid pavements and overlays.

Course Content

Unit 1: Transport System Planning (06 hours)
Transportation planning process, types of origin: destination surveys. Origin: destination matrix, travel demand forecasting, trip generation: growth factor and synthetic models, modal spilt analysis, trip distribution and route assignment analysis, transportation system management (TSM), application in comprehensive mobility plan (CMP) and detailed project report (DPR).

Unit 2: Urban Transport Technology (06 hours)
Classification: light, medium, mass and rapid transit system, introduction to intelligent transportation system (ITS) and its application for urban roads (IRC SP 110:2017), public transport policy (National and Maharashtra State), introduction to BRT, Mono rail, Metro rail, Bullet train and Hyperloop, use of drone, concept of integrated inter model transit system, freight transportation. Environmental impact assessment: EIA requirement of highway projects, procedure and guidelines.

Unit 3: Introduction to Non-Motorized Transport (NMT) (06 hours)
Introduction, NMT Systems, NMT in developed countries, data collection techniques, mobility and NMT in sustainable urban development, role of city developers, analysis of NMT, Impacts, pedestrian characteristics, pedestrian level of service, pedestrian facility design (IRC 11-2015): footpath, zebra crossing, underpass, pedestrian actuated signals, bicycle level of service, bicycle facility design.

Unit 4: Traffic Systems **(06 hours)**

Traffic Stream Models: Greenshield's model and Greenberg's logarithmic model, concept of level of service (LOS) as per highway capacity manual (HCM) and Indo-HCM**.** Concepts of delay and queuing in traffic streams, design of traffic signal by Webster's method and IRC method, overview of IRC SP: 12 – 2015, guidelines for parking facilities in urban areas.

Unit 5: Study of Flexible Pavement **(06 hours)**

Analysis and design of flexible pavement as per IRC 37: 2018 (Complete design including the use of IITPAVE), distresses in flexible pavement and recommended rectification as per IRC 82: 2015, surface unevenness and measuring road roughness as per IRC SP: 16 - 2019.

Unit 6: Rigid Pavement and Overlay Design **(06 hours)**

Seismic design factors: building configuration, damping, torsion, ductility, lateral load resisting systems, moment resisting frames, shear walls, diaphragms, braced frames, IS: 1893 code provisions, strength and ductility of steel and concrete structures, ductile detailing of steel and concrete structures, IS 13920 provisions.

Text books

01 Traffic Engineering and Transport Planning, L R Kadiyali, Khanna Publishers.
02 Understanding Traffic System, Michel A Taylor, William Young, Peter W Bonsall.
03 Principles of Urban Transport Systems Planning, B. G. Hutchinson.
04 Principles of Transportation Engineering, Partha Chakraborty and Animesh Das.
05 Introduction to transport planning, M. J. Bruton

Reference books

01 Transport Networks, Potts Oliver (Academic Press).
02 Principles of Pavement Design, E. F. Yoder (John Wiley & Sons, lnc USA).
03 Fundamentals of Transportation Engineering, C. S. Papacostas.
04 Pavement analysis and Design, Huang Y H, Prentice Hall, Englewood Cliff, New Jersey.
05 Introduction to Transportation Engg. and Planning, Morlok E K, McGraw-Hill company.
06 Fundamentals of Traffic Flow Theory , Drew, McGraw-Hill book co.
07 A Course in Traffic Planning and Design, Saxena Subhash, Dhanpat Rai & sons,Delhi

