हरकोर्ट बटलर प्राविधिक विश्वविद्यालय
नवाबगंज, कानपुर – 208002, उ.प्र., भारत
HARCOURT BUTLER TECHNICAL UNIVERSITY
NAWABGANJ, KANPUR - 208002, U.P., INDIA
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100+ YEARS 1921 - 2021

ACCREDITED WITH GRADE A+ NAAC

Course Structure, Evaluation Scheme
&
Detailed Syllabus of
B.Tech. Civil Engineering
(Effective from Session 2022-23)

Department of civil engineering
HBTU, KANPUR

HARCOURT BULTER TECHNICAL UNIVERSITY KANPUR

Civil Engineering Department

B. Tech. Program Semester-wise Course Structure

(Applicable from Session 2022-2023 for new entrants)

Year I, Semester-I

S. No.	Course Type	Course Title	Subject Code*	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Chemistry		4	3	0	2	15	20	15	50	50	100
2	ESC	Introduction to Computer Science &Engineering		4	3	1	0	30	20	-	50	50	100
3	ESC	Introduction to Electronics Engineering		4	3	1	0	30	20	-	50	50	100
4	ESC	Introduction to Civil Engineering	NCE 101/103	4	3	1	0	30	20	-	50	50	100
5	ESC	Introduction to Chemical Engineering &Chemical Technology		4	3	1	0	30	20	-	50	50	100
6	ESC	Workshop Practice		2	0	0	4	-	20	30	50	50	100
	Total Credits: 22												**600**

Year I, Semester-II

S. No.	Course Type	Course Title	Subject Code *	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Physics		4	3	0	2	15	20	15	50	50	100
2	BSC	Engineering Mathematics-I		4	3	1	0	30	20	-	50	50	100
3	ESC	Introduction to Electrical Engineering		4	3	0	2	15	20	15	50	50	100
4	ESC	Introduction to Mechanical Engineering		4	3	1	0	30	20	-	50	50	100
5	HSMC	Professional Communication		4	2	1	2	15	20	15	50	50	100
6	ESC	Engineering Graphics	NCE 102/104	2	0	0	4	30	20	-	50	50	100
	Total Credits: 22												**600**

*To be allotted by Academic Section

HARCOURT BULTER TECHNICAL UNIVERSITY KANPUR

Civil Engineering Department

B. Tech. Program Semester-wise Course Structure

(Applicable from Session 2022-2023 for new entrants)

II, Semester- III

S. No.	Course Type	Course Title	Subject Code*	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engg. Math-II		4	3	1	0	30	20	-	50	50	100
2	ESC	Strength of Material	NME201	4	3	1	0	30	20	-	50	50	100
3	PCC	Fluid Mechanics	NCE201	4	3	1	0	30	20	-	50	50	100
4	PCC	Surveying	NCE203	4	2	1	2	15	20	15	50	50	100
5	PCC	Building Material and Construction	NCE205	4	3	0	2	15	20	15	50	50	100
6	PCC	Geotechnical Engineering-I	NCE207	4	2	1	2	15	20	15	50	50	100
	Total Credits: 24												**700**

Year II, Semester- IV

S. No.	Course Type	Course Title	Subject Code *	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engg. Math III		4	3	1	0	30	20	-	50	50	100
2	ESC	HHM/C	NCE202	4	2	1	2	15	20	15	50	50	100
3	PCC	SA-I	NCE204	3	2	1	0	30	20	-	50	50	100
4	PCC	DCS-I	NCE206	4	2	1	2	15	20	15	50	50	100
5	PCC	Environmental Engg – I	NCE208	3	2	1	0	30	20	-	50	50	100
6	HSMC	Engg. Economics & Management		3	3	0	0	30	20	-	50	50	100
7	PCC	Transportation Engineering-I	NCE210	3	3	0	0	30	20	-	50	50	100
	Total Credits: 24												**700**

*To be allotted by Academic Section

HARCOURT BULTER TECHNICAL UNIVERSITY KANPUR SCHOOL OF ENGINEERING

Civil Engineering Department

B. Tech. Program Semester-wise Course Structure

(Applicable from Session 2022-2023 for new entrants)

Year III, Semester- V

S. No.	Course Type	Course Title	Subject Code*	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PCC	Structural Analysis II	NCE301	3	2	1	0	30	20	-	50	50	100
2	PCC	Design of Concrete Engineering-II	NCE303	3	2	1	0	30	20	-	50	50	100
3	PCC	Geotechnical Engineering, II	NCE305	4	3	1	0	30	20	-	50	50	100
4	PCC	Transportation Engineering-II	NCE307	4	3	0	2	15	20	15	50	50	100
5	PCC	Environmental Engineering II	NCE309	4	3	0	2	15	20	15	50	50	100
6	PCC	Computer Applications in Civil Engineering	NCE311	2	1	0	2	15	20	15	50	50	100
7	-	Open Elective*		2	2	0	0	30	20	-	50	50	100
	Total Credits: 22												**700**

Year III, Semester- VI

S. No.	Course Type	Course Title	Subject Code *	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PCC	Design of steel structure	NCE302	3	2	1	0	30	20	-	50	50	100
2	PCC	Engg Hydrology	NCE304	3	3	0	0	30	20	-	50	50	100
3	PCC	Estimation & Construction Management	NCE306	3	3	0	0	30	20	-	50	50	100
4	PCC	Irrigation & Hydraulic Design	NCE308	4	3	1	0	30	20	-	50	50	100
5	PCC	Earthquake Resistant Design	NCE310	3	3	0	0	30	20	-	50	50	100
6	PEC-I	As per Annexure-I		4	3	1	0	30	20	-	50	50	100
7	HSMC	Entrepreneurship Development		2	2	0	0	30	20	-	50	50	100
	Total Credits: 22												**700**

*To be allotted by Academic Section

HARCOURT BULTER TECHNICAL UNIVERSITY KANPUR

Civil Engineering Department

B. Tech. Program Semester-wise Course Structure

(Applicable from Session 2022-2023 for new entrants)

Year IV, Semester- VII

S. No.	Course Type	Course Title	Subject Code*	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PEC-II	As per Annexure-I		4	3	1	0	30	20	-	50	50	100
2	PEC-III	As per Annexure-I		3	3	1	0	30	20	-	50	50	100
3	PEC-IV	As per Annexure-I		3	3	1	0	30	20	-	50	50	100
4	Seminar	Seminar	NCE471	2	0	0	4	-	-	-	50	50	100
5	Industrial Training	Industrial Training	NCE481	2	0	0	4	-	-	-	50	50	100
6	Minor Project	B.Tech MinorProject	NCE491	6	0	0	6	-	-	-	50	50	100
7	OCE-II	As per Annexure-I		2	2	0	0	30	20	-	50	50	100
	Total Credits: 22												**700**

Year IV, Semester- VIII

S. No.	Course Type	Course Title	Subject Code *	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PEC-V	As per Annexure-I		4	3	1	0	30	20	-	50	50	100
2	OCE-III	As per Annexure-I		2	2	0	0	30	20	-	50	50	100
3	Project	B.Tech Project	NCE492	16	0	0	16	-	-	-	100	100	200
	Total Credits: 22												**400**

***To be allotted by Academic Section**

Annexure-I

List of Program Elective Course (PEC) and
Open Electives (OE)

PEC I		
S.no	Name of the Course	Course code
1	Repair and Maintenance of Concrete Structures	NCE 322
2	Ground Improvement Technology	NCE 324
3	Environmental Impact Assessment	NCE 326
4	Advanced Concrete Technology	NCE 328
5	Industrial Waste Management	NCE 330
6	Remote Sensing And GIS	NCE 332
7	Traffic Engineering	NCE 334
8	Open Channel Flow	NCE 336
PEC II		
1	Site Investigation and Foundation Design	NCE 421
2	Earthquake Resistant Design of Structures	NCE 423
3	Municipal Solid Waste Management	NCE 425
4	Transportation System and Planning	NCE 427
5	Bridge Engineering	NCE 429
6	Stochastic Hydrology	NCE 431
7	Advanced Steel Structures	NCE 433
8	Environmental Risk Assessment	NCE 435
PEC III		
1	Design of Tanks and Reservoirs	NCE 441
2	Structural Dynamics	NCE 443
3	Soil Dynamics	NCE 445
4	Industrial Wastewater Treatment	NCE 447
5	Advanced Hydrology	NCE 449
6	Introduction to Intelligent Transportation Systems	NCE 451
7	Solid Waste Engineering	NCE 453
8	Advanced Structural Analysis	NCE 455
PEC IV		
1	Structural Fire Engineering	NCE 461
2	Earthquake Resistant Design of Foundations	NCE 463
3	Slope Stability Analysis and Design	NCE 465
4	Water Quality Modelling	NCE 467
5	Pavement Construction and Maintenance	NCE 469
6	Urban Hydrology	NCE 471
7	Highway Soil Mechanics	NCE 473
PEC V		
1	Geo-Environmental Engineering	NCE 422
2	Planning And Management of Buildings	NCE 424
3	Environmental Pollution and Control	NCE 426
4	Ground Water Flow and Pollution Modelling	NCE 428
5	Construction And Contract Management	NCE 430
6	Sustainable Transport System	NCE 432
7	Precast And Modular Construction Practices	NCE 434
8	Pre-Stressed Concrete Design	NCE 436
Open Elective II		
1	Environmental Pollution and Management	OCE401
2	Disaster Management	OCE403
Open Elective -III		
1	Introduction to RS and GIS	OCE402
2	Introduction to Infrastructure Engineering	OCE404

INTRODUCTION TO CIVIL ENGINEERING

L T P C 3 1 0 4

Course Outcomes for Introduction to Civil Engineering

After successful completion of the course, the students will be able to:
CO1. To understand the overview and scope of Civil Engineering and apply fundamentals of Surveying.
CO2. To understand the various types of materials used in Civil Engineering.
CO3.To understand the basic concepts of water and wastewater quality, infrastructure, and also basics of different pollution.
CO4. To understand the basics of Highways, Railways and Airport Engineering.
CO5.To understand the basic design principles for various Civil Engineering structure

Course Articulation matrix for Engineering Graphics

Program Outcomes (PO) / Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	2	-	-	-	-	-	1
CO2	2	-	-	-	-	2	3	-	-	-	-	1
CO3	2	-	-	-	-	2	3	-	-	-	-	1
CO4	2	-	-	-	-	2	3	-	-	-	-	1
CO5	2	1	1	-	-	2	1	-	-	-	-	1
Average	**2**	1	1	-	-	**2**	**2**	-	-	**-**	-	**1**

Course Content:

Unit-1: Introduction

Civil Engineering: Overview and scope of Civil Engineering, Civil Engineering landmarks, Job opportunities in Civil Engineering

Fundamentals of Surveying: Introduction, Types of Surveying - Chain, Compass, levelling and contouring, Total Station, Introduction to Remote Sensing/ GIS/ GPS

Unit-2: Civil Engineering Materials

Building materials: Bricks, Stones, Cement, Aggregate, Concrete, RCC, Steel, Timber, Tiles, lime, paint.

Highway materials: bitumen, concrete, surkhi, sand, stone dust

Soil: Types of soil, classification of soil.

Unit-3: Environmental Engineering

Water and Wastewater Quality, Drinking Water Standards, Water infrastructure - Intake, Treatment plants, distribution system, and household plumbing.
Waste water infrastructure - household drainage system, sewerage system, Treatment Plant, and, disposal, effluent standards.
Introduction to Air Pollution, Air Quality Index, Air quality standards, Solid Waste Management- collection and segregation, Noise Pollution- standards

Unit-4: Transportation Engineering

Highway Engineering: Introduction, Model, elemental and functional classification of Transportation System, IRC classification of roads, Typical cross section of pavements, Control system.
Railway Engineering: Types of rails, Components of permanent way, stations
Airport- Components of airport
Introduction to Docks, Harbour, and Inland waterways

Unit-5: Civil Engineering Structures

Introduction to buildings: Elements- slab, beam, column, footing
Introduction to various Civil Engineering Structures - Bridges, Retaining Wall, Tanks and Reservoirs, Hydraulic Structures-Dams, Canals, Weirs, Barrage, Industrial Structures

Proposed textbooks

1. Basic Civil Engineering by S.S. Bhavikatti, New Age International Publishers
2. Basic Civil Engineering by Sateesh Gopi, Pearson India 2009.
3. Water Supply engineering by S K Garg , Khanna Publishers.
4. Building Material & Construction Planning by S. K. Duggal, New Age International Publishers

Reference Books

1. An Introduction to Civil Engineering by V. Okumu, Create Space Independent Publishing Platform.
2. Penn M. R. and Parker P. J. "Introduction to Infrastructure: An Introduction to Civil and Environmental Engineering" John Wiley & Sons 2011.
3. Water Supply Engineering by Dr B C Punmia.
4. Basics of Civil Engineering by Dhale Shrikrishna A. & Tajne Kiran M., S.Chand

Web Resources

https://nptel.ac.in/courses/105106201

ENGINEERING GRAPHICS

L T P C 0 0 4 2

Course Outcomes for Engineering Graphics

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

CO1. To understand and apply the concept of lettering, dimensioning, scales and geometric construction.

CO2. To visualize the position and location of any point, line, plane, or surface and draw their orthographic projections.

CO3. To visualize and draw/develop the true shape, size, and sections of solid objects the true shape, size, and specifications of physical objects.

CO4. To apply the visualization skill, to draw a simple isometric and perspective projections.

CO5. To understand and draw basic civil Engineering building components using AutoCAD.

Course Articulation matrix for Engineering Graphics

Program Outcomes (PO) / Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	1	2	-	-
CO2	2	-	-	-	-	-	-	-	1	2	-	-
CO3	2	-	-	-	-	-	-	-	1	2	-	-
CO4	2	-	-	-	-	-	-	-	1	2	-	-
CO5	2	-	-	-	3	-	-	-	1	2	-	-
Average	**2**	**-**	**-**	**-**	**3**				**1**	**2**	-	-

Course Content:

Unit –I

Lettering and Dimensioning: Introduction, lettering practices, Rules of dimensioning – systems of dimensioning.

Geometric Constructions: Freehand sketching, Conic Sections, Special Curves.

Engineering Scales

Unit –II

Orthographic Projection

Projection of Points: First and Third Angle Projections; Projection of Points

Projection of Lines: Projection of straight lines (First angle projection only); Projection of lines inclined to one plane and both planes, true length and true inclinations.

Projection of solids: Classification of solids, Projection of solids in simple position, Projection of solids inclined to one plane.

Unit –III

Sections of Solids: Right regular solids and auxiliary views for the true shape of the sections.

Development of Surfaces: Development of surfaces for various regular solids.

Unit –IV

Isometric Projection: Isometric scales, Isometric projections of simple and combination of solids;

Perspective Projection: Orthographic representation of perspective views – Plane figures and

simple solids – Visual Ray Method.
Conversion of pictorial view into orthographic Projection.

Unit –V

Introduction to Auto CAD, Drawings of Buildings and their components – front view, top view, and sectional views of a typical residential building using Auto CAD.
Detailed Drawing of RCC Design- Slab, beam, column, footings.

