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	Transpiration 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	Application of Python in Civil Engineering Lab	01	02	--	--	--	50	--	--	50	--	02	--	--	--	02
401010	Audit Course I:	--	--	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 Resource 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 Structure	03	--	--	30	70	--	--	--	100	03	--	--	--	--	03
401012	Quantity Surveying, Contract 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 Structure **Lab**	--	02	--	--	--	--	--	50	50	--		--	01	--	01
401017	Quantity Surveying, Contract and Tenders **Lab**	--	02	--	--	--	--	--	50	50	--		--	01	--	01
401018	Elective V **Lab**	--	02	--	--	--	50	--	--	50	--	01	--	--	--	01
401019	Audit Course II:	--	--	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 Green 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	**Credit**	**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 outcome

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 a) 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 book

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	Credit	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 outcome
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 book

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 Standard and Handbook

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	**Credit**	**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 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 outcome
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 1: 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 III: 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 IV: 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 V: 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-VI: 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.

Reference Books

01 Shore protection manual, Brunn Per and B. U. Naik, Nio, Goa.
02 Port planning, Qeen A. D. Mc Grow Hill Book Co. New York.
03 Coastal engineering, Vol-I-II, Silvester Richard, University of Western Australia.
04 Shore Protection Manual, U. S. Waterways Experiment Station Corps of Engineer.
05 Costal Engineering Research Center, Vickburg and USA1984,Coastal Protection Manual 2002.
06 Harbour and Coastal engineering Vol I & II, Ocean and Coastal Engineering Publication.

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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	**Credit**	**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	**Credit**	**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 II: 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 III: 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 IV: 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 V: 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 VI: 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	**Credit**	**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 in Civil Engineering

Teaching scheme	Credit	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 outcome

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	**Credit**	**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 outcome
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	**Credit**	**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 outcome

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 book

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 Atmospheric Chemistry and Physics, Seinfeld, J.H., Pandis, S.N., John Wiley, 2006.

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

05 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	**Credit**	**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 I: 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 II: 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 III: 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 IV: 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 V: 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 VI: 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 & Gore, Structures Publication, Pune

05 Punmia and Jain, Comprehensive Design of steel structure, Laxmi Publication, New Delhi

IS Code

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	**Credit**	**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 I: **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 II: **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 III: **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 IV: **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 V: **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 VI: **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	**Credit**	**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 outcome
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 book

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	Credit	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 outcome
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 book

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	**Credit**	**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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