Indian standards and handbooks

01 IRC 37-2018, Guidelines for the design of Flexible Pavement (Fourth Revision).
02 IRC 58-2015, Guidelines for the Design of Plain Jointed Rigid Pavements for Highways (Fourth Revision).
03 IRC 81-1997, Guidelines for Strengthening of Flexible Road Pavements using Benkelman Beam Deflection Technique (First Revision).
04 IRC 82-2015, Code of Practice for Maintenance of Bituminous Surfaces of Highways.
05 IRC SP 110: 2017, Application of Intelligent Transport System for Urban Roads.
06 IRC SP: 12 – 2015, Guidelines for Parking Facilities in Urban Areas (First Revision).
07 IRC 93: 1985, Guidelines on Design and Installation of Road Traffic Signals.
08 IRC SP: 16 – 2019, Guidelines on Measuring Road Roughness and Norms. (Second Revision).
09 IRC SP: 83 – 2018, Guidelines for Maintenance, Repairs & Rehabilitation of Cement Concrete Pavements.
10 Handbook of Road Technology, Lay M. G. Gorden Breach Science Pub. Newyork.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
4010 14 c Elective VI: Geo-Synthetic Engineering

Teaching scheme	Credits	Examination scheme
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites

Geotechnical Engineering, Foundation Engineering

Course objectives

01 To deal with the geo-synthetics as construction materials in civil engineering project.
02 To introduce the manufacture, behaviour and concept of geo-synthetics.
03 Applications of geo-synthetics in different civil engineering projects.

Course outcomes

On successful completion of this course, the learner will be able to,

01 Explain types of Geo-synthetic material and its application in construction industry
02 Define physical and engineering properties of geo-synthetics material
03 Describe function of geo-synthetics material and its application in geo environment engineering
04 Analyse effect of geo-synthetics in design of flexible pavements
05 Design the reinforced soil retaining structures
06 Explain mechanism of soil reinforcement to improve bearing capacity of soil

Course Content

Unit 1: Overview of Geo-synthetics (06 hours)

Types of geo-synthetics: geo-textile, geo-grid, geo-nets, geo-membranes, geo-foam, geo-composite, introduction of geo-synthetic clay liners, primary functions of each geo-synthetics material, manufacturing of geo-synthetics, raw materials used, different types of geo-synthetics manufacturing system.

Unit 2: Properties of Geo-synthetics material (06 hours)

Geo-synthetics testing, various properties of geo-synthetics, physical properties, mechanical properties, hydraulic properties and endurance properties

Unit 3: Functions of Geo-synthetics material (06 hours)

Geo-synthetics in filtration, drainage and erosion control, mechanism of filtration and drainage function and their application, design step for erosion control and re-composite drainage, application of geo-synthetics in geo environment.

Unit 4: Geo-synthetics in Pavement (06 hours)

Mechanism and concept of pavement, design of unpaved road using geo-synthetic material, giroud and Noiray method, airfield pavement design.

Unit 5: Geo-synthetics in reinforced soil retaining wall (06 hours)

Types of the facing element, construction procedure, cost, design of geo-synthetics wrap around face wall, geo-grid reinforced soil wall, geo-cell wall and gabion wall.

Unit 6: Geo-synthetics in ground improvement **(06 hours)**

Consolidation technique, prefabricated vertical drain, ground instrumentation and monitoring, design of encased stone column, bearing capacity of geo-synthetics reinforced soil system, mechanism of geo-cell reinforced sand overlaying soft clay.

Text books

01 Advanced Soil Mechanics, Das. B. M. 2008, Taylor and Fracis group, London

Reference books

01 Designing with Geo-synthetics. Vols. 1 & 2, Koerner, R. M., 6th Edition, Xlibris Corporation, USA.

02 Geo-synthetics Design and Construction Guidelines, Holtz. R. D., Christopher. B. R. and Berg. R. R. Technical Consultant, Dr. DiMaggio, U.S. Department of Transportation, Washington DC, FHWA-H1-98-038

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 014 d Elective VI: Structural Design of Foundations

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Basics of geotechnical engineering

Course objectives
01 To assess the soil condition at a given location in order to suggest suitable foundation based upon bearing capacity.
02 To study design procedure of raft foundation and Machine foundations.
03 To study design principles of pile foundation, pile caps, well and caissons foundations.
04 To have knowledge on methods of retaining structures.