Proposed textbooks

1. A.J. Dhananjay, *Engineering Drawing*, TMH, 2008.
2. N D Bhatt and V M Panchal, *Engineering Drawing*, 43rd Ed., Charator Publishing House, 2001.
3. M B Shah and B C Rana, *Engineering Drawing*, 2nd Ed., Pearson Education, 2009
4. Engineering Graphics by N.D. Bhatt, Charotar Publishing House

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4. K Venugopal, *Engineering Drawing and Graphics*, 3rd Ed., New Age International, 1998

Web Resources

https://nptel.ac.in/courses/112103019
https://nptel.ac.in/courses/112102304
https://nptel.ac.in/courses/112105294
https://archive.nptel.ac.in/courses/112/102/112102304/

INTRODUCTION TO CIVIL ENGINEERING

L T P C 3 1 0 4

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CO1	2	-	-	-	-	2	-	-	-	-	-	1
CO2	2	-	-	-	-	2	3	-	-	-	-	1
CO3	2	-	-	-	-	2	3	-	-	-	-	1
CO4	2	-	-	-	-	2	3	-	-	-	-	1
CO5	2	1	1	-	-	2	1	-	-	-	-	1
Average	**2**	1	1	-	-	**2**	**2**	-	-	**-**	-	**1**

Course Content:

Unit-1: Introduction

Civil Engineering: Overview and scope of Civil Engineering, Civil Engineering landmarks, Job opportunities in Civil Engineering
Fundamentals of Surveying: Introduction, Types of Surveying - Chain, Compass, levelling and contouring, Total Station, Introduction to Remote Sensing/ GIS/ GPS

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Waste water infrastructure - household drainage system, sewerage system, Treatment Plant, and, disposal, effluent standards.
Introduction to Air Pollution, Air Quality Index, Air quality standards, Solid Waste Management- collection and segregation, Noise Pollution- standards

Unit-4: Transportation Engineering

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Airport- Components of airport
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Unit-5: Civil Engineering Structures

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ENGINEERING GRAPHICS

L T P C 0 0 4 2

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CO4. To apply the visualization skill, to draw a simple isometric and perspective projections.

CO5. To understand and draw basic civil Engineering building components using AutoCAD.

Course Articulation matrix for Engineering Graphics

Program Outcomes (PO) / Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	1	2	-	-
CO2	2	-	-	-	-	-	-	-	1	2	-	-
CO3	2	-	-	-	-	-	-	-	1	2	-	-
CO4	2	-	-	-	-	-	-	-	1	2	-	-
CO5	2	-	-	-	3	-	-	-	1	2	-	-
Average	**2**	**-**	**-**	**-**	**3**				**1**	**2**	-	-

Course Content:

Unit –I

Lettering and Dimensioning: Introduction, lettering practices, Rules of dimensioning – systems of dimensioning.
Geometric Constructions: Freehand sketching, Conic Sections, Special Curves.
Engineering Scales

Unit –II

Orthographic Projection
Projection of Points: First and Third Angle Projections; Projection of Points

Projection of Lines: Projection of straight lines (First angle projection only); Projection of lines inclined to one plane and both planes, true length and true inclinations.
Projection of solids: Classification of solids, Projection of solids in simple position, Projection of solids inclined to one plane.

Unit –III

Sections of Solids: Right regular solids and auxiliary views for the true shape of the sections.
Development of Surfaces: Development of surfaces for various regular solids.

Unit –IV

Isometric Projection: Isometric scales, Isometric projections of simple and combination of solids;
Perspective Projection: Orthographic representation of perspective views – Plane figures and simple solids – Visual Ray Method.
Conversion of pictorial view into orthographic Projection.

Unit –V

Introduction to Auto CAD, Drawings of Buildings and their components – front view, top view, and sectional views of a typical residential building using Auto CAD.
Detailed Drawing of RCC Design- Slab, beam, column, footings.

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https://nptel.ac.in/courses/112105294

https://archive.nptel.ac.in/courses/112/102/112102304/

B.Tech 2nd year (Civil Engineering)

3rd. Semester

FLUID MECHANICS

L T P C 3 1 0 4

Course Objective

The course is aimed at understanding the fluid properties and other concepts of fluid mechanics such as statics, kinematics, dynamics, boundary layer and pipe flow.

Syllabus

UNIT-I

Introduction

Scope and importance of Fluid Mechanics, Physical properties of fluids (density, specific weight, specific volume, sp.gravity, viscosity, Surface tension, Capillarity, Vapour Pressure), Rheological classification of fluids.

Fluid Statics

Pressure, Pascal's Law, Pressure measurement devices – Piezometer, manometers, Forces on plane and curved surfaces, Centre of pressure, Buoyancy, Metacentre, Stability of Submerged and floating bodies, Fluid masses subjected to accelerations.

UNIT-II

Fluid Kinematics

Introduction to Lagrangian and Eulerian approach, Classification of fluid flow, Streamlines, Path lines and Streak lines, Stream and Potential function, Flow Net, Continuity equation, Rotation, Vorticity and Circulation, Free and Forced vortex motion.

UNIT-III

Fluid Dynamics

Forces acting on fluid in motion, Euler's equation, Bernoulli's Theorem and applications – Pitot Tube, Venturimeter, Orificemeter, Orifices and Mouthpieces, Concept of HGL & TEL.

Dimensional Analysis: Units and Dimensions, Dimensional analysis, Buckingham's Π theorem, Non-dimensional numbers.

Hydraulic Similitude and Model Studies: Model and prototype; Similitude; Geometric, Kinematic and Dynamic similarity; Model Laws.

UNIT-IV

Flow in pipes

Laminar flow: Reynold's Experiment, Coutte& Hazen Poisulle's Equation for viscous flow between parallel plates and circular pipes; Darcy's Law; Transition from laminar to turbulent flow.

Turbulant flow: Velocity distribution, Prandtl mixing length theory, Introduction to Moody's Chart.

Losses in pipes

Darcy - Wiesbach Equation, factors affecting friction, Minor Losses in pipes, Concept of equivalent length of pipe for different pipe fittings, Equivalent diameter of pipes, Pipes in

parallel, Series, Surge tanks, Pipe network- Hardy Cross method.

Unit-V

Boundary layer theory

Concept, Boundary layer along thin plate- Characteristics, Laminar, Turbulent Boundary Layer, laminar sub layer, Various Thicknesses- Nominal, displacement, Momentum, Energy, Hydraulically smooth and Rough boundaries.

Forces on submerged bodies: Introduction to Drag and Lift on submerged bodies (like Flat plates, Sphere, Cylinder, aerofoil), stokes law, Drag and Lift coefficients.

Text Books

1. Fluid Mechanics – Hydraulic & Hydraulic Mechanics -Modi / Seth – Standard Book House, Delhi
2. R K Bansal: Fluid Mechanics and Hydraulic Machines.
3. Fluid Mechanics – A.K. Jain – Khanna Pub., Delhi

Reference Books

1. Fluid Mechanics – Streeter-McGraw-Hill International Book Co., Auckland
2. Fluid Mechanics – Garde-Mirajgaonkar – Nemchand & Bros., Roorkee
3. Fluid Mechanics – Shames - McGraw-Hill International Book Co., Auckland
4. Introduction to Fluid Mechanics and Machines - Som and Biswas, TMH.
5. Fluid Mechanics and Machinery – Ojha, Berndtsson and Chandramouli, Oxford University Press, new Delhi.

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

CO 1 Study of fluid properties and compute hydrostatic forces and analyze floating and submerged bodies.

CO 2 Analyze concept of stream & potential function and vortex flow.

CO 3 Analyze and apply the fluid dynamics and dimensional analysis & model analysis to solve fluid problems

CO 4 Apply laminar and turbulent flow theory and analyze for solution to real life field problems.

CO 5 Compute and analyze boundary layer and forces on submerged bodies.

CO- PO Mapping / Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	2	2	2	1	-	2	-	-	-	1	1	3	2	2	2
CO-2	3	3	2	3	1	-	-	-	-	-	-	-	3	3	2	3
CO-3	3	3	2	3	3	-	-	-	-	-	-	-	3	3	2	3
CO-4	3	3	3	3	3	3	2	-	1	-	1	2	3	3	3	3
CO-5	3	3	3	3	3	3	2	-	-	-	1	2	3	3	3	3
Average	3	2.8	2.4	2.8	2.2	3	2	-	1	-	1	1.67	3	2.8	2.4	2.8

SURVEYING

L T P C 2 1 2 4

COURSE OBJECTIVE: Students undergoing this course are expected to-understand the basic knowledge of the different type of basic and advanced surveying and train the students in handling of surveying instruments.

Syllabus

UNIT-I

Introduction to Surveying: Importance of surveying, types of surveying, principle of surveying, provision of control, conventional signs, scales (plain and diagonal), plan and map. Errors, Types of tapes and chains, offsets, Errors and Corrections

Chain Survey: Chain survey, instruments, principles of chain survey, chaining and ranging, survey stations and lines, errors in chaining, chaining on uneven ground, chaining on sloping ground, basic problems in chaining, obstacle in chaining, field book entry, standard conventional symbols for different objects.

UNIT-II

Compass Surveying: Measurement of directions and angles, types of compasses, meridians and bearings, local attraction, magnetic declination, traversing, plotting of traverse, adjustment of closing error.

Plane Table Surveying: Principle and instruments used in plane table surveying, working operations, methods of plane table surveying.

UNIT-III

Levelling and Contouring: Description of a point (position) on the earth's surface, instruments for leveling, principle and classification of leveling, bench marks, leveling staff, readings and booking of levels, field work, longitudinal section and cross section, plotting the profile, height (level) computations, contours, characteristics of contours, methods of contouring, interpolation, contour gradient, contour maps, calculation of areas of a closed traverse, measurements from cross sections, earth work calculations.

UNIT-IV

Theodolite and Tacheometric Surveying: Principle of theodolite survey, Theodolite component parts, observations, Traversing, traverse computations, Trigonometrical Surveying, Tacheometry, principle of tacheometry, methods of tacheometry

Curve Settting: Types of curves, elements of a curve, setting out a simple curve, setting out a compound curve, checks on fieldwork, reverse curve, transition curves, super elevation, deflection angles, transition curves, characteristics of transition curves, method of setting out a compound curve, types of vertical curves, setting out vertical curves.

UNIT-V

Advanced Surveying: Principle of EDM, Features and Functions of Total Station, Global Positioning System.

List of Experiments

1. To study instruments used in chain surveying and to measure distance between two points by ranging.
2. To determine of distance between two inaccessible points with compass.
3. To plot details using radiation and intersection methods in plane tabling.
4. To solve two point and three-point problem in plane table.
5. To find out the reduced levels of given points using level. (Reduction by Height of collimation method and Rise and fall method).
6. Measurement of Horizontal and vertical angle by theodolite
7. Study of Total Station, Measuring Horizontal and vertical angles
8. Determination of distance and difference in elevation between two inaccessible points using Total station.
9. Determination of the Tacheometric constants of a given theodolite.

Text Books

1. Elementary Surveying, Charles D. Ghilani, Paul R. Wolf. 14th Edition, Prentice Hall, 2014.
2. Surveying-Bannister, Raymond and Baker, Pearson Education

Reference Books

1. A Text Book of Surveying by Kochar, CL; Katson Publishing House, Ludhiana,
2. Surveying and Leveling by Kanetkar,TP and Kulkarni, SV; AVG Parkashan, Poona
3. Surveying –I by Mahajan, Sanjay; Tech. Publication, Delhi
4. E-books/e-tools/relevant software to be used as recommended by AICTE/UBTE/NITTTR, Chandigarh.
5. Prof. T. P. Kanetkar and Prof. S.V.Kulkarni, Surveying and leveling Vol. I & II, Pune Vidyarthi Griha Prakashan, Pune, 23rd Edition, 1985
6. Dr. A.M.Chandra , Plane surveying, New Age International Publishers New Delhi, Second Edition, 2006
7. Dr. B.C.Punmia , Surveying Vol I & II, Laxmi Publications (P) Ltd. New Delhi, Sixteenth Edition Reprint 2008 R. Subramanian, Surveying and Levelling, Oxford University Press, New Delhi, First Edition, 2007

Laboratory Manuals

1. H. S. Moondra, Rajiv Gupta, "Laboratory Manual for Civil Engineering", CBS Publishers Pvt .Ltd., New Delhi, 2nd Edition, 2013.
2. James M. Anderson, Edward M. Mikhail, "Surveying: Theory and Practice", Tata Mc Graw Hill Education, 2012.
3. S. S. Bhavikatti, "Surveying Theory and Practice", IK Books, New Delhi, 2010.

Course Outcomes

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

CO1: Apply the basic principles of Surveying

CO2: To operate and use different instruments and techniques to determine the positions

CO3: Prepare maps/plans from the collected field data

CO4: Apply the techniques for setting out curves and other layouts etc.

CO5: Demonstrate advanced surveying equipment in preparing maps

CO6: To provide hands-on exercise and make the students to learn the basics offield-oriented problems in surveying

CO- PO Mapping (Articulation Matrix)

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	3	2	3	1	1	1	3	3	3	1	2	1	1	1
CO-2	3	3	3	2	2	2	1	1	3	2	3	2	3	1	1	1
CO-3	2	1	-	1	-	2	-	-	3	2	1	2	3	1	1	1
CO-4	3	3	3	3	2	2	1	1	3	2	2	2	3	1	1	1
CO-5	3	3	3	3	2	1	1	1	3	2	1	2	3	1	1	1
CO-6	2	-	1	2	-	1	-	-	3	2	1	1	3	2	2	3
Average	2.67	2.6	2.6	2.17	2.25	1.5	1	1	3	2.17	1.83	1.67	2.83	1.16	1.16	1.33

BUILDING MATERIALS & CONSTRUCTION

LTPC 3 0 2 4

Couse objective: To understand various building materials their properties and components of building.

Unit-I

Building Materials: Bricks, Stone, Lime and Timber

Introduction: Materials and types, properties of engineering materials, selection of materials, standard.

Bricks: Classification, manufacture, properties and selection criteria of burnt clay bricks, tests for bricks.

Stone: Classification, characteristics of good building stone.

Lime: IS specifications, field tests of limes.

Timber: Characteristics of good timber, defects, seasoning, tests on timber, plywood.

Unit-II

Building Materials: Cement, Admixtures, Aggregate& Mortar

Cement: Manufacture of cement, types of cement – ordinary Portland cement, Portland pozzolana cement, high alumina cement, sulphate resisting, Portland cement, their characteristics, composition, use and properties, tests on cements

Admixtures: Mineral admixtures, chemical admixtures

Aggregates: Classification, source, physical and mechanical properties, testing of aggregates

Mortar: Types, classification and strength

Unit-III

Building Construction: Masonry Works &Building Byelaws

Building bye-laws: Classification of buildings, recommendations of NBC, Building byelaws

Masonry: Brick masonry, stone masonry, types of walls, partition and cavity walls, plastering and pointing, damp proofing materials and techniques

Unit-IV

Building Construction: Foundation, Floor, Roof, Stairs, Lifts and Escalators

Foundation: Types of foundation and selection criteria
Floor : Types of floors, construction details and selection criteria
Roofs : Types of roofs and roof covering, shuttering, scaffolding and centering
Stairs : Types of stairs

Unit-V

Building Construction: Doors, Windows, Finishes & Building Protections

Doors and windows: Types, sizes, purpose of doors and windows
Finishes: White washing, colour washing, painting, distempering
Protections: Fire protection, expansion and construction joints, anti-termite treatment, roof treatment for water proofing

List of Experiments

1. Cement
    1. Normal consistency of cement
    2. Initial & final setting time of cement
    3. Compressive strength of cement
    4. Fineness of cement
    5. Soundness of cement
2. Coarse Aggregate
    1. Sieve analysis of aggregate
    2. Water absorption of aggregate
    3. Specific gravity and bulk density of aggregate
    4. Crushing value of aggregate
    5. Impact value of aggregate
3. Fine Aggregate
    1. Sieve analysis of sand
    2. Silt content of sand
    3. Bulking of sand
4. Bricks
    1. Water absorption
    2. Dimensional tolerances
    3. Compressive strength
    4. Efflorescence
5. Physical and mechanical properties of reinforcing steel

Text books and References

1. Arora, S.P. &Bindra, S. P., 'A text book of building construction", Dhanpat Rai & Sons, Delhi.
2. Jha, J. & Sinha, S.K., "Building construction", Khanna Publishers, Delhi.
3. Kulkami, C.J., "A text book of engineering materials", Ahmedabad book Depot, Ahmedabad.
4. Kulkami, C. J., "A text book of engineering construction", Ahmedabad Book Depot, Ahmedabad.