Course outcomes
On successful completion of this course, the learner will be able to,
01 Judge suitable type of shallow foundation based on the available soil category.
02 Decide suitable type of pile foundation for different soil stratum and evaluation of group capacity by formulation.
03 Design Raft foundations.
04 Design well and caissons Foundations.
05 Design different types of Machine foundations.
06 Design Retaining Structures.

Course Content

Unit 1: Shallow Foundations **(06 hours)**
Review of soil investigation, estimation of bearing capacity, settlement and depth of foundation, types of foundations and their specific applications, structural design of combined footings: strip footing, trapezoidal and strap.

Unit 2: Raft Foundation **(06 hours)**
Structural design of rafts by conventional method, principles of design of buoyancy raft and basement (no design problems), pressure relieve valves or ground/rock anchors (no design problems), concept of modulus of sub-grade reactions.

Unit 3: Pile Foundation **(06 hours)**
Types of pile foundations and their applications, estimation of load capacity of piles by static and dynamic formulae, pile load test, settlement and detailing as per IS 2911, concept of negative skin friction, piles subjected to uplift load (including under reamed piles), structural design of piles and pile caps, modulus of sub-grade reaction for laterally loaded piles.

Unit 4: Well and Caisson Foundations **(06 hours)**

Review of well and caisson foundations, structural elements of caisson and well foundations, load carrying capacity, grip length, structural design of well foundation and lateral stability, design of individual components of caisson foundation (only forces acting and design principles).

Unit 5:Machine Foundations **(06 hours)**

General requirements and design criteria, analysis and design by Barkans method, determination of coefficient of uniform elastic compression, design of a machine foundation, IS. Method of design (IS 2974).

Unit 6: Retaining walls **(06 hours)**

Types of flexible and rigid earth retention systems: counter fort, gravity, diaphragm walls, sheet pile walls, soldier piles and lagging, support systems for flexible retaining walls (struts, anchoring), construction methods, stability calculations, design of flexible and rigid retaining walls (Cantilever), types of reinforced earth (RE) walls, gabbions, soil nailing & rock bolting.

Text books

01 Soil Mechanics and Foundation Engineering, A. K. Arora, Standard Publishers
02 Soil Mechanics and Foundation Engineering, B. C. Punmia, Laxmi Publication.
03 Foundation Engineering, P. C. Varghese, PHI learning private limited
04 Principles of Foundation Engineering, Dass B. M., Thomson Learning

Reference books

01 Advanced Foundation Engineering, Murthy V. N. S., C.B.S. Publishers
02 Foundation Analysis and Design, Bowels J. E., McGraw-Hill International Book Co.
03 Foundation Design: Principles and Practice, Coduto, Donald P., Prentice Hall
04 Principles of Foundations Engineering, Braja M. Das, Thomson Asia (P) Ltd.
05 Foundation Design manual for Practicing Engineers, Nayak, N. V., Dhanpat Rai and Sons
06 Foundation Engineering Handbook, Robert W. Day, Tata McGraw- Hill Companies Inc.
07 Foundation Design and Construction, Tomlinson, M. J. and Boorman. R., ELBS Longman.

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Savitribai Phule Pune University, Pune
B E Civil (2019 pattern) w. e. f. June 2021
401014 e: Elective VI: Green Structures and Smart Cities

Teaching scheme	Credits	Examination scheme
Lectures: 3 hours/week	03	In semester exam: 30 marks End semester exam: 70 marks

Pre-requisites
Understanding of basic civil and environmental engineering

Course objectives
01 To understand green structures and energy efficient materials and their impacts on sustainability
02 To describe different terminologies and engineering concepts involved in smart city.
03 To understand the importance of smart cities with available case studies from India.

Course outcomes
On successful completion of this course, the learner will be able to,
01 Students should be able to describe the importance of energy and minimization by altering the building materials.
02 Students should be able to understand the importance green construction and green rating system
03 Students should be able to introduce the applications of energy conservation and efficiency practices in buildings.
04 Students should be able to understand phases and approval involved in smart city project.
05 Students should be able to assess the national and global experience of smart cities.
06 Students should be able to understand the importance of sustainable development and current protocol of sustainable development goals.

Course contents

Unit 1: Introduction to Embodied Energy (06 hours)
Introduction to embodied energy, operational energy in building and life cycle energy, ecological foot print, bio-capacity and calculation of planet equivalent, introduction to civil engineering materials with embodied energy minimization concept and utilization

Unit 2: Green Construction Practices (06 hours)
Introduction to green construction practices, operational energy reduction and net zero building, introduction to optimization for design of building for energy efficiency, examples of optimization, introduction to radiation budget, surface water balance, effects of trees and microclimatic modification through greening, importance of rating and rating systems.

Unit 3: Building Integrated Photo Voltaic (06 hours)
Introduction to use of building integrated photo voltaic (BIPV) and other renewable energy in buildings their basic concepts and efficiency, introduction to energy conservation building code (ECBC-2017), mandaroty requirement for comfort system and control and electrical and renewable energy system, introduction to concepts of overall thermal transfer value (OTTV) etc.

Unit 4: Introduction to Smart Cities (06 hours)
Introduction to smart cities, introduction to city planning, dimensions of smart cities, phases, stages of project & their approval status, conventional Vs. smart city components, energy demand, green

approach to meet energy demand, index of Indian cities towards smartness, introduction to statistical analysis.

Unit 5: Singular-Hybrid Smart Cities **(06 hours)**

Conventional cities, consequences, alternative resources, reliability on predictability scale, solar options, PV and thermal; singular or hybrid, global experience of smart cities, smart cities, global standards and performance benchmarks, practice codes, India "100 smart cities" policy and mission, smart city planning and development.

Unit 6: Sustainable Smart City **(06 hours)**

Swachh Bharat mission and smart cities program, financing smart cities development, smart city case studies, governance of smart cities, introduction to artificial intelligence (AI) in smart cities, introduction to (sustainable development goal) SDG, the importance of SDG 11.

Text Books

01 Green Building Materials: A Guide to Product Selection and Specification, 3rd Edition, Ross Spiegel, Dru Meadows

02 Mindful Smart Cities: Rethinking Smart Cities with Mindfulness Engineering, Shima Beigi PhD, VUB PRESS

Reference Books

01 Climate responsive architecture (A design hand book for energy efficient buildings), Arvind Krishnana, Simos Yannas, Nick Baker, S V Szokolay, McGraw hill Education, Seventh reprint.

02 Energy and the Environment, J M Fowler, McGraw Hill, New York, 2nd Edition.

03 Time-Saver Standards For Building Types, Joseph De Chiara, Michael J. Crosbie, McGraw-Hill.

04 Smart Cities: Foundations, Principles, and Applications, Houbing Song, Ravi Srinivasan, Tamim Sookoor, Wiley.

05 Beyond Smart Cities: How Cities Network, Learn and Innovate, Tim Campbell, Routledge.

IS Codes

01 Handbook on functional requirements of buildings (SP41), Bureau of Indian Standards, New Delhi, New Delhi, 1987

02 Energy Conservation Building Code (ECBC), Bureau of energy efficiency, 2017

03 Sustainable Building Design Manual- Volume I & II, TERI, 2009.

04 Green Rating for Integrated Habitat Assessment (GRIHA) guidelines

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Savitribai Phule Pune University, Pune
B E Civil (2019 pattern) w. e. f. June 2021
401014 f: Elective VI: Rural Water Supply Engineering

Teaching scheme	Credits	Examination scheme
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Understanding of basic civil and environmental engineering

Course Objectives
01 Students will gain knowledge of techno-economic issues related to Rural Water Supply.
02 Students will study interdisciplinary aspects of water supply engineering.
03 Subject will make students understand administrative aspects related to water supply.

Course Outcomes
On successful completion of this course, the learner will be able to,
01 Understand issues related to rural water supply with respect to source, water related issues in rural areas.
02 Understand role of various government departments and importance of participatory approach.
03 Understand various types of rural water supply scheme and infrastructure requirements therein.
04 Understand interdisciplinary requirements in RWS including Software
05 Understand Automation requirements for a Water Supply Project
06 Understand Documentation and O and M issues related Water Supply Project including Leak Detection.