5. Kumar, S., "Engineering materials", Standard Publishers Distributors, Delhi.
6. Kumar, S., "Building construction", Standard Publishers Distributors, Delhi.
7. McKay W.B., "Building construction", Vol.1 to 4, Orient Longman Ltd, Delhi.
8, Punmia, B.C.,"A text book of building construction", Laxmi Publications, Delhi, Madras.
9. Singh, S., "Engineering materials", Konark Publishers Pvt. Ltd.
10. "Civil engineering materials", TTTI Chandigarh, Tata McGraw- New Delhi.
11. Somayaji, S., "Civil engineering materials" Pearson, New Delhi

Course Outcomes

At the end of this course, the students will be able to:

CO1 Identify and characterize various building materials
CO2 Analyze cement, mortar, concrete and admixtures
CO3 Analyze building bye-laws and brick masonry
CO4 Analysis of building construction – foundation, floor and roof
CO5 Analyze doors, windows and finishes in building.
CO 6: Carryout testing on various building materials (cement, aggregates, bricks, steel) and analyze their properties for quality control in construction projects

CO- PO Mapping / Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	-	-	-	-	-	-	-	-	-	-		2	2	1	1
CO-2	2	-	-	3	3	2	2	-	-	-	-	-	2	2	1	2
CO-3	-	-	2	2	2	2	-	-	-	-	-	-	3	1	2	2
CO-4	-	-	2	2	-	2	2	-	-	-	-	-	3	1	2	2
CO-5	-	-	2	1	-	2	1	-	-	-	-	-	-	-	1	1
CO-6	1	2	2	3	2	2	1	-	1	-	-	1	2	3	2	1
Average	1.67	2.00	2.00	2.20	2.33	2.00	1.50	-	1.00	-	-	1.00	2.40	1.80	1.50	1.50

GEOTECHNICAL ENGINEERING-I

L-T-P-C 2-1-2-4

Course Objectives

At the end of this course, the student will be able to explain the formation of soil and its properties and be able to classify them. They will also be able to formulate and analyze engineering behavior and the development of stresses in the soil in the field situation.

SYLLABUS

Unit I

Introduction to Engineering Geology

Physiographic features of India, Branches of Geology and the importance of Engineering Geology,

Weathering, types, and their effects.

STRUCTURAL GEOLOGY

Stratification, dip, strike, and unconformities, Folds their classification, causes, Engineering consideration, Faults their classification, causes, Engineering consideration.

Unit II

Origin, classification and phase relationship in soils, soil structure and clay minerals, Soil Phase Relationship, Mass-volume-weight relationship, specific gravity, water content, Index Properties of soil, Grain size distribution, Sieve analysis, Hydrometer, Density index, Consistency of clay soil, Effective stress principle, effective stresses under hydrostatic flow. Classification of soils, Textural system, ISC systems, General comments.

Unit III

PERMEABILITY - Factors affecting permeability, Lab and field determination methods, Seepage Pressure, Quick-Sand Condition, and filter media.

COMPACTION-Standard and modified Proctor's test, Field control of compaction, Different types of field compaction equipment, and their suitability for the compaction process.

CONSOLIDATION - Compressibility, Consolidation, Terzaghi's one-dimensional Consolidation Theory, Time Factor and Degree of consolidation, Computation of settlement, Consolidation Test, Square root time fitting method, and logarithmic time fitting methods, NC & OC Clays.

Unit IV

STRESS DISTRIBUTION IN SOILS - Boussinesq's and Westergaard's formula, Approximate σz , Isobars, Contact pressure over the base of footing.

SHEAR STRENGTH - Shear strength parameters-Total stress and effective stress, Factors affecting strength, Drainage Condition and Pore water pressure, UCS, Mohr's circle, Failure Envelope, Direct shear test, Triaxial shear test.

Unit V

EARTH PRESSURE - Concept of lateral earth pressure; Active, passive, and earth pressure at rest; Rankine's and Coloumb's theories, Earth pressure computation in different soils and surcharge load, Rebhnann's and Culmann's construction. Design considerations of earth retaining structures.

List of experiments

a) To determine grain size distribution by sieve analysis
b) To conduct Specific gravity tests by Pycnometer
c) To determine In-situ density using the Sand Replacement Method
d) To Determine the Liquid limit and Plastic limit
e) To determine the coefficient of permeability by the falling head method
f) To determine the coefficient of permeability by the constant head method
g) MDD and OMC by Standard Proctor compaction test
h) To determine shear strength parameters by Direct Shear Test
i) To perform Unconfined Compression Test

Text Books

1. "Principles of Geotechnical engineering," Braja M. Das, Cengage Learning, New Delhi. (2009)
2. "Basic and Applied Soil Mechanics," Gopal Ranjan & A.S.R. Rao. New Age International Publishers. (2006)
3. "Soil Mechanics," T. William Lambe & Robert V. Whitman, John Wiley & Sons, NY. (2008)
4. "Soil Mechanics and Foundations," Muni Budhu, John Wiley & Sons. (2010)
5. "Soil Engineering," Alam Singh, CBS Publishers, New Delhi. (2009)
6. "Soil Mechanics in Engineering Practice," Terzaghi and Peck, John Wiley and Sons, New Jersey. (1948)
7. "Manual of Soil Laboratory Testing of Soil" - Part I, II, III – Roger Epps, K. H. Head.
8. "Engineering soil testing" – Shamsher Prakash and P. K. Jain, Nem Chand, (1984).

References / Useful Indian Standard Codes

1. SP 36: Part 1: 1987 Compendium of Indian Standards on Soil Engineering: Part – 1 Laboratory Testing of Soils for Civil Engineering Purposes
2. SP 36: Part 2: 1988 Compendium of Indian Standards on Soil Engineering: Part – 2 Field Testing of Soils for Civil Engineering Purposes
3. IS 1904: 1986 Code of practice for Design and Construction of foundations in soils: general requirements (Third Revision)
4. IS 2131: 1981 Method for standard penetration test for soils.
5. IS 2720: Various parts for the field and laboratory tests.
6. IS 2809: 1972 Glossary of terms and symbols relating to soil engineering (First Revision)
7. IS 2810: 1979 Glossary of terms relating to soil dynamics (First Revision)
8. IS 2911: Various parts for the Design of foundations.
9. IS 2974: Various parts for the Design of machine foundations.

E-LEARNING RESOURCES

1. https://nptel.ac.in/courses/105/105/105105168/ NPTEL video course on Geotechnical Engineering
2. https://nptel.ac.in/courses/105/101/105101201/ NPTEL video course on Geotechnical Engineering
3. https://nptel.ac.in/courses/105/103/105103097/ NPTEL web course on Soil Mechanics
4. https://nptel.ac.in/courses/105/106/105106142/ NPTEL web course on Geotechnical and Foundation Engineering
5. https://nptel.ac.in/courses/105/101/105101160/ NPTEL video course on Geotechnical Engineering Laboratory

Course Outcomes (COs)
At the end of the course, the students will be able to:

CO1: Identify the basic concepts of geological processes and their importance in civil engineering
CO2: Characterize and classify soils and their various parameters.
CO3: Identify and analyze the properties of soil governing its behavior.
CO4: Understand the concept of shear strength
CO5: Apply the principles of soil mechanics in the design of earth-retaining structures and foundations.
CO6: Apply the knowledge of site-specific field investigations. Identify the types of soil and collection of soil samples for testing and observation Perform laboratory testing of soils for various geotechnical applications.

Course Mapping / Articulation Matrix for Geotechnical Engineering -I

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	3	3	3	2	2	1	-	-	-	-	-	3	3	1	1
CO-2	2	3	3	3	2	2	1	-	-	-	-	-	3	3	1	1
CO-3	2	3	3	3	2	2	1	-	-	-	-	2	3	3	1	3
CO-4	2	3	3	3	2	2	1	-	-	-	-	-	3	3	1	3
CO-5	2	3	3	3	2	2	1	-	-	-	-	-	3	3	3	3
CO-6	2	3	3	3	2	2	1	-	3	-	-	2	3	3	1	3
Average	2.00	3.00	3.00	3.00	2.00	2.00	1.00	-	3.00	-	-	2.00	3.00	3.00	1.33	2.33

IV Semester

HYDRAULICS AND HYDRAULIC MACHINES

L T P C 2 1 2 4

Course Objective

The course is aimed at understanding and applying the principles of open channel flow for the solution of field problems and also analyze the hydraulic machines.

Unit-I

Introduction: Difference between pipe flow and open channel flow. Types of open channels, Types of flows in open channel, Geometric elements, Velocity distribution, Velocity and pressure distribution in an open channel, Continuity equation.

Uniform Flow: Chezy's & Manning's formula, Roughosity coefficient, Uniform Flow computations, Hydraulically efficient section (Rectangular, Triangular, Trapezoidal), compound channel sections.

Unit-II

Depth-energy relationship in open channel flow: Specific energy (definition & diagram, Critical, Sub-critical, Super-critical flow), Specific discharge, flow through vertical and horizontal contractions.

Unit-III

Gradually varied flow (G.V.F.): Definition, Classification of channel Slopes, Equation of G.V.F., Classification of G.V.F. profiles-examples, Direct step method of Computation of G.V.F. profiles.

Unit-IV

Rapidly varied flow (R.V.F.): Definition, examples, Hydraulic jump- Phenomenon, relation of conjugate depths, Parameters, Uses, Types of Hydraulic jump, Hydraulic jump as an energy dissipater, Notches & weirs.

Unit-V

Impact of jet: Impulse momentum principle, Impact of jet on Vanes, Series of vanes mounted on wheel.

Hydraulic turbines: Importance of hydro-power, Introduction to turbines and pumps, Unit quantities, Specific speed, Performance Characteristics.

List of Experiments

1. To determine the Manning's coefficient of roughness 'n' for the given channel bed.
2. To study the flow characteristics over a hump and horizontal contraction placed in an open channel.
3. To study the characteristics of free hydraulic jump.
4. To study rotodynamic turbines and their characteristics.
5. To calibrate and to determine the coefficient of discharge for rectangular and triangular notches.
6. To determine the metacentric height of a ship model experimentally.

7. To determine the coefficients of velocity, contraction and discharge of an orifice (or a mouth piece) of a given shape.
8. To verify the Bernoulli's theorem.
9. To calibrate an orifice meter and venturimeter and to study the variation of the coefficient of discharge with the Reynolds number.
10. To determine the loss coefficients for the various pipe fittings.

Text Books

1. Subramanya, K., Flow in Open Channels, Tata McGraw Hill
2. Srivastava R., Flow through open channel, Oxford university press.

Reference Books

1. Henderson, F.M., Open Channel Flow, McGraw Hill International
2. Chow, V.T., Open channel Hydraulics, McGraw Hill International
3. Ranga Raju, K.G., Flow through open channels, T.M.H.
4. French, R.H., Open Channel Hydraulics, McGraw Hill International
5. Graf, W.H., Hydraulics of Sediment Transport, McGraw Hill International

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

CO 1 To analyze different types of flows, velocities and uniform flow in open channel.
CO 2 to analyze depth and energy relationship in open channel flow and apply concepts of transitions in channel.
CO 3 To analyze Gradually varied flow profiles and their computations.
CO 4 To analyze Rapidly varied flow and flow measurement devices in channel.
CO 5 To analyze impact of jet on vanes and different types of hydraulic machines
CO 6 To experimentally demonstrate the concept of fluid statics, dynamics, pipe flow, open channel flow and hydraulic machines.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	3	-	2	1	1	-	-	1	-	-	1	2	3	1
CO-2	3	3	3	2	2	1	1	-	-	1	-	-	2	1	3	1
CO-3	3	3	3	-	2	-	1	-	-	1	-	-	1	2	3	1
CO-4	3	3	3	2	2	1	1	-	1	1	1	1	1	2	2	1
CO-5	3	3	3	-	2	-	1	-	1	1	1	1	1	2	2	1
CO-6	2	2	3	3	3	1	1	-	3	2	1	2	2	3	1	1
Average	2.83	2.83	3.00	2.33	2.17	1.00	1.00	-	1.67	1.17	1.00	1.33	1.33	2.00	2.33	1.00

Structural Analysis- I

L T P C 2 1 0 3

Course Objective

The students will be able to understand and analyse various structures using the concepts of shear force, bending moment, indeterminacy, influence lines, arches, cables, portal and cantilever

Syllabus

UNIT 1

Introduction & Analysis of Plane Structures: Introduction and Classification of Structures, Review of AFD, SFD and BMD for Beam and frames, Degree of Freedoms, Static and Kinematic Indeterminacy of Structures, Analysis of Compound and Complex Trusses, Analysis of Plane Frames.

UNIT 2

Displacements of Plane Structures: Introduction, Energy methods, Maxwell's Reciprocal & Betti's Theorem, Unit Load method, Deflection of trusses and plane frames.

UNIT 3

Rolling Loads and Influence Line Diagrams: Introduction, Influence Line Diagrams for Beams & Trusses, Absolute Maximum Bending Moments, Muller- Breslau principle and its applications.

UNIT 4

Arches and Cables: Introduction, Linear Arch, Eddy's Theorem, Three-Hinged & Two-Hinged Arches, Influence Lines for Arches, Analysis of Cables.

UNIT 5

Approximate methods of analysis: Portal method - Cantilever method – Substitute frame method.

Textbooks

1. Theory of Structures (Vol. 1), G. Pandit, S. Gupta, Rajesh Gupta, Tata McGraw Hill Pub., 2017.
2. Theory and Problems in Structural Analysis, L.S. Negi, Tata McGraw Hill Pub., 1997.
3. Mechanics of Structures Vol 1 & Vol.2, Junarkar. S. B and Shah H.J, Charotar Publishers, 2008, 32nd Edition.

Reference Books

1. Intermediate Structural Analysis, Chu-Kia Wang, Tata McGraw Hill Publishers, 2017.
2. Structural Analysis, R C Hibbeler, Pearson, 2017.
3. Analysis of Structures (Analysis, Design And Details of Structures) - Vol.1, V. N. Vazirani, M. M. Ratwani, S. K. Duggal, Khanna Publishers, 1999
4. Basic Structural Analysis, C S Reddy, Tata McGraw Hill Publishers, 2017

Online Resources

1. https://nptel.ac.in/courses/105/105/105105166

Course Outcomes (COs)

At the end of the course the students will be able to:

CO1 Understand the concept of structural analysis.
CO2 Understand the concept of the different methods of finding deflection of Trusses and frames.
CO3 Analyse structures for gravity loads and moving loads.
CO4 Analyse internal forces and reactions for two hinged, three hinged arches and cables.
CO5 Analyse the structure by approximate methods.

CO-PO Mapping

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	3	-	1	-	-	-	-	-	-	-	3	3	3	3
CO-2	3	3	3	-	1	-	-	-	-	-	-	-	3	3	3	2
CO-3	3	3	3	-	1	-	-	-	-	-	-	-	3	2	3	2
CO-4	3	3	3	-	1	-	-	-	-	-	-	-	3	3	3	3
CO-5	3	3	3	-	1	-	-	-	-	-	-	-	3	3	3	2
Average	3	3	3	-	1	-	-	-	-	-	-	-	3	2.8	3	2.4

DESIGN OF CONCRETE STRUCTURE-I (Theory and Lab)

L T P C 2 1 2 4

Couse Objective: To understand the properties of concrete and limit state design method for reinforced concrete beam.

Syllabus

Unit I

Concrete Technology: Ingredients, properties, mix design, durability, inspection and quality control, provisions of IS: 456
Steel: Properties of steel, Structural steel, reinforcing steel

Unit II

Special Concrete: Mass concrete, self-compacting concrete, lightweight concrete, fibre reinforced concrete, fly ash concrete, polymer concrete, high strength concrete, high performance concrete, ready mixed concrete, grouting, sprayed concrete, under water concrete

Unit III

Introduction: Structural systems, loadings and structural analysis
Introduction to Design of Concrete Structures**:** Design philosophies, Working stress design for flexure – rectangular beams

Unit IV
Limit State Design: Assumption, design of rectangular singly and doubly reinforced beams, flanged beams.