Course Contents

Unit I: Introduction to Water Related Issues (06 hours)
Source vis-à-vis population (e.g. up to 2000 ground water, > 2000 surface), introduction to reservation of water, permissions of concerned authorities to lift water from notified river, water related issues in rural areas, water supply scheme for single gram Panchayat/Group gram Panchayat, geology/ certificate from GSDA, geology and its relation with groundwater, strengthening of source, introduction to RWH, horizontal bore, hydro-fracturing, well sinking, unconventional methods by GSDA, retrofitting of schemes. use of weep holes, yield test of open well, tube and bore well, introduction to Shivkalin Pani Sathawan Yojana, water quality and quantity.

Unit II: Socio- Economic Aspects of WS Schemes (06 hours)
Various departments involved in water conservation, participatory approach for success of project, financial scheme available with department, case studies: such as Palsoshi (Bhor), Hiware Bazar, Lamkani-(Dhule) available with MJP, capacity building of villagers.

Unit III: Various Types of Rural Water Supply Schemes (06 hours)
Introduction to single village scheme, introduction to regional rural W. S. Scheme, use of available infrastructure if any, retrofitting to available infrastructure, various components and layout of W. S. Schemes, scour depth calculation for well on bank/in a river bed, intake- Jack well (pump house), slotted pipe galleries and trench galleries, percolation wel, connecting mains, recuperation test (owner's responsibility), introduction to rising main/gravity main, introduction to WTP SR-ESR/GSR/MBR, introduction to distribution, including house connection (Ferrule).

Unit IV: Interdisciplinary Aspects of Rural Water Supply **(06 hours)**

Introduction to electro mechanical aspects, pumping machinery, source-intake/WTP/ESR, introduction to hydraulic testing of pipelines, source: conveyance, selection of rising main and its appurtenances to control water hammer, flow, airlocks etc., introduction to pumps & pumping machinery, selection of types of pumps, calculation of hours of power required, requirements of electric supply (3 phase), availability of E. S. Software/Programmes for design of economical diameter of R. M., techno- economic comparison of various pipe materials (R. M./Gravity Main, as well as distribution lines), requirement of residual hydraulic pressure, calculation of hydraulic grade line HGL and frictional head with total head acting on pump, introduction to JALTANTRA software of IIT Bombay.

Unit V: Instrumentation in WSE **(06 hours)**

Introduction to auto pump controller, sensor for water quality monitoring cycle PH, turbidity meter, TDS meter, ultrasonic level sensor, hydraulic modeling, use of instrumentation and robotics in WSS, use of SCADA and introduction to SCADA based automation, PLC in WSE, application of GPS in WSE, application of GIS in WSE, introduction to the water meter, case study of Malakapur Town.

Unit VI: Documentation of Presentation **(06 hours)**

Record drawings of executed works, (As built drawings), periodical maintenance of pumping machinery, electrical components and other machinery, training requirements to villagers on operation and maintenance issues, introduction to preventive maintenance, leakage detection: techniques used and importance.

Text Books

01 Water Supply Engineering, S. K. Garg, Khanna Publications

02 Water Supply Engineering, Dr. P. N. Modi, Standard Book House

Reference Books

01 CPHEEO Manual on Water Supply and Treatment

02 Rural Water Supply And Sanitation by Sanjay Gupta

03 IWWA Technical Data Book (Available with IWWA Pune Local Centre)

04 Special Reference Material Recommended:
Compendium of Training Materials for the Capacity Building of the Faculty and Students of Engineering Colleges on Under the Unnat Maharashtra Abhiyan (UMA) Prepared By Institute for Resource Analysis and Policy, Hyderabad & CTARA, IIT Bombay Supported by UNICEF, Mumbai March, 2018

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 015: Project Stage II

Teaching scheme	**Credits**	**Examination scheme**
Practical: 04 Hours/week	03	Term Work: 100 Marks
	02	Oral: 50 Marks

Pre-requisites

Fundamentals of Civil Engineering

Course objectives

01 Identify latest technical/practical problems in the field of Civil Engineering.
02 Inculcate the ability to describe, interpret and analyze technical content.
03 Develop competence in preparing report which will enhance critical thinking and develop the skill of technical writing along with presentation.

Course outcomes

On successful completion of this course, the learner will be able to:

01 Appraise the current Civil Engineering research/techniques/developments/interdisciplinary areas.
02 Review and organize literature survey utilizing technical resources, journals etc.
03 Evaluate and draw conclusions related to technical content studied.
04 Demonstrate the ability to perform critical writing by preparing a technical report.
05 Develop technical writing and presentation skills.

Term Work

The Project Stage II report should contain the following. Internal guides may prepare a continuous evaluation sheet for each student and refer as continuous assessment for term work marks.

01 Introduction including aim and objective
02 Review of literature
03 Problem statement and methodology
03 Concepts associated with the project topic
04 Results and discussion
05 Validation of results
06 Conclusions and future scope of work
07 References
08 Students publication/achievements

In Project Work Stage II, the student shall complete the project and prepare the final report of project work in standard format duly certified for satisfactory completion of the project work by the concerned guide and Head of the Department/Institute. The final project report shall be submitted in hard bound copy as well as a soft copy. The term work of project stage II shall be assessed jointly by the pair of internal and external examiners, along with oral examination of the same. It is recommended that at least one publication on the project topic to be presented in a conference or published in a referred journal.

Oral Examination: The students must prepare presentation on Project Stage II and present in presence of pair of examiners through a viva-voce examination.

Savitribai Phule Pune University, Pune
B.E. Civil (2019 Pattern) w. e. f. July 2022
401016: Dams and Hydraulics Structures Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work consists of following compulsory assignments. Oral examination is based on term work.

01 Literature collection of introductions to dams (minimum 5 dams) or case study of failure of any hydraulic structure.
02 Stability analysis of gravity dam
03 Design of profile of spillway
04 Design of energy dissipation device below the spillway
05 Stability analysis of zoned earthen dam (Preferably use of AutoCAD sheet)
06 Analysis of weirs on permeable foundations
07 Design of lined canal
08 Site visits and reports with photographs (compulsory) of the following.
Gravity dam/earthen dam
Spillway
CD/Canal structures/Weirs/Barrage

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 017: Quantity Surveying, Contracts and Tenders Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Oral: 50 Marks

Term Work

Term work consists of following compulsory exercise. Oral examination is based on term work.

01 Detailed estimate of load bearing structure (for a single storied building), calculation of steel reinforcement by percentage basis, using rates as per current SSR.
02 Working out detailed quantities for two storied (G+1) R.C.C. framed building based on prevailing SSR.
03 Preparation of bar bending schedule for the G + 1 building as in exercise No. 2.
04 Detailed estimate for any one of the following
a. Factory Shed of Steel Roof Truss
b. Elevated Water Reservoir
c. Pipe/Slab Culvert
d. Road / Railway Track/Runway
05 Detailed specifications for major construction items of building/road.
06 Working out rate analysis for major construction items of building/road.
07 Preparation of tender documents for exercise No. 2 (Preparation of schedule A & B, conditions of contract regarding time, labour payment, etc.) and collection of tender notice for different government construction works (minimum 3)
08 Preparing valuation report of a Residential building and writing report using O-1 form
09 Appropriate software/excel spread sheet for exercise in serial No 1 to 4 is recommended.
10 Site visit and reports for understanding of BBS with photographs (Mandatory)

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 018 a Elective V: Earthquake Engineering Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work consists of the following experiments or assignments. Term work marks will be based on continuous assessment.

01 Assignments on each unit.
02 Using any programming language or spreadsheets, plot the response functions for various types of excitations.
03 Demonstrate the applications of horizontal and vertical shake tables.
04 Perform seismic analysis of a multi-story building using any software.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 018 b Elective V: Structural Design of Bridges Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work consists of the following experiments or assignments. Term work marks will be based on continuous assessment.