Unit-V
Design of beams in shear and torsion, development length, bond strength

Note: All designs shall be conforming to IS: 456 – 2000.

List of Experiments

1. Workability of concrete by using compaction factor, slump test
2. Compressive strength of concrete
3. Flexural strength of concrete
4. Mix design by I.S. code method
5. Concrete permeability test
6. Effect of fire on concrete
7. N.D.T. using Rebound hammer test
8. N.D.T. using ultrasonic pulse velocity test
9. Destructive test on core sample
10. Determination of constituents of hardened mortar

Text Books and Reference books

1. Pillai, S.U. and Menon, D., "Reinforced concrete design", Tata McGraw Hill.
2. Jaikrishna and Jain, O.P., "Plain and reinforced concrete – Vol I & II", Nem Chand & Bros.
3. Gambhir, M.L., "Fundamental of reinforced concrete design", PHI Learning Pvt. Ltd.
4. Park, R. and Paloy, T., "Reinforced concrete structures", Wiley Publ.
5. Vargheses, P.C.., "Limit state design of reinforced concrete", PHI Learning Pvt. Ltd.
6. Dayaratnam, P., "Design of reinforced concrete structures", Oxford & IBH Publ.
7. Jain, A.K. "Limit state design of reinforced concrete ", Nem Chand & Bros, Roorkee.
8. Sinha, S.N., "Reinforced concrete design", Tata Mc Graw Hill
9. Gambhir, M.L., "Concrete technology", Tata McGraw-Hill Education
10. Shetty, M.S., "Concrete technology – Theory and Practice", S.Chand& Co.
11. Neville, A.M. and Brooks, J.J., "Concrete technology" Prentice Hall
12. Mehta, P. K., "Concrete: microstructure, properties, and materials", McGraw-Hill Education

Course Outcomes
At the end of this course, the students will be able to:
CO 1 Analysis of the properties of concrete and steel
CO 2 Analysis of various types of special concrete
CO 3 Introduction to loads, working stress method and design of beams.
CO 4 Limit state design of singly and doubly reinforced and flanged beams
CO 5 Design of beams in shear and torsion
CO 6 Demonstrate various quality control tests on concrete and use of NDT for structures

CO- PO Mapping /Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	2	2	-	-	-	-	-	-	-	-	3	3	1	3
CO-2	-	-	-	2	-	2	2	-	-	-	-	-	3	3	1	2
CO-3	2	2	3	3	3	-	-	-	-	-	-	-	3	2	1	2
CO-4	2	2	3	3	3	-	-	-	-	-	-	-	3	3	3	3
CO-5	3	3	3	2	3	-	-	-	-	-	-	-	3	3	3	2
CO-6	1	2	2	3	2	2	1	-	1	-	-	1	2	2	2	2
Average	2.00	2.20	2.60	2.50	2.75	2.00	1.50	-	1.00	-	-	1.00	2.83	2.67	1.83	2.33

Environmental Engineering -I

L T P C 2-1-0 3

Course Objective: The objective of this course is to familiarize the students with importance of planning and execution of modern water supply schemes and understanding the basic concepts of water quality, treatment methods and distribution systems.

Syllabus

Unit I

Water demands: Various types of demands; the per capita demand: variations in demand; design periods; population forecasting by various methods.

Sources of water: Kinds of water sourcesand their characteristics; factors governing the selection of a source of water supply, storage capacity of impounded reservoir.

Quality of water: Physical, chemical and biological characteristics of water, common water borne diseases, Global and national standards of purified water for various purposes

Unit II

Intake Structures: Factors affecting location of intake structures, Types of Intakes, Design of Intakes.

Screening: coarse and fine screen

Sedimentation: Theory of Type-I and Type-II settling principles, Sedimentation aided with Coagulation: chemicals used as coagulants, Calculation of Alum dosage, Design of sedimentation Tank

Filtration: Theory, Types of Filters, design principles, head loss in filters

Unit III

Disinfection: methods, application of disinfectant, chlorination-break point chlorination, Calculation of dose of disinfectant, disinfection kinetics-Watsons and

Chicks law
Water Softening: methods of removing temporary and permanent hardness, Use of Lime soda technique for water softening,
Calculation of dose for water softening using Lime soda technique.
Miscellaneous: Removal of dissolved salts, arsenic, fluoride,
packaged natural mineral water, adsorption with activated carbon, ion exchange resins

Unit IV
Distribution system: Introduction, requirements of good distribution system, layouts, methods of distribution systems
Distribution of reservoirs: functions, types, stand pipes, storage capacity, location and heights.
Design of Distribution Network: Fixing the size of pipes, analysis, Hardy-Cross method
Distribution system: Introduction, requirements of good distribution system, layouts, methods of distribution systems

Unit V
Water Supply Plumbing in building and houses: Plumbing system, House water connection, pipe fittings, storage of water in buildings, design considerations for water piping system in Buildings. Local, regional, national and global issues related to water supply. Implementation of different proposals under GOI schemes

Textbooks

1. Water Supply and Sanitary Engineering by G.S Birdie and J.S Birdie (Dhanpat Rai Publishers, 9th edition, 2014)
2. Water Supply Engineering by S.K. Garg (Khanna publishers, 33rd edition, 2010)
3. Water Supply, Waste disposal and Environmental pollution engineering by A.K. Chatterjee, (Khanna publishers, 8th edition, 2006)
4. Water Supply and Sanitary Engineering by B.C. Punmia, A.K. Jain, (Laxmi Publications, 2016)
5. Environmental Engineering by Howard S. Peavey and Donald R Rowe (TMH publications, Indian edition)

Reference Books

1. Manual on Water Supply and Treatment, C. P. H. E. E. O., Ministry of Housing and Urban Affairs, Government of India, New Delhi. Available online for download at https://cpheeo.gov.in//cms/manual-on-water-supply-and-treatment.php
2. Theory and Practice of Water and Wastewater Treatment by Ronal L. Droste and Ronald Gehr (Wiley Publications, 2nd Edition, 2018)
3. Introduction to Environmental Engineering by Mackenzie Davis and David A. Cornwell (McGraw Hill Publications, 6th Edition, 2022)

Other Useful Resources

1. Link to NPTEL course contents: http://nptel.ac.in/courses/105104102/
2. Link to YouTube Video (NPTEL Course – Water and Wastewater Engineering) https://www.youtube.com/watch?v=zVZ9c6EXfTA&list=PL1BFC82F3A63B4172

3. Link to YouTube Video (Short video – Water Treatment Process)
   https://www.youtube.com/watch?v=KMP9-49I1U4
4. Link to YouTube Video (Extended video – Water Treatment Process)
   https://www.youtube.com/watch?v=EoE_NkF8N8k

Lecture Notes
https://classroom.google.com/u/7/c/NDU3NDcxODc1ODA4

Course Outcomes
After successful completion of the course, the students will be able:

CO 1: To ***identify*** and ***explain*** the different water sources and assessing the water demand for planning and design of water supply systems.
CO 2: To ***classify*** the different types of intake
structures and ***analyse*** the different primary units for water treatment process
CO 3: To ***assess*** and ***analyze*** the different disinfection processes used and other miscellaneous treatments for water supply
CO 4: To ***identify*** and ***design*** the appropriate water distribution system
CO 5: To ***plan*** and ***design*** for plumbing requirements in residential buildings

CO-PO Mapping (Course Articulation Matrix for Environmental Engineering-I)

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	2	3	2	2	2	1	-	-	2	1	1	2	2	3
CO-2	2	2	3	3	2	2	2	-	-	-	1	1	2	2	3	3
CO-3	2	2	2	2	2	2	2	-	-	-	1	2	2	2	2	2
CO-4	2	3	3	3	3	2	2	-	-	-	1	3	2	3	3	3
CO-5	2	2	3	2	2	2	1	1	-	-	1	2	1	2	3	2
Average	2	2.2	2.6	2.6	2.2	2	1.8	1	-	-	1.2	1.8	1.6	2.2	2.6	2.6

TRANSPORTATION ENGINEERING-I

L T P C 2-1-0-3

Couse Objective: To introduce the fundamentals of highway engineering including geometric design and construction processes.

Syllabus

Unit -I

Geometric Design: Design factors; Cross-section elements, Sight distances; Road Alignment - Horizontal and Vertical profiles; Combination of profiles; Placement of utilities and services; Design considerations in hill areas; Design software.

Unit -2

Highway Materials and Mix Design: Soil – Desirable properties, Tests – Atterberg limits, Proctor values, CBR, Modulus (k); Stone Aggregates – Desired properties, Tests; Asphalt – Classification, properties, routine tests and modifiers; Cement and Cement Concrete

Unit -3

Pavement Design: Factors affecting design; Traffic volume and Axle load survey; Flexible pavements – Layers, design requirements and IRC-37 based design; Rigid pavements: Layers, design requirements, stresses in layers, Design based on IRC-58.

Unit -4

Highway Construction: Design specification and construction steps of subgrade, embankments, granular layers (GSB, WBM, WMM), bituminous sub-bases, bases, binder and surface courses, concrete pavement (DLC and PQC), Joints in bituminous and rigid pavements; Guidelines for Externally funded Road Projects.

Unit -5

Highway Maintenance: Types of surface and sub-surface failures, Evaluation and remedial measures; Drainage – surface and sub-surface,
Filter design criteria; Design of overlays based on Benkelman Beam and Falling Weight Deflectometer (FWD), Full Depth Reclamation(FDR)

Text books

1. Khanna S.K. & Justo C.E. G., 'Highway Engineering" Khanna Publishers, Delhi.
2. Kadiyali L.R.., "Transportation Engineering". Khanna Publishers, Delhi.
3. Sharma S.K..., "Highway Engineering". S. Chand & Co. Ltd.

Reference books

1. Wright, Paul H. and Dixon, Karen K., "Highway Engineering", John Wiley and Sons Inc.
2. Khanna, S.K. and Justo, C.E.G., "Highway Material Testing Manual", Nem Chand & Bros.
3. Khanna, S.K. and Justo, C.E.G., "Highway Engineering", Nem Chand & Bros
4. Papacostas, C.S. and Prevedouros, P.D., "Transportation Engineering and Planning",

Prentice Hall

Course Outcomes
At the end of the course, the students will be able to:

CO1: Planning and geometric design of highway and design of horizontal and vertical curves.
CO 2: Analyze various types of pavement materials.
CO 3: Design of flexible and rigid pavements.
CO 4: Analyze various methods of road construction.
CO 5: To understand highway maintenance and design of overlays.

CO- PO Mapping / Articulation Matrix of Transportation Engineering-I

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	3	1	1	1	2	2	-	-	-	1	2	2	3	3
CO-2	2	2	3	2	1	2	2	1	-	-	1	1	2	2	3	3
CO-3	2	2	2	2	2	2	2	-	-	-	-	-	2	1	1	2
CO-4	2	3	3	2	2	2	2	-	-	-	-	-	2	3	3	3
CO-5	2	2	3	2	2	2	1	-	-	-	-	-	1	1	2	2
Average	2	2.2	2.8	1.8	1.6	1.8	1.8	1.5	-	-	1	1	1.8	1.8	2.4	2.6

Year III, 5th Semester

Structural Analysis- II

L-T-P-C 2-1-0-3

Course Objective

To know about the concept of the different methods of analyzing structures.

Syllabus

Unit 1

Introduction, Force and Displacement Methods of Analysis of Indeterminate Structures, Method of Minimum Strain Energy for indeterminate beams, Trusses, and plane frames.

Unit 2

Moment Distribution and Slope Deflection Methods: Introduction, Moment distribution and Slope Deflection methods for continuous beams and plane frames.

Unit 3

Introduction to Structural Dynamics: Single degree of freedom system without and with damping

Unit 4

Matrix Method of Analysis Introduction, Flexibility Method- Application to Beams, Trusses and Frames; Stiffness Method- Application to Beams, Trusses and Frames.

Unit 5

Plastic Analysis of Structures Introduction, Analysis of Plastic Structures, Plastic hinge concept. Shape factor-Static and kinematic method for beams and frames with portal and sway mechanism.

Textbooks

1. Indeterminate Structures, R L Jindal, S. Chand & Co. , New Delhi,
2. Basic Structural Analysis, C S Reddy, Tata McGraw Hill Publishers, 2017
3. Structural Dynamics: Theory and Computation, Mario Paz and Young Hoon Kim, Springer Publisher, 2018, 6th Edition.

Reference Books

1. Intermediate Structural Analysis, Chu-Kia Wang, Tata McGraw Hill Publishers, 2017.
2. Computational StructuralMechanics,Rajasekaran &SankaraSubramanian,PHI,2003.
3. Theory of Structures (Vol. II), G. Pandit, S. Gupta, Rajesh Gupta, Tata McGraw Hill Publishers 2017.
4. Analysis of Structures (Theory, Design & Details Of Structures) - Vol.2, V. N. Vazirani, M. M. Ratwani, S. K. Duggal, 1994.

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105109/

Course Outcomes (COs)

At the end of the course, the students will be able to:
CO1: Analyse displacements and internal forces of statically structures by Method of Minimum Strain Energy
CO2: Understand the concept of analysis of indeterminate structures by various classical methods.
CO3: Understand the concept of dynamic loading on structures with single degree of freedom.
CO4: Analyse displacements and internal forces of statically indeterminate beams, trusses and frames by matrix methods.
CO5: Analyse the structure using the Plastic design concept.

CO- PO Mapping

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	3	-	1	-	-	-	-	-	-	-	3	3	2	2
CO-2	3	3	3	-	1	-	-	-	-	-	-	-	3	3	2	2
CO-3	3	3	3	-	1	-	-	-	-	-	-	-	3	3	2	2
CO-4	3	3	3	-	1	-	-	-	-	-	-	-	3	3	2	2
CO-5	3	3	3	-	1	-	-	-	-	-	-	-	3	3	2	2
Average	3	3	3	-	1	-	-	-	-	-	-	-	3	3	2	2

DESIGN OF CONCRETE STRUCTURE-II

L T P C 2 1 0 3

Course Objective
To understand the limit state design method for reinforced concrete slab, column, footing & retaining walls and basics of prestressed concrete.

Unit I
Design of one-way and two-way slabs
Design of staircases
Serviceability limit states, control of deflection, cracking and vibrations

Unit II
Design of Columns: Short column under axial compression, short column under axial load and uniaxial bending
Design of columns under biaxial loading by design charts

Unit III

Foundation: Structural behavior of footings, design of isolated footing, design of combined rectangular and trapezoidal footings

Unit IV

Stability analysis of retaining walls, design of gravity and cantilever type retaining wall

Unit V

Prestressed Concrete: Advantage, method of prestressing, losses in prestress, analysis of simple prestressed rectangular and flanged sections

Text Books

1. Pillai, S.U. and Menon, D., "Reinforced concrete design", Tata McGraw Hill
2. Jaikrishna and Jain, O.P., "Plain and reinforced concrete – Vol I & II", Nem Chand & Bros.
3. Gambhir, M.L., "Fundamental of reinforced concrete design", PHI Learning Pvt. Ltd.
4. Park, R. and Paloy, T., "Reinforced concrete structures", Wiley Publ.
5. Vargheses, P.C.., "Limit state design of reinforced concrete", PHI Learning Pvt. Ltd.
7. Dayaratnam, P., "Design of reinforced concrete structures", Oxford & IBH Publ.
8. Jain, A.K. "Limit state design of reinforced concrete ", Nem Chand & Bros, Roorkee.
9. Sinha, S.N., "Reinforced Concrete Design", Tata McGraw Hill
10. Raju, N. Krishna, "Prestressed concrete" Tata McGraw Hil

Course Outcomes

At the end of this course, the students will be able to:

CO 1: Design one-way and two-way slabs

CO 2: Design Columns under axial and bending.