01 One project on RC highway bridges which shall include: design of deck slab, longitudinal girder, cross-girder, bearings, abutment and pier. The detailing shall be shown in at least three full imperial sheets.

02 One project on railway steel bridges which shall include: design of steel trussed bridges 'or' the design of plate girder bridges. The detailing shall be shown in at least two full imperial sheets.

03 Report of at least two site visits covering the contents of the syllabus.

Note: 1. The projects can be done using suitable finite element and drafting software.

2. The term work can be prepared in a group of not more than four students in a group.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 018 c Elective V: Irrigation and Drainage Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work consists of the following experiments or assignments. Term work marks will be based on continuous assessment.

01 Assignment to summarize types of irrigation methods and application of artificial intelligence techniques in irrigation and drainage.
02 Assignment on evapotranspiration estimation using Penman's equation or FAO Penman-Monteith equation. *(Hand calculations).*
03 Assignment on solution of Assignment 2 using computer programme/spreadsheet.
04 Assignment on design of drip irrigation system.
05 Assignment on design of sprinkler irrigation system.
06 Assignment based on Unit 5. (Min. 6 questions).
07 Assignment on design of surface drainage system and design of subsurface drainage system
08 Assignment on use of **CropWat** software to determine crop water requirement and irrigation scheduling.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 018 d Elective V: Design of Precast and Composite Structures Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work should consist of the following. Term work marks will be based on continuous assessment.

01 Assignment one at least five questions on Unit 1 covering all the topics listed in syllabus.
02 Assignment two at least five questions on Unit 2 covering all the topics listed in syllabus.
03 Full imperial drawing sheet: detailing of any one design problem from Unit 3 or Unit 4
04 Full imperial drawing sheet: detailing of any one design problem from Unit 5 or Unit 6
05 Report on site visit (Precast or Composite Structures) covering the contents of the syllabus mentioned above.
06 Analysis and design of composite building using any suitable FE based software.

Note: The group size should not be more than five students and each group should have different design data.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 018 e Elective V: Hydropower Engineering Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work should consist of the following. Term work marks will be based on continuous assessment.

01 Calculating the electricity bill of upper middle class family that uses various electrical appliances.
02 Determination of power output for a run of river plant with and without pondage.
03 Justification of economics of pumped storage plants.
04 Design of Kaplan / Francis / Pelton turbine.
05 Design of straight conical draft tube.
06 Use of any software to calculate water hammer pressure.
07 Study of any hydropower project.
08 Design of intake of a hydropower plant with neat sketch**:** Design of settling basin of a hydropower plant with neat sketch.
09 Hydraulic Design of Forebay and preparation of plan and longitudinal sections **::** Hydraulic Design of Surge Tank and preparation of plan and vertical sections **::** Estimation of hydrodynamic pressure and steel thickness of penstock.
10 Report based on visit to any micro/small/mega hydropower project.

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Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. June 2022
401 018 f Elective V: Structural Audit and Retrofitting of Structures Lab

Teaching scheme	**Credit**	**Examination scheme**
Practical: 02 Hours/week	01	Term Work: 50 Marks

Term Work

Term work should consist of the following. Term work marks will be based on continuous assessment.

01 Report on various repair materials available in the market
02 Conduction of Visual observation of any damaged structure and preparation of report
03 Determination of compressive strength of polymer modified mortar
04 Determination of compressive strength of polymer modified concrete
05 Non-destructive test on concrete (any one)
06 Assignment on materials and methods of retrofitting.
07 Demonstration of Moisture barrier coatings and membranes
08 Assignment on Retrofitting of RC Beams using FRP
09 Assignment on Retrofitting of RC Columns using FRP
10 Site Visit to any structure where repair/retrofitting work is in progress
11 Conduction of Structural Audit of any nearby structure and preparation of detailed report