CO 3: Design isolated, combined and trapezoidal footings.

CO 4: Design and stability analysis of retaining walls.

CO 5: Analyze simple pre-stressed rectangular and flanged sections

CO- PO Mapping / Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	1	3	3	3	1	1	-	-	1	1	1	1	3	3	2	3
CO-2	1	3	3	3	2	1	-	-	1	1	1	1	3	2	2	3
CO-3	1	3	3	3	1	1	1	1	1	1	1	1	3	3	2	3
CO-4	2	3	3	3	2	2	1	1	2	2	2	1	3	2	2	3
CO-5	1	3	3	3	2	1	1	-	2	2	2	2	3	2	2	3
Average	1.2	3	3	3	1.6	1.2	1	1	1.4	1.4	1.4	1.2	3	2.4	2	3

GEOTECHNICAL ENGINEERING II

L-T-P-C 3-1-0-4

COURSE OBJECTIVES

At the end of this course, the student should describe different types of foundations, decide their suitability, and be familiar with the design and construction process. The student will also learn ground improvement techniques.

SYLLABUS

Unit I

SOIL EXPLORATION – Boring, Sampling, SPT, SCPT, VST, PLT, PMT, Flat Dilatometer Test, Groundwater Conditions, Geophysical Explorations

BEARING CAPACITY - Ultimate and allowable bearing pressure; general, local, and punching shear failures; Bearing capacity theories; corrections for size, shape, depth, the eccentricity of loading, water table, etc., Presumptive bearing capacities, Codal provisions, Skempton's Analysis, Meyerhof Method, Vesic's Method.

Unit II

SHALLOW FOUNDATIONS - Design considerations - factors of safety, allowable settlements, location and depth of foundations, Codal provisions, and Layered soils. Choice of shear strength parameters, Total and differential settlement. Stress distribution, Consolidation settlement in clays (with correction factors), Settlement computation from N-values

PILE FOUNDATIONS - Types of piles, Axial capacity of single piles – dynamic and Static formula, Skin friction, and end bearing in sands and clays, axial capacity of pile groups, group efficiency, Settlement of single piles and groups, Negative skin friction, Pile load tests, Codal provisions, Laterally loaded piles, Expansive Soils, Under reamed Piles, Pile Integrity Testing.

CASSION AND WELL FOUNDATIONS - Types of Caissons, scour depth, parts of the well foundation, Design Criterion, Estimation of allowable bearing pressure, well sinking, tilt and shift

Unit III

SLOPE STABILITY – Pressure at rest, Rankine's Theory, Coulomb's Theory, Finite and infinite slopes, Critical failure surface, factor of safety, Swedish circle method, Friction circle method, Bishop's Method, Stability Number, Taylor's stability chart, Culmann's Method, Causes of failure in earthen dams, and remedial measures.

Unit IV

GROUND IMPROVEMENT - Mechanical soil stabilization, mixing additives, Compaction piles, dynamic compaction, Pre-loading using a sand drain, stone column, vibroflotation, Reinforced soil.

GEOSYNTHETICS - Types, properties and functions, Principles of soil reinforcement, Design, and Construction of geosynthetic reinforced soil retaining structures, functional requirements related to endurance and degradation, Geosynthetics in pavements, separations, drainage and filtering in road pavements, Field applications of different types of geosynthetics.

Unit V

SOIL DYNAMICS - Engineering problems involving soil dynamics; Dynamic loading, Theory of

Vibrations, Types of machine foundations, Design criteria for machine foundations, Codal provisions.
INTRODUCTION TO GEOTECHNICAL EARTHQUAKE ENGINEERING - Engineering problems involving soil dynamics; measurement of small strain and large strain dynamic soil properties; ground response analysis; Soil liquefaction and remedial measures

REFERENCES

1. "Analysis and Design of Sub-Structure," Swami Saran, CRC Press. (2006)
2. "Foundation Analysis and Design," J.E. Bowles, McGraw-Hill. (1996)
3. "Foundation Engineering," P.C. Varghese, PHI Learning Private Limited. (2013)
4. "Principles of Foundation Engineering," B. M. Das, Cengage Learning, New Delhi. (2013)
5. "Theory and Practice of Foundation Design," N. N Som and S.C Das, PHI Learning Pvt Ltd. (2013)
6. "Pile Foundation Analysis and Design" Poulos H.G. and Davis, E. H., John Wiley (1980)
7. "Soil Mechanics and Foundations," Muni Budhu, John Wiley & Sons. (2010)
8. "Design Aids in soil mechanics and foundation engineering," Kaniraj S.K., Mc Graw Hill Publications. (1988)
9. "Reinforced Soil and its Engineering Applications," Swami Saran, I.K International Pvt Ltd. (2006)
10. "Soil Dynamics," Prakash, S., McGraw Hill Book Company. (1981)
11. "Construction and Geotechnical Methods in Foundation Engineering" – Robert M. Koerner, McGraw Hill Pub, Co., New York.
12. "Geotechnical-Earthquake Engineering," Kramer, S.L., Pearson Education – Indian Low-Price Edition. (2004)
13. "Soil Dynamics & Machine Foundation," Saran, S., Galgotia Publication. (2006)

USEFUL INDIAN STANDARD CODES

1. SP 36: Part 1: 1987 Compendium of Indian Standards on Soil Engineering: Part – 1 Laboratory Testing of Soils for Civil Engineering Purposes
2. SP 36: Part 2: 1988 Compendium of Indian Standards on Soil Engineering: Part – 2 Field Testing of Soils for Civil Engineering Purposes
3. IS 1904: 1986 Code of practice for Design and Construction of foundations in soils: general requirements (Third Revision)
4. IS 2131: 1981 Method for standard penetration test for soils.
5. IS 2720: Various parts for the field and laboratory tests.
6. IS 2809: 1972 Glossary of terms and symbols relating to soil engineering (First Revision)
7. IS 2810: 1979 Glossary of terms relating to soil dynamics (First Revision)
8. IS 2911: Various parts for the Design of foundations.
9. IS 2974: Various parts for the Design of machine foundations.

E-LEARNING RESOURCES

1. https://nptel.ac.in/courses/105/105/105105207/ NPTEL video course on Advanced Foundation Engineering
2. https://nptel.ac.in/courses/105/105/105105185/ NPTEL video course on Foundation Engineering
3. https://nptel.ac.in/courses/105/105/105105176/ NPTEL video course on Foundation Engineering
4. https://nptel.ac.in/courses/105/108/105108069/ NPTEL video course on Advanced Foundation Engineering
5. https://nptel.ac.in/courses/105/106/105106142/ NPTEL web course on Concepts in Geotechnical and Foundation Engineering
6. https://nptel.ac.in/courses/105/101/105101083/ NPTEL web course on Foundation Engineering
7. https://nptel.ac.in/courses/105/107/105107120/ NPTEL video course on Foundation Engineering
8. https://nptel.ac.in/courses/105/105/105105039/ NPTEL video course on Advanced Foundation Engineering
9. https://freevideolectures.com/course/2674/foundation-engineering Video course on Foundation Engineering

Course Outcomes

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

CO1: Identify and classify soil characteristics from field observations and associated problems with it.

CO2: Compute the foundation design parameters from field observations based on the various site conditions

CO3: Analyze the problems associated with the stability of slopes and its remedial measures

CO4: Review the ground conditions and recommend the suitable improvement methodology

CO5: Design the foundations for dynamic loadings

CO-PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	3	3	3	2	2	1	-	-	-	-	-	3	3	1	3
CO-2	2	3	3	3	2	2	1	-	-	-	-	-	3	3	1	3
CO-3	2	3	3	3	2	2	1	-	-	-	-	2	3	3	1	3
CO-4	2	3	3	3	2	2	1	-	-	-	-	-	3	3	3	3
CO-5	2	3	3	3	2	2	1	-	-	-	-	-	3	3	3	3
Average	2	3	3	3	2	2	1	-	-	-	-	2	3	3	1.8	3

TRANSPORTATION ENGINEERING-II

L-T-P-C 3-0-2-4

Course Objectives

To introduce the fundamentals of Railway and Airport Engineering, design and construction

Syllabus

Unit -I

Permanent way and components: Historical development and set-up of Indian Railways; Rail Gauges; Permanent way – functions, requirements, sections.

Joints and Fastenings: Types of joints; Welded rails – short and long, continuous; Rail to Rail and Rail to Sleeper fastenings, Elastic fastenings, Induced effects – Creep, wear.

Unit -2

Electrified tracks; Locomotives, Wheel and Axle arrangement.

Coning of wheels; Components – Rail, Sleeper and Ballast and their functional Requirements.

Resistances and Stresses in tracks, Hauling Capacity: Resistances to traction; Stresses in the track; Hauling capacity and tractive effort.

Unit -3

Track Geometry Turnouts and Crossings: Track alignment, Horizontal alignment – curves, super elevation, cant, safe speed, transition curves, widening of gauge, track clearances; Vertical alignment – gradients, points.

and Crossings – terminologies, types, turnouts, design of turnouts and crossings

Unit -4

Railway Safety: Signals – Classification, functions; Train operation control systems – Absolute, Automatic Block system, Centralized control system, ATS; Interlocking of tracks – Principle, types; Railway Certification process.

Rail Transit Systems: Classification; Urban and medium distance technologies; Technological and Operational Features; Medium performance transit modes, high-performance transit modes; Station and station area development.

Unit -5

High Speed Rails: HSR systems in world; Types of HSR technologies; track requirements and speed limitations; HSR development in India.

Airport Engineering: Introduction of Air Transport, Air craft characteristics, Factor affecting airport planning and design; runway orientation, wind rose diagram, estimation of runway length and corrections, taxiways, Runway pavement design, design of overlay; Runway lighting, Zoning laws, Visual aids, Helipads, hangers

List of experiments

1. To determine the Crushing Value of Aggregate.
2. To determine the Impact Value of Aggregate.
3. To determine the Abrasion Value of Aggregate.
4. To determine the Shape (Flakiness & Elongation Index) of Aggregate.

5. To determine the Penetration Value of Bitumen.
6. To determine the Softening Point of Bitumen.
7. To determine the Flash & Fire Point of Bitumen
8. To determine the Ductility of Bitumen.
9. To determine the Stripping Value of Bitumen.
10. To determine the Traffic Speed.

Text books

1 Highway Material Testing by S. K. Khanna & C. E. G. Justo, Nem Chand & Bros., Roorkee

2. Chandra, Satish and Agarwal, M. M., "Railway Engineering", Oxford University Press, New Delhi 2nd edition 2013

3. Arora, S. P. and Saxena, S. C, "A Textbook on Railway Engineering", Dhanpat Rai Publications (P) Ltd., New Delhi 7 th edition, 2006

Reference books

1. Mundrey, J. S., "Railway Track Engineering", Tata McGraw-Hill Publishing Company, New Delhi. 2017
2. M M Agarwal, "Railway Works Engineering", Prabha & Co. Delhi 2007 5. M M Agarwal, "Indian Railway Track", Prabha & Co. Delhi 2007

Course Outcomes

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

CO 1 Gain knowledge about Railways, tracks & ballast.
CO 2 To understand wheel arrangement and evaluate resistance and stresses in track.
CO 3 Analyze the track geometry and design curves.
Gain knowledge about the laying of tracks, yards, and railway stations.
CO 4 To understand railway safety and rail transit system.
CO 5 Gain knowledge about high-speed rails and airport engineering.
CO6 To identify engineering properties of aggregate and the grade & properties of bitumen.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	3	1	1	1	2	2	-	-	-	1	1	1	2	2
CO-2	2	2	3	2	1	2	2	1	-	-	1	1	2	2	3	3
CO-3	2	2	2	2	2	2	2	-	-	-	-	-	1	2	2	2
CO-4	2	3	3	2	2	2	2	-	-	-	-	-	2	2	3	3
CO-5	2	2	3	2	2	2	1	-	-	-	-	-	2	2	2	2
CO-6	1	3	3	3	2	3	2	1	1	1	1	2	1	2	3	3
Average	1.83	2.33	2.83	2.00	1.67	2.00	1.83	1.33	1.00	1.00	1.00	1.33	1.50	1.83	2.50	2.50

Environment Engineering -II

L-T-P-C 3-0-2-4

Course Objective

The students on completion of the course should be able to understand chemical and biological processes involved in wastewater treatment plant and wastewater treatment flow-sheet.

Syllabus

Unit -1

Collection of sewage: Importance of sanitation, Systems of sewerage – separate, combined and partially separate. Quantity of sanitary sewage and variations. Shapes of sewer – circular and egg-shaped. Design of sewers, self-cleansing velocity and slopes, Construction and testing of sewer lines. Sewer materials. joints and appurtenances

Unit -2

Sewage Characterization: Quality parameters- BOD, COD, Solids, D.O., Oil & Grease. Indian Standards for disposal of effluents into inland surface sources and on land.
Preliminary Treatment: Screening, grit removal, and flow equalization, Purpose and function of preliminary treatment processes, Design considerations for preliminary treatment units

Unit -3

Primary Treatment Sedimentation tanks and primary clarifiers**,** Removal of settleable and floatable solids**,** Design and operational considerations for primary treatment
Secondary Treatment: Biological Processes, Activated sludge process, Trickling filters, rotating biological contactors, Aerated lagoons and oxidation ditches, wastewater disposal in rural areas

Unit -4

Advanced Processes: Membrane bioreactors (MBRs)**,** Sequencing batch reactors (SBRs)**,** UASB**,** Biological nutrient removal (BNR)**,** Design and operation of tertiary treatment systems
Disposal of Sewage: Disposal of sewage by dilution – self-purification of streams, Sewage disposal by irrigation (sewage treatment), Sludge treatment

Unit -5

Air pollution Control: Types and sources of pollutants, units of measurement, causes and effect of air pollution, air quality monitoring and standards, control measures, brief introduction to control devices for particulate contaminants-gravitational setting chambers, centrifugal collector, electrostatic precipitators, automotive emission control, the concept of clean and biofuels.
Solid waste management: Terminology, characteristics, collection and transport, disposal methods, Design of landfills, solid waste disposal in rural areas

List of Experiments

1. To determine the pH of water and wastewater samples.
2. To determine the Electrical Conductivity of water and wastewater samples.
3. To determine the turbidity of water and wastewater samples.
4. To determine the Total Solids concentration of water and wastewater samples
5. To determine the acidity of water and wastewater samples.

6. To determine the alkalinity of water and wastewater samples.
7. To determine the hardness of water samples.
8. To determine the chloride concentration of water and wastewater samples.
9. To determine the optimum coagulant dosage.
10. To determine the Dissolve Oxygen (DO) concentration of water and wastewater.
11. To determine the Biological Oxygen Demand (BOD) of wastewater samples.
12. To determine the Chemical Oxygen Demand (COD) of wastewater samples

Text books

1. Sewage Disposal and Air Pollution Engineering, by S.K Garg Khanna Publishers.
2. Wastewater treatment: Concepts and design approach by G.L. Karia and R.A. Christian, Prentice Hall of India private ltd, New Delhi.
3. Environmental Engineering laboratory manual by R.C.Gaur New Age International Publishers.