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Savitribai Phule Pune University, Pune
B E Civil (2019 Pattern) w. e. f. July 2022
401019Audit Course II a: Social Responsibility

Teaching scheme	Credit	Examination scheme
Tutorial: 01 Hours/week	--	Grade

Pre-requisites
None

Course objectives
01 Develop understanding of social responsibility
02 Understand the International framework for Social Responsibility
03 Know the drivers of social responsibility in India
04 Identify the key stakeholders of social responsibility

Course outcomes
On successful completion of this course, the learner will be able to:
01 Develop understanding of social responsibility
02 Learn the International framework for Social Responsibility
03 Know the drivers of social responsibility in India
04 Identify the key stakeholders of social responsibility

Course Contents

Unit 1: Introduction to social responsibility meaning and definition, history of social responsibility, concepts of charity, social philanthropy, citizenship, sustainability and stakeholder management, environmental aspects of social responsibility. International framework for social responsibility: millennium development goals, sustainable development goals, relationship between corporate social responsibility and millennium development goals, OECD corporate social responsibility policy tool.

Unit 2: Drivers of social responsibility in India: market based pressure and incentives, civil society pressure, the regulatory environment in India counter trends, review of current trends and opportunities in social responsibility, review of successful corporate initiatives and challenges of social responsibility. Identifying key stakeholders of social responsibility: role of public sector in corporate, government programs, non-profit and local self-governance in implementing social responsibility, global compact self-assessment tool, national voluntary guidelines by govt. of india, roles and responsibilities of corporate foundations.
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Reference books

01 Strategic Corporate Social Responsibility: William B. Werther Jr. and David Chandler, Stakeholders in a Global Environment, Second Edition, Sage Publications.
02 Corporate Social Responsibility in India: Sanjay K Agarwal, Sage Publications.
03 Corporate Social Responsibility: An Ethical Approach: Mark S. Schwartz, Broadview Press.

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Savitribai Phule Pune University, Pune
B E Civil (2019 Pattern) w. e. f. July 2022
401019 Audit Course II b: Human Rights

Teaching scheme	Credit	Examination scheme
Tutorial: 01 Hours/week	--	Grade

Pre-requisites
None

Course objectives
01 Understand the concept of Human rights and Human rights Movement
02 Understand the Human rights and Indian Constitution
03 Gather Knowledge about Human Rights of the Different Sections and contemporary issues
04 Gather knowledge about international scene towards human rights with reference to engineering Industry

Course outcomes
On successful completion of this course, the learner will be able to,
01 Gather Knowledge about Human rights and Human rights Movement
02 Develop understanding of Human rights and Indian Constitution
03 Discuss Human Rights of the Different Sections and contemporary issues
04 Discuss International scenario towards human rights with reference to engineering Industry

Course Content

Unit 1: Human rights: concept, development, evolution-philosophical, sociological and political debates, benchmarks of human rights movement. Human rights and the Indian constitution: constitutional framework, fundamental rights and duties, directive principles of state policy, welfare state and welfare schemes. Human rights and state mechanisms: police and human rights, judiciary and human rights, prisons and human rights, national and state human rights commissions.

Unit 2: Human rights of the different sections and contemporary issues: unorganized sector, right to environment, particularly industrial sectors of civil engineering and mechanical engineering, globalization and human rights, right to development, citizens' role and civil society: social movements and non-governmental organizations, public interest litigation. Role of non-government organizations in implementation of human rights: right to information. Human rights and the international scene: primary information with reference to engineering. Industry: UN documents, International mechanisms (UN & Regional), International criminal court.

Reference Books

01 Human Rights in India- A Mapping: Usha Ramanathan.
Free download from http://www.ielrc.org/content/w0103.pdf
02 Introduction to International Humanitarian Law by Curtis F. J. Doebbler - CD Publishing
03 Study material on UNESCO, UNICEF web site
04 http://www.unipune.ac.in/pdf_files/final%20book_03042012.pdf
05 http://eclm.unipune.ac.in/Human rights

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