Reference books

1. Wastewater Engineering Treatment and Reuse Fourth Edition by Metcalf & Eddy, McGraw Hill Education.
2. Environmental Engineering by Howard S. Peavey and Donald R Rowe, McGraw Hill Education.
3. Water Supply and Sanitary Engineering by G.S Birdie and J.S Birdie, Dhanpat Rai Publications

Course Outcomes

CO1: To describe the importance of sanitation & sewerage systems and design of sewers.
CO2: To understand the different parameters which affect the wastewater quality and operation of primary treatment units.
CO3: To analyze the concept of primary and secondary treatment of wastewater.
CO4: To categorize the different advanced treatment techniques and evaluate the different sewage disposal techniques.
CO5: To understand the basic concepts of air pollution and solid waste management.
CO6: Analyze and demonstrate the quality of wastewater samples and develop related field investigations

Course Mapping / Articulation Matrix for Environmental Engineering -II

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	3	1	1	1	2	2	-	-	-	1	-	2	2	3
CO-2	2	2	3	2	1	2	2	1	-	-	1	1	2	2	3	3
CO-3	2	2	2	2	2	2	2	-	-	-	-	-	1	2	2	2
CO-4	2	3	3	2	2	2	2	-	-	-	-	-	2	2	3	3
CO-5	2	2	3	2	2	2	1	-	-	-	-	-	1	1	3	2
CO-6	2	3	3	3	2	3	2	2	1	1	1	2	1	1	1	1
Average	2	2.33	2.833	2	1.67	2	1.83	1.67	1	1	1	1.33	1.4	1.66	2.33	2.33

Computer Application in Civil Engineering

L T P C 1 0 2 2

Course Objective

The course is aimed at making the student familiar with the softwares used in Civil engineering

List of Experiments

1. To understand the basics of computer programming
2. To familiarize the students with STAAD Pro, ETAB, BUILDMASTER
3. To analyze water supply systems using LOOP, WATERGEMS, WATERCAD
4. To solve geotechnical problems using PLAXIS
5. To carry out slope stability analysis using GEOSTUDIO
6. To model river water quality using QUAL2Kw software
7. To model groundwater flow and contaminant transport using MODFLOW and MT3D
8. To use MXROAD for design of roads

References

Manuals of various softwares of all above mentioned softwares

Course Outcomes

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

1. Understand the basics of computer programming
2. Analyse and design buildings and structures using softwares
3. Analyse and design water supply systems
4. Carry out software-based analysis for solution of geotechnical and transportation problems.
5. Model the surface and groundwater using softwares

Course Mapping / Articulation Matrix for CASE Laboratory

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	3	3	3	-	-	-	2	1	-	1	-	-	-	-
CO-2	2	2	3	3	3	2	2	1	2	1	-	1	2	2	1	1
CO-3	2	2	3	3	3	2	2	1	2	1	-	1	2	2	-	-
CO-4	2	2	3	3	3	2	2	1	2	1	-	1	2	2	-	-
CO-5	2	2	3	3	3	2	2	1	2	1	-	1	1	1	1	1
Average	2	2	3	3	3	2	2	1	2	1	-	1	1.75	1.75	1	1

Year III, 6th Semester

Design of Steel Structures

L-T-P-C 2-1-0-3

Course Objectives

To understand and analyze steel structures using the provisions of IS 800-2007

Syllabus

UNIT 1

General Considerations: Structural Steel, Stress-Strain Curve for Mild Steel, Rolled Steel Sections, Working stress and Limit State Method of Steel Design, Connections: Types of connections & joints, Bolted and Welded Connections, Load Transfer Mechanism, Failure Modes, Prying Action, Slip-Critical Connections, Moment Resistant Connections, Eccentric Connections, Beams Column Connections, Bracket Connections, Framed Connections, Seat Connections.

UNIT 2

Tension Members & Compression Members: Types of Tension Members, Net and effective Sectional Areas, Types of Failure, Design Strength and design of Tension Member, Lug Angles, Splices, Gusset Plate. Effective Length and Slenderness Ratio of compression members, Classification of Cross Sections, Column Formula, Design of Axially Loaded Compression Members, Built-Up Columns (Latticed Columns), Encased Column, Column Splices, Design of Column Bases, and Caps

UNIT 3

Flexural Members: Structural behaviour of Beams, Types of Sections for flexural design Lateral Stability of Beams, Lateral Torsional Buckling, Plastic design of beams, Design of Laterally Supported Unsupported Beams Rolled Beams, Built-Up Beams, Lintels, Purlins, Bearing Plates, Design of Beam-columns.

UNIT 4

Plate Girders: Elements of Plate Girder, General considerations, proportioning of web, Proportioning of flanges, Design methods, End panel design, Design of Stiffeners, Curtailment of Flanges, Gantry Girders: -Introduction, Loads, Fatigue Effects, Design of gantry Girders, Design of Column Bases, and Caps

UNIT 5

Industrial Buildings: - Introduction, Planning, Structural Framing, Types, Roof and Side Coverings, Elements of an Industrial Building, Design Steps of Industrial Building.

Textbooks

1. Limit State Design of Steel Structures, S K Duggal, Tata Mc Graw Hill Publishers, 2019, 3rd Edition.
2. IS-800-2007, BIS Publication
3. Steel Structures: Design and Practice, N.Subramanian, Oxford Publishers, 2018.

4. Design of Steel Structures: By Limit State Method as per IS:800 – 2007, S.S. Bhavikatti, 2019, 5th Edition.

Reference Books

1. Design and Analysis Of Steel Structures, V. N. Vazirani and M. M. Ratwani, Khanna Publishers, 1988.
2. Design of Steel Structures, P Dayaratnam, S. Chand Publishers, 2012
3. Design of Steel Structures, L S Negi, Tata Mc Graw Hill Publishers, 2017

Online Resources

1 https://nptel.ac.in/courses/105/105/105105162/

Course Outcomes (COs)

At the end of the course, the students will be able to:
CO1: Evaluate steel as building material, and design Connections.
CO2: Analyse design philosophy for creating steel structure members (Design of tension, compression members).
CO3: Design Beams, Beam-columns, and column bases.
CO4: Apply knowledge for creating innovative steel structures and typical log span beams.
CO5: Analyse the various industrial structures and designs.

CO- PO Mapping / Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	3	-	1	-	-	-	-	-	-	-	3	3	2	3
CO-2	3	3	3	-	1	-	-	-	-	-	-	-	3	3	2	3
CO-3	3	3	3	-	1	-	-	-	-	-	-	-	3	3	2	3
CO-4	3	3	3	-	1	-	-	-	-	-	-	-	3	3	2	3
CO-5	3	3	3	-	1	-	-	-	-	-	-	-	3	3	2	3
Average	3	3	3	-	1	-	-	-	-	-	-	-	3	3	2	3

ENGINEERING HYDROLOGY

L T P C 3 0 0 3

Course Objective:

Syllabus

Unit I

Hydrologic cycle: Overview and applications of hydrology in engineering, Hydrologic cycle, water budget equation.

Precipitation: Forms, measurement, presentation, mean precipitation, missing data, error in estimation, consistency of rainfall records, IDF curve, PMP, frequency of a point Rainfall, Precipitation patterns and trends at local, regional and National level

Unit II

Abstractions from precipitation: Factors, measurement: Infiltration, infiltration indices, Evaporation, Evapotranspiration

Streamflow measurement: Measurement of stage and velocity, Stage discharge relationship

Runoff: Components and factors affecting runoff, methods of estimation of runoff volume, Rainfall–runoff relationships. Flow Mass Curve

Unit III

Hydrograph analysis: components, factors affecting hydrographs, base flow separation, Direct Runoff Hydrograph, Unit Hydrograph, Derivation of Unit Hydrograph (for an isolated storm and complex storm), S-Hydrograph,

Unit IV

Flood Routing

Introduction, Hydrologic and hydraulic routing, Hydraulic routing through a channel – Muskingham Method, Reservoir routing

Floods: Estimation of peak discharge, rational method, Design flood, return period, flood frequency analysis, Gumbel's method.

Unit V

Introduction, occurrence of Ground Water -Unsaturated and saturated zone, aquifer properties, Basic equation of Groundwater movement, flow through a confined aquifer and unconfined aquifer, Well loss and specific capacity, transmissivity and storage coefficient.

Surface and Groundwater resources at local, regional and National level

Text Books

1. Open Channel Hydraulics by Ven Te Chow, McGraw Hill International Book Company
2. Engineering Hydrology by Subramanya, K., 2nd edition, Tata McGraw Hill publishing Co.ltd., New Delhi
3. Rajesh Srivastava and Ashu Jain, McGraw Hill Eductaion(I) Pvt. LTD,Chennai

References Books

1. Applied Hydrology, Chow, V.T., Maidment, D., and Mays, L.W., Tata McGraw Hill Publications, 2010
2. Engineering Hydrology, Subramanya, K., Tata McGraw Hill Publications, 2008
3. Water Resources Engineering, Mays, L.W., Wiley Publications, 2012
2. Introduction to Hydrology, Viessman, W., and Lewis, G.L., Prentice Hall of India, 2008

Course Outcomes

At the end of this course, the students will be able to:

CO 1 Analyze Precipitation and forecast the rainfall.

CO 2 Analyze the abstractions from precipitation, stream flow and runoff; develop rainfall-runoff models.

CO 3 Understand and apply the concept of unit hydrograph and its variants such as S-curve

CO 4 Understand and apply the concept of flood routing and carry out flood routing and carry out flood-frequency analysis.

CO 5 Understand and apply the groundwater flow equations for the solution of problems in confined and unconfined aquifers and well hydraulics.

CO-PO Mapping / Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	2	-	1	3	2	-	-	-	-	-	2	2	2	-
CO-2	1	2	2	3	1	2	-	-	-	-	-	-	1	2	2	3
CO-3	2	2	2	-	3	2	-	-	-	-	-	-	2	2	2	-
CO-4	2	2	2	3	3	2	-	-	-	1	-	-	2	2	2	3
CO-5	2	2	2	-	1	3	2	-	-	1	1	-	2	2	2	-
Average	1.8	2	2	3	1.8	2.4	2	-	-	1	1	-	1.8	2	2	3

ESTIMATION & CONSTRUCTION MANAGEMENT

L T P C 3 0 0 3

Course Objective: The course is aimed at making the students familiar with methods of estimation of quantities, carrying out rate analysis, contracts procedure and construction planning and management techniques such as PERT/CPM

Syllabus

Unit I

Purpose of estimate, different types of estimates, approximate estimate, estimate of building, RCC works.

Unit II

Analysis of rates, estimation of quantity of materials, specifications, method of measurement of works, public works accounts.

Unit III

Contracts, types of contracts, contract document, conditions of contracts, contract procedure, termination of contracts, and specification important condition of contract, arbitration.
Valuation, scrap value, salvage value, market value, book value, depreciation, appreciation, mortgage.

Unit IV

Significance of construction management, objectives and functions of construction management, types of construction, resources for construction industry, stages of construction, construction team, engineering drawings. Bar Chart and milestone

Unit V

Critical path method (CPM), programme evaluation and review technique (PERT) – Network techniques breakdown structures, classification of activities, rules for developing networks, network development, network analysis, critical activities and critical path.

Text Books

1. Estimating, Costing and Valuation in Civil Engineering by M. Chakraborty. The anthor,1987 Publishers
2. PERT and CPM Principles and Application by L. S. Shrinath, East-West Press private limited, New Delhi, 3rd edition (1989)
3. Estimating and Costing by B. N. Dutta. CBS Publishers & Distributors Private Limited, 2020.
4. S.B Suman(2017) , Construction Technology and management , Krishna Prakashan media Pvt Ltd, Meerut,India

Reference Books

1. Construction project Management, K K Chitkara, Tata McGraw Hill Publishing Company Limited, New Delhi, 2019, Fourth Edition 2. Construction Planning Equipment & methods, Puerifoy R.L, 2010

2. Construction Project Management, Kumar Neeraj Jha , Pearson Publication , 2015, Second edition

3. Project Management, Choudhary S, Tata McGraw Hill Publishing Company Limited, New Department of Civil Engineering Scheme and Syllabi w.e.f. 2021-22 Delhi, 2017.
4. Project Planning and Control with PERT and CPM, Punmia and Khandelwal K.K., Laxmi Publications Delhi, 2016

Online Resources:

1.https://nptel.ac.in/courses/105/106/105106149/ 2. https://nptel.ac.in/courses/105/103/105103093/
2. https://www.udemy.com/course/estimating-and-costing/

Course Outcomes

At the end of this course, the students will be able to:
CO1 Prepare quantity estimates for buildings and roads
CO2 Carry out rate analysis and prepare specifications for various civil construction items
CO 3 Analyze contracts and carry out the valuation of civil infrastructure.
CO 4 Understand and applying various techniques of construction management
CO 5 Understand and apply various construction planning nad management such as PERT and CPM.

CO- PO Mapping / Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	-	1	3	2	1	1	-	-	-	-	-	-	3	2	1	-
CO-2	1	2	2	2	-	1	-	-	-	-	-	-	2	1	1	1
CO-3	-	1	2	1	2	1	-	-	-	-	-	-	1	1	1	2
CO-4	-	2	3	3	2	1	-	-	-	-	-	-	2	3	1	3
CO-5	1	1	2	1	-	1	1	-	-	-	-	-	1	-	-	-
Average	1	1.4	2.4	1.8	1.67	1	1	-	-	-	-	-	1.8	1.75	1	2

IRRIGATION AND HYDRAULIC DESIGN

L-T-P-C 3-1-0-4

Course Objective

The objective of this course is to familiarize the students with the basic concepts of irrigation and the design of hydraulic structures.

Syllabus

Unit I

Introduction: Role and importance of irrigation in agriculture, Types and Methods of irrigation, Irrigation methods in rural India
Water Requirements of crops: Quality of irrigation water, Irrigation water requirements Duty and Delta, Irrigation efficiencies, Irrigation frequency, Intensity of irrigation.
Well irrigation- Types, specific yield of well, steady flow into wells, well loss, specific capacity, relative merits of canal and well irrigation, types of tube wells, well shrouding and development**.**

Unit II

Canal irrigation: Canal classifications, canal alignments, parts of canal irrigation system, curves in channels, losses in canals, Silt theories, Design of canal by Kennedy's and Lacey's theories.
Canal Lining: Advantages, Design of lined canal, economics of canal lining.
Water logging: Effects, causes and prevention of water logging, Types of drains- open and closed, Spacing of drains, Layout of canal system.

Unit III

Diversion Headworks: Selection of site and layout, Parts of diversion head works, types of weirs and barrages, effects of construction of a weir on the regime of river, Design of impervious floor for sub surface flow, Silt excluders and different types of silt ejectors

Canal regulation work: Canal falls, Head regulators and cross regulators, Canal escapes.
Cross drainage works: Necessity of cross drainage works, their types and selection, Design of various types of cross drainage works-Aqueduct, Siphon aqueduct, Super passage, Siphon, Level crossing, field visit to hydraulic structures

Unit IV

River training works: Classification of rivers, meandering, Classification and types of River training works.
Reservoir Planning: Investigations for reservoir planning, types of reservoirs, selection of site for reservoir, zones of storage of a reservoir, reservoir yield, estimation of capacity of reservoir using mass curve.

Unit V

Gravity dams: Forces acting on a gravity dam, causes of failure of a gravity dam, elementary profile, and practical profile of a gravity dam, limiting height of a low gravity dam, Factors of Safety – Stability Analysis, drainage and inspection galleries.
Spillways: Introduction, Types of spillways, Design Consideration for spillways.

Text books

1. Irrigation Engineering and Hydraulic Structures – P.N Modi, Standard Book House.
2. Irrigation Engineering and Hydraulic Structures – S.K Garg, Khanna Publishers.
3. A text book of Hydrology and Water Resources Engineering by R.K Sharma and T.K. Sharma, Dhanpat Rai Publications.
4. Irrigation and Water power engineering- B.C. Punmia, Pandey, B.B. Lal, Standard publishers.

Reference books

1. A.M. Micheal, "Irrigation, Theory and Practice", Vikas Publishing House Pvt. Ltd.
2. Design of minor irrigation and canal structures by C. Satyanarayana Murthy, Wiley Eastern Ltd.

Course Outcomes

At the end of this course, the students will be able to:

CO 1: To understand the water requirement of crops and methods of irrigation.
CO 2: To carry out the design of canals and the Purpose of canal lining. flood routing.
CO 3: To apply the design principles of diversion head works, cross drainage works and other canal regulation work.
CO 4: To apply the design principles of river training work and to understand the concepts of Reservoir planning
CO 5: To carry out the design of Gravity Dams and Spillways.

CO- PO Articulation Matrix for Irrigation and Hydraulic Design

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	3	3	2	2	1	-	1	1	1	1	2	2	3	3
CO-2	2	2	3	3	1	2	1	1	1	1	1	1	3	3	3	3
CO-3	1	1	3	3	3	2	2	1	2	1	1	1	3	3	3	3
CO-4	2	2	3	3	3	1	-	1	1	1	2	1	3	2	3	3
CO-5	1	1	2	2	1	1	1	-	1	1	1	1	3	3	3	3
Average	1.6	1.6	2.8	2.8	2	1.6	1.25	1	1.2	1	1.2	1	2.8	2.6	3	3

EARTHQUAKE RESISTANT DESIGN

L T P C 3 1 0 4

Couse objective

To understand the earthquake phenomenon, dynamics of structure and earthquake-resistant design of buildings.

Unit I

Engineering Seismology: Introduction to seismic hazard, Earthquake phenomenon, Seismotactonics and seismic zoning of India, Earthquake monitoring and seismic instrumentation, characteristics of strong earthquake motion, effect of structural irregularities on the performance of buildings during earthquake and seismo-resistant building architecture

Unit II

Dynamics of structures: Analysis of single degree of freedom and multi degree of freedom systems, concept of shear building.

Unit III

Evaluation of earth forces: Seismic analysis by IS: 1893- 2000 (Part- I)

Unit IV

Earthquake resistant design of buildings: Ductility considerations, earthquake resistant design of RC buildings, concept of design for infill wall and shear wall.

Unit V

Earthquake resistant earthen and masonry buildings: design consideration, guidelines.

References

1. Pankaj Agarwal and Manish Shrikhande “Earthquake Resistant Design of Structures”, Prentice Hall of India.

2. S.K. Duggal “Earthquake Resistant Design of Structures”, Oxford University Press.
3. M. Paz “Structural Dynamics- Theory and Computation” CBR Publishers.
4. A.K. Chopra, “Dynamics of Structures: Theory & Application of Earthquake engineering”, Pearson.
5. IS: 1893 (Part- I)
6. IS: 4326
7. IS: 13920
8. IIT K- BMTPC Earthquake Tips

Course Outcomes

At the end of this course, the students will be able to:

CO 1: To understand the Earthquake phenomenon and its characteristics.
CO2: To understand the dynamics of structure.
CO3: To evaluate Earth forces using IS 1893-2016(Part-I).
CO4: To understand the Earthquake resistant design of buildings.
CO5: To acquire knowledge of earthquake resistant earthen and masonry buildings.

CO- PO Mapping / Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	1	1	3	1	1	1	-	-	1	1	1	1	1	1	3	-
CO-2	1	1	3	1	2	1	-	-	1	1	1	1	2	1	3	1
CO-3	1	1	3	1	1	1	1	-	1	1	1	1	2	2	2	1
CO-4	2	1	3	1	2	2	1	-	2	2	2	1	3	2	2	1
CO-5	1	1	3	1	2	1	1	-	2	2	2	2	3	2	2	1
Average	1.2	1	3	1	1.6	1.2	1	-	1.4	1.4	1.4	1.2	2.2	1.6	2.4	1

PEC – I (6th Semester)

REPAIR AND MAINTENANCE OF CONCRETE STRUCTURES

L T P C 3 1 0 4

Course Objective

This course will help students learn how to identify various deterioration mechanisms or damage mechanisms in concrete structures (deterioration of metallic reinforcement and cementitious materials).

Syllabus

Unit I

Introduction, significance of corrosion, and corrosion mechanisms, embedded metal corrosion

Unit II

Deterioration of cementitious systems – Sulphate and Acid attack, Deterioration of cementitious systems – Alkali Silica Reaction (ASR), Shrinkage, and others, Concrete assessment using non-destructive tests (NDT)

Unit III

Concrete assessment and load effects, Surface repair – Condition assessment, Surface repair – Analysis, strategy, and design

Unit IV

Surface repair – Material requirement, surface preparation, placement of repair material

Unit V

Strengthening and stabilization – Introduction and beam shear capacity strengthening, Column Strengthening, Flexural Strengthening

References:

1. "Concrete Structures Protection Repair And Rehabilitation," R. Ooode Woodson (2006)
2. "Repair And Rehabilitation Of Concrete Structures", Poonam I. Modi and Chirag N. Patel
3. "Building Code Requirements for Structural Concrete" ACI 318-19.

E-resources

1. NPTEL :: Civil Engineering - NOC:Maintenance and Repair of Concrete Structures

Course Outcomes

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

CO1: understand the scientific aspects and its use while practicing repair works at site.
CO2: understand the use of various non-destructive, partially-destructive tools to assess the condition of the structure
CO3: analyze and identify measurable parameters that are useful in deciding the further repair and maintenance practices
CO4: understand the strengthening and stabilization of beam shear capacity
CO5: understand the strengthening and stabilization of columns

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	-	2	3	2	3	3	-	2	3	3	3	3	3	2	2	2
CO-2	2	3	3	2	3	3	3	2	3	3	3	3	3	2	2	2
CO-3	2	2	3	2	3	3	3	2	3	3	3	3	3	2	2	2
CO-4	2	2	3	2	3	3	3	2	3	3	3	3	3	2	2	1
CO-5	2	1	3	2	3	3	3	2	3	3	3	3	3	2	1	1
Average	2	2	3	2	3	3	3	2	3	3	3	3	3	2	1.8	1.6

GROUND IMPROVEMENT TECHNOLOGY

L T P C 3 1 0 4

Course Objective

At the end of the course, the students would be able to identify various ground improvement methods. The student should choose a suitable method for specific ground conditions and learn the design aspects of Reinforced Earth structures, Diaphragm walls, and Stone Columns.

Syllabus

Unit I

INTRODUCTION

Soil improvement Techniques, Principles of Ground Improvement, Depth of improvement, Environmental considerations.

DYNAMIC AND VIBRO COMPACTION

Compaction using vibratory probes, Vibro techniques, Vibro equipment, Vibro Compaction, and replacement process, Compaction Piles, dynamic compaction

Unit II

PRELOADING TECHNIQUES

Preloading techniques with Sand drains, Sand wicks, Vertical and radial consolidation, and construction methods.

Unit III

SOIL STABILIZATION

Stabilization using admixtures- lime, Cement, fly ash, granulated blast furnace slag, rice husk, etc. Chemical stabilization, Thermal treatment, Introduction to biotechnical stabilization.

Unit IV

GROUTING SYSTEMS

Types of grout, Grouting methods- Jet grouting, Permeation grouting, Displacement grouting, Grouting pressure, Chemical grouting, and Compaction grouting, Commonly used chemicals, grouting operations, applications, Grouted Columns.

STONE COLUMNS

Stone columns, their effectiveness, Construction techniques, Design aspects.

Unit V

GEOSYNTHETICS:

Family of Geosynthetics-Geotextiles, Geogrids, Geonets, Geomembranes, Geocomposites, Geocells, Properties, and test methods, Functions, Design methods for separation, stabilization, filtration, Drainage., Physical and strength properties of Geosynthetics, behavior of soils on reinforcement, Effect on Strength, Bearing capacity, Compaction, and Permeability.

INTRODUCTION TO REINFORCED SOIL

Types of reinforcement, Load transfer mechanism, strength development, Construction of flyovers using Reinforced soil walls, Anchored Earth Nailing, Reinforced soil retaining walls, Reinforcement of soil beneath foundations.

References

1. "Reinforced Soil and its Engineering Application," Swami saran, New Age Publication. (2006)
2. "Construction & Geotechnical Methods in Foundation Engineering," Koerner, Tata McGraw Hill. (2012)
3. "Engineering Principles of Ground Modifications," Manfred R Haussmann, Tata McGraw Hill. (1989)
4. "Fundamentals of Geosynthetic Engineering," Shukla, S.K. and Yin, J.H., Taylor & Francis. (2006)
5. "Geotechnical Engineering," Gulati, S.K. and Datta, M., Tata Mc Graw Hill Publishing Co. New Delhi. (2005)
6. "Theory and Practice of Foundation Design," N. N Som and S.C Das, PHI Learning Pvt. Ltd. (2013)

E-resources

1. https://nptel.ac.in/courses/105/105/105105210/ NPTEL video course on Ground Improvement
2. https://nptel.ac.in/courses/105/108/105108075/ NPTEL video course on Ground Improvement
3. https://nptel.ac.in/courses/105/106/105106052/ NPTEL video course on Geosynthetics and Reinforced Soil Structures
4. https://nptel.ac.in/courses/105/101/105101143/ NPTEL video course on Geosynthetics Engineering: Theory and Practices

Course Outcomes

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

CO1: Assess the existing ground conditions

CO2: modify the ground as per the requirement of the proposed structure to be constructed.

CO3: Select an appropriate technique for the ground improvement comparing its merits and demerits.

CO4: Design and supervise the Construction for the chosen technique.

CO5: Design and construct the reinforce earth walls

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	1	3	3	3	3	3	3	1	3	3	1	3	3	1	2	1
CO-2	1	3	3	3	3	3	3	1	3	3	1	3	2	1	2	1
CO-3	1	3	3	3	3	3	3	1	3	3	1	3	2	1	2	1
CO-4	1	3	3	3	3	3	3	1	3	3	1	3	2	1	2	1
CO-5	1	3	3	3	3	3	3	1	3	3	1	3	3	1	2	1
Average	1	3	3	3	3	3	3	1	3	3	1	3	2.4	1	2	1

ENVIRONMENTAL IMPACT ASSESSMENT

L T P C 3 1 0 4

Course Objective

In this course, the students are exposed to learn the need, methodology, documentation and usefulness of environmental impact assessment and to develop the skill to prepare environmental management plan.

Syllabus

Unit-I
INTRODUCTION
Definition, Concept of sustainable development, Planning and management of impact studies Basic concept of EIA and Methodologies: Initial environmental Examination, Elements of EIA, factors affecting EIA Impact evaluation and analysis, Environmental Impact Statement, preparation of Environmental Base map, Classification of environmental parameters.

Unit-II
IMPACT IDENTIFICATION AND PREDICTION
Methods of Impact identifications: Interaction-Matrix method, network methods, checklist methods Description of environmental setting (affected environment) Conceptual framework, Selection process- site visits, interdisciplinary team discussions, scoping; documentation, data sources. Environmental indices and indicators for describing the affected environment- media index for water quality, noise, ecological sensitivity and diversity, archaeological resources and quality of life, development of indices.

Unit III
PREDICTION AND ASSESSMENT
Prediction and assessment of impacts on the: air, surface water, groundwater, soil, noise environment, biological environment, archaeological environment, visual impacts, socioeconomic environment

Unit- IV
ENVIRONMENTAL MANAGEMENT PLAN
Environmental Management Plan - preparation, implementation and review - Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Addressing the issues related to the project affected people - Post project monitoring - Post project audit – Ethical and Quality aspects of Environmental Impact Assessment.

Unit- V

CASE STUDIES

EIA for infrastructure projects – Dams – Highways – Multi-storey Buildings Water Supply and Drainage Projects – Wastewater treatment plants – Localized area specific industrial projects.

References:

1. Whyte, A.V. & Burton, I. "Environment Risk Assessment (Scope 13-18)", John Wiley.
2. Anjaneyulu, Y. & Manickam, V. "Environmental Impact Assessment Methodologies", Taylor & Francis.

Course Outcomes

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

CO1: Understand types of environmental risk and conduct modelling for the problem.
CO2: Understand environmental monitoring and health surveillance.
CO3: Conduct risk evaluation with help of national policies.
CO4: Understand emerging needs for common national problems.
CO5: Understand the risk assessment process for environment

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	-	-	2	-	1	3	2	3	2	3	3	-	-	-	1
CO-2	1	1	-	2	-	2	3	3	3	3	3	3	-	-	-	-
CO-3	1	1	-	2	-	1	3	2	3	2	3	3	-	-	-	-
CO-4	1	1	-	2	-	1	2	2	3	3	3	3	-	-	-	-
CO-5	1	1	-	2	-	2	3	3	3	2	2	2	-	-	-	-
Average	1.2	1	-	2	-	1.4	2.8	2.4	3	2.4	2.8	2.8	-	-	-	1

ADVANCED CONCRETE TECHNOLOGY

L T P C 3 1 0 4

Course Objective

At the end of this course, the student should be able to learn the rheology, strength and durability characteristics of concrete and to design different types of concretes.

Syllabus

Unit I

Fundamental Concrete Technology: Mixing, transportation, placing and curing of concrete, properties of fresh and hardened concrete, use of chemical and mineral admixtures.

Unit II

Special Concrete: Properties and applications of: High strength - high performance concrete, reactive powder concrete. Lightweight, heavyweight, and mass concrete; fibre reinforced concrete; self-compacting concrete; shotcrete; other special concretes.

Unit III

Special Construction Methods: Mechanical construction, roller compaction and shotcreting, preplaced aggregate and antiwashout concrete.

Special Concrete methods: Ready mixed concrete, grouting, sprayed concrete, under water concrete

Unit IV

Repair, Rehabilitation and Enhancement of Concrete: Durability problems in concrete, masonry and steel structures, NDT and partially destructive test methods, repair methodology –principles and practices, concept of residual life and whole life cycle costing, perspective and preventive maintenance.

Unit V

Durability of Concrete: Introduction to durability; relation between durability and permeability. Chemical attack of concrete; corrosion of steel rebars; other durability issues.

Text Books

References:

1. P.K.Mehta and Paulo J.M.Monteiro, "Concrete: microstructure, properties and materials", The McGraw-Hill Companies
2. AM Neville, Properties of concrete, Pearson
3. ML Gambhir, Concrete Technology, Tata McGraw Hill Companies
4. AR Santakumar, Concrete Technology, Oxford University Press

Course Outcomes

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

CO1: Understand the fundamentals of Concrete Technology
CO2: Understand the properties of Special concrete.
CO3: Understand the functions of Special concrete methods.
CO4: Understand the Repair, Rehabilitation and Enhancement of Concrete.
CO5: Understand the Durability of Concrete.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	2	2	-	-	-	-	-	-	-	1	1	1	-	2
CO-2	-	-	-	2	-	2	2	-	-	-	-	1	1	1	-	2
CO-3	2	2	3	3	3	-	-	-	-	-	-	1	1	1	-	2
CO-4	2	2	3	3	3	-	-	-	-	-	-	1	1	1	-	2
CO-5	3	3	3	2	3	-	-	-	-	-	-	1	1	1	-	2
Average	2.25	2.25	2.75	2.4	3	2	2	-	-	-	-	1	1	1	-	2

INDUSTRIAL WASTE MANAGEMENT

L T P C 3 1 0 4

Course Objective

The objective of this course is to familiarize the students with pollutants generated from major industries and the possible means to control them. The student should possess knowledge regarding the pollution levels generated by key industries and the strategies employed to regulate and reduce such pollution.

Syllabus

Unit I

Types of industries and industrial pollution: Characteristics of industrial wastes, Population equivalent, Bioassay studies. Effects of industrial effluents: on streams, sewer, land, sewage treatment plants and human health. Environmental legislations: Global and national legislations related to prevention and control of industrial effluents and hazardous wastes.

Unit II

Waste management Approach: Waste Audit, Volume, and strength reduction. Material and process modifications – Recycle, reuse and byproduct recovery – Applications.

Unit III

Pollution from Major Industries: Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Electroplating industries, Dairy, Sugar, Paper, distilleries, Steel plants, Refineries, fertilizer, thermal power plants. Wastewater reclamation: concepts, principles, applications, examples – local regional, national, global.

Unit IV

Treatment Technology - I: Equalization, Neutralization, Removal of suspended and dissolved organic solids, Chemical oxidation, Adsorption, Removal of dissolved inorganics. Treatment Technology - II: Combined treatment of industrial and municipal wastes, Residue management, Dewatering, Disposal

Unit V

Hazardous wastes - Physico chemical treatment – solidification – incineration – Secured land fills

Text Books

1. Eckenfelder, W.W. Jr., Industrial Water Pollution Control, 3rd Edition, McGraw Hill International Edition, Singapore, 2000.

2. Arceivala, S.J., Wastewater Treatment for Pollution Control, 2nd Edition, Tata McGraw Publishing Co. Ltd., New Delhi, 1998.

3. Rao, M.N. and Dutta, A.K. “Wastewater Treatment”, 3rd Edition, Oxford Publishing. Publishing Co. Ltd., UK, 2017.

References:

1. Nemerow, N.L. Industrial Waste Treatment – Contemporary Practise and Vision for Future. Latest Edition, Butterworth-Heinemann Publishers, UK, 2007.

2. H.M. Freeman, “Industrial Pollution Prevention Hand Book”, McGraw-Hill Inc., New Delhi, 1995.

3. Bishop, P.L., “Pollution Prevention: Fundamental & Practice”, McGraw-Hill, 2000.

E-resources

1. Link to YouTube Video (Short Video – Industrial Waste Management) https://www.youtube.com/watch?v=aS-U8xsvZ 4&pp=ygUbaW5kdXN0cmlhbCB3YXN0ZSBtYW5hZ2VtZW50
2. Link to YouTube Video (Lecture Videos – Industrial Waste Treatment) https://www.youtube.com/watch?v=SRvRFY-c5-U&list=PL4SPMn8HFBYBhLHBY8D7iCNek9sWGWPCX

Course Outcomes

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

CO1: To identify the different types of industries and the pollutants generated from them and explain the effects of industrial effluents on surrounding environment and the environmental legislations in place to control them

CO2: To understand the different waste management approaches, assess the different material recovery processes and modifications

CO3: To assess the pollutants being generated from different industries and explain the principles of wastewater reclamation

CO4: To assess and analyze the different treatment methods for industrial wastewater and their disposal.

CO5: To understand and assess the different treatment procedures for hazardous wastes generated in an industry

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	2	3	2	2	2	1	-	-	2	1	2	2	2	2
CO-2	2	2	3	3	2	2	2	-	-	-	1	1	2	2	2	2
CO-3	2	2	2	2	2	2	2	-	-	-	1	2	2	2	2	2
CO-4	2	3	3	3	3	2	2	-	-	-	1	3	2	2	2	2
CO-5	2	2	3	2	2	2	1	1	-	-	1	2	2	2	2	2
Average	2	2.2	2.6	2.6	2.2	2	1.8	1	-	-	1.2	1.8	2	2	2	2

REMOTE SENSING AND GIS

L T P C 3 1 0 4

Course Objective

Students undergoing this course are expected to understand about
the principles of Remote Sensing, GIS, Spatial Systems, and its application to Civil Engineering problems.

Syllabus

UNIT 1

Fundamentals of Remote Sensing

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water, spectral signatures.

UNIT II

Data Acquisition

Different types of sensors and platforms; contrast ratio and possible causes of low contrast; aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; air-photo interpretation- interpretation elements;

UNIT III

Photogrammetry

Photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography; satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices.

UNIT IV

Geographic Information System

Introduction, concept and terminology, components of GIS, Rastor and Vector formats, scanners and digitizers, methods of digitization, data Preprocessing, form conversion, data reduction, and generalization. Data bases and DBMS, Spatial databases, co-ordinate systems and geo-referencing. Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS,

UNIT V

Application

Application of remote sensing and GIS for the management of land and water resources, Integrated use of Remote sensing and GIS, Introduction to Arc view, Arc info, Map Info, MODFLOW software.

Text Books

1. A.M. Chandra, S.K. Ghosh, "Remote Sensing and Geographical Information System", 1st Edition, Narosa Publishing house, 2007.
2. M. Anji reddy, "Remote Sensing and Geographical Information Systems", 3rd Edition, B.S. Publications, 2006.

References

1. Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
2. Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
3. George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
4. Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
5. Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
6. Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.

Course Outcomes

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

CO1: Analyse the principles and components of photogrammetry and remote sensing.
CO2: Describe the process of data acquisition of satellite images and their characteristics.
CO3: Compute an image visually and digitally with digital image processing techniques.
CO4: Explain the concepts and fundamentals of GIS.
CO5: Compute knowledge of remote sensing and GIS in different civil engineering applications.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	1	-	-	2	3	1	1	3	2	2	3	2	1	2	3
CO-2	1	1	1	2	2	3	1	1	3	2	2	3	2	1	2	3
CO-3	2	1	2	3	2	3	1	1	2	2	2	3	2	1	2	3
CO-4	2	1	-	2	3	3	1	1	3	2	3	2	2	1	2	3
CO-5	1	1	1	2	1	2	1	2	3	3	1	3	2	1	2	3
Average	1.6	1	1.33	2.25	2	2.8	1	1.2	2.8	2.2	2	2.8	2	1	2	3

TRAFFIC ENGINEERING

L T P C 3 1 0 4

Course objective

On completion of this course the students will have an overall knowledge of the traffic components, traffic planning and intelligent transport system (ITS).

Syllabus

Unit I

Introduction: Role of traffic Engineer, Road user characteristics, Human and vehicle characteristics. Fundamental parameters and relations of traffic flow, Traffic stream models: Greenshields's model, Greenberg's logarithmic model, Underwood's exponential model, Pipe's generalized model, Multi-regime models.

Unit II

Traffic flow: Interrupted and Un-interrupted Traffic Flow, Highway capacity: Urban, rural and intersection, Capacity of transit system, Traffic flow theory: Car Following and Queuing Theory.

Unit III

Traffic Studies: Traffic volume studies, Speed studies, Speed and Delay Studies, Origin and Destination studies, Accident studies, Capacity studies, Parking studies. Automated traffic measurement: GPS devices, loop detectors, video analysis, and other technologies.

Unit IV

Traffic Control: Regulations and other operational controls, Traffic Signal and marking, street lighting, Traffic Safety: Barricades, delineators.

Design of Intersections: Canalizing islands, Design of Rotaries, Intersection and terminal design, Parking facilities.

Unit V

Intelligent Transportation System, Electronic payment, Planning and ITS Architecture, Advanced vehicle control and safety systems, Standards, Advanced ITS

Text Books

1. May, A. D. (1990), Fundamentals of Traffic Flow, Prentice Hall.
2. Papacostas, C. S. (1987), Fundamentals of Transportation Engineering, Prentice Hall.
3. Kadiyali, LR (1987), Traffic Engineering and Transportation Planning, Khanna.
4. Highway Capacity Manual (2000), Transportation Research Board, USA.

References

1. Khanna, S. K. and Justo, C. E. G. (1991), Highway Engineering, Nemchand.
2. Roess, RP., McShane, WR. and Prassas, ES. (1998), Traffic Engineering, Prentice Hall.
3. Pingnataro, G. J. (1970), Principles of Traffic Engineering, Mc Graw - Hill.
4. Principles of Highways Engineering and Traffic Analysis - Fred Mannering & Walter Kilareski, John Wiley & Sons Publication.

Course Outcomes

At the end of this course, the students will be able to:

CO1: To describe the role of traffic engineer and to understand different transport. models.

CO2: To identify the traffic flow.

CO3: To evaluate the traffic studies and automated traffic measurement.

CO4: To analyse traffic control and design of intersections.

CO5: To describe the different techniques adopted in the Intelligent Transportation systems (ITS).

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	1	2	3	3	2	2	2	1	-	-	1	2	3	1	1	2
CO-2	1	3	3	3	2	1	1	-	2	2	1	1	3	1	1	2
CO-3	1	3	3	3	2	1	1	-	1	1	1	2	3	1	1	2
CO-4	-	2	2	2	2	1	1	1	2	1	2	2	3	1	1	2
CO-5	1	3	3	3	2	1	1	1	2	2	3	2	3	1	1	2
Average	1	2.6	2.8	2.8	2	1.2	1.2	1	1.75	1.5	1.6	1.8	3	1	1	2

OPEN CHANNEL FLOW

L T P C 3 1 0 4

Course Objective Students undergoing this course are expected to understand and apply the fundamental principles governing open channel hydraulics to the design of engineering systems.

Syllabus

Unit I

Introduction to OCF, Global and national scenario, Uniform flow, GVF, RVF, Dynamics of SVF – increasing and decreasing discharge, classification of SVF Profiles, Numerical Methods of solutions, Computation of profiles with increasing and decreasing discharge, side weirs.

Unit II

Gradually varied flow: Differential equation governing GVF, Classification analysis and control sections of flow profiles, Computation of GVF profiles by different methods. Rapidly varied flow: Types, Analysis and characteristics of Hydraulic jump in rectangular and non-rectangular channels, Location of jump, Introduction to jump in non-rectangular channels and on sloping floor, Use of jump as Energy dissipater.

Unit III

Flow in channels of nonlinear alignment, introduction spiral flow, super elevation, cross waves, design of flow in channels of nonlinear alignment, bends, Application of energy and momentum principle to non-prismatic channels, computation of flow profiles in non-prismatic channels, design of transition, culverts, role of a hydraulic structure designer.

Unit IV

Fluvial hydraulics, sediment transport, mode of sediment motion and bed formation, threshold movement, total sediment load, suspended and bed load theories, reservoir sedimentation and its social impact.

Unit V

Sediment properties: Incipient sediment motion of uniform and non-uniform sediments, stable channel design, flow resistance and bed form regimes Bed loads, suspended loads and total load, Sediment sampling, stable channel design, sediment control, aggradation, degradation, sediment discharge, Local scour around hydraulic structure and scour protection

Text Books

1. Yang C.T. Sediment transport – theory and practice, international edition, McGraw Hill 1996
2. R.J. Garde and K.G. Rangarajan – Mechanics of sediment transport, New Age Publications, New Delhi,2006.
3. Flow in Open Channel – K. Subramanya, Tata McGraw Hill,2008.

References

1. Chow, .V.T., Open Channel Hydraulics, McGraw Hill Inc. N York, 1979
2. French, R.H., Open Channel Hydraulics, McGraw Hill Pub Co., N York, 1986
3. Terry Sturm, Open Channel Hydraulics, Tata McGraw Hill Pub., 2011
4. Stern T.W., open channel hydraulics, international edition, Mcgraw Hill 1996 2000

Course Outcomes

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

CO1: Understand open channel flow and evaluate numerical methods of solutions
CO2: Understand GVF profiles and analyze hydraulic jump
CO3: Apply energy and momentum principles
CO4: Apply fluvial hydraulics and understand the concepts of sediment phenomenon
CO5: Apply the concepts of sediment transportation

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	2	3	2	2	1	2	-	2	1	1	2	3	2	2	2
CO-2	3	3	2	2	1	1	2	-	2	1	1	2	3	2	2	2
CO-3	3	2	2	1	2	1	2	2	1	1	1	1	3	2	2	2
CO-4	2	2	1	1	1	1	1	-	1	1	1	2	3	2	2	2
CO-5	2	1	1	1	1	2	1	-	1	2	1	1	3	2	2	2
Average	2.6	2	1.8	1.4	1.4	1.2	1.6	2	1.4	1.2	1	1.6	3	2	2	2

PEC – II (7th Semester)

SITE INVESTIGATION AND FOUNDATION DESIGN

L T P C 3 1 0 4

Course Objective To learn how to plan a site investigation program to design of shallow foundations, deep foundations and laterally loaded piles

Syllabus

Unit I

Planning of investigation programmes, Information required for planning different stages of investigation. Geophysical methods: electrical resistivity, and seismic refraction methods. Methods of site investigation: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record.

Unit II

Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test. Codal provisions. Sampling techniques, Sampling disturbances, storage, labelling and transportation of samples, sampler design, influence on properties. Report writing. Safety measures.

Unit III

Shallow Foundations: Design considerations – factors of safety (including limit state), allowable settlements, location and depth of foundations, codal provisions. Presumptive bearing capacity. Bearing capacity theory, Layered soils, Choice of shear strength parameters. Bearing capacity from N-values, Static cone tests, Plate load tests.

Shallow foundations: Total and differential settlement. Stress distribution. Consolidation settlement in clays (with correction factors). Immediate settlement. Settlement in sands from N-values, elastic solutions. Static cone tests, plate load tests.

Unit IV

Deep foundations: Types of piles. Construction methods. Axial capacity of single piles – dynamic formula, soil mechanics approach. Skin friction and end bearing in sands and clay. Axial capacity of groups. Settlement of single piles and groups.

Uplift capacity (including under-reamed piles). Negative skin friction. Pile load tests. Pile integrity tests. Codal provisions. Caissons.

Unit V

Laterally Loaded Piles: Short and long piles; Free head and fixed head piles; Lateral load capacity of single piles; Lateral deflection; Elastic analysis; Group effect; Lateral load test; Code provisions. Foundations in difficult soils: expansive soils, chemically aggressive environment, soft soils, fills, regions of subsidence.

References:

1. Clayton R, Mathews, C. M. and Simons, N E, Site Investigation, Wiley Blacwell, 1995
2. Bowles J Foundation Analysis and Design, McGrawHill, 2008
3. Kurian, N. P. (1994), Design of Foundation Systems - Principles and Practices, 2nd Edition, Narosa Publishing House, 1994.

4. Tomlinson M. and Woodward, J. Pile design and construction Practice, 5th Edition, Taylors & Francis, 2008.
5. Coduto, D. P. Foundation Design, Prentice Hall, 2012

Course Outcomes

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

CO1: Understand the methods suitable for investigation

CO2: execute field tests required for the specific project

CO3: understand and apply the civil engineering concepts for the design of foundations

CO4: understand the design concepts for different soil conditions

CO5: Apply and design foundations on difficult ground conditions

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	2	3	2	2	1	2	-	2	1	1	2	3	2	2	1
CO-2	3	3	2	2	1	1	2	-	2	1	1	2	3	2	2	1
CO-3	3	2	2	1	2	1	2	2	1	1	1	1	3	2	2	1
CO-4	2	2	1	1	1	1	1	-	1	1	1	2	3	2	2	1
CO-5	2	1	1	1	1	2	1	-	1	2	1	1	3	2	2	1
Average	2.6	2	1.8	1.4	1.4	1.2	1.6	2	1.4	1.2	1	1.6	3	2	2	1

EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

L T P C 3 1 0 4

Course Objective

To understand the earthquake phenomenon, dynamics of structure and earthquake resistant design of buildings.

Syllabus

Unit I

Engineering Seismology: Introduction to seismic hazard, Earthquake phenomenon, Seismotactonics and seismic zoning of India, Earthquake monitoring and seismic instrumentation, characteristics of strong earthquake motion, effect of structural irregularities on the performance of buildings during earthquake and seismoresistant building architecture

Unit II

Dynamics of structures: Analysis of single degree of freedom and multi degree of freedom systems, concept of shear building.

Unit III

Evaluation of earth forces: Seismic analysis by IS: 1893- 2000 (Part- I)

Unit IV

Earthquake resistant design of buildings: Ductility considerations, earthquake resistant design of RC buildings, concept of design for infill wall and shear wall.

Unit V

Earthquake resistant earthen and masonry buildings: design consideration, guidelines.

References

1. Pankaj Agarwal and Manish Shrikhande "Earthquake Resistant Design of Structures", Prentice Hall of India.
2. S.K. Duggal "Earthquake Resistant Design of Structures", Oxford University Press.
3. M. Paz "Structural Dynamics- Theory and Computation" CBR Publishers.
4. A.K. Chopra, "Dynamics of Structures: Theory & Application of Earthquake engineering", Pearson.
5. IS: 1893 (Part- I)
6. IS: 4326
7. IS: 13920
8. IIT K- BMTPC Earthquake Tips

Course Outcomes

At the end of this course, the students will be able to:

CO 1: To understand the Earthquake phenomenon and its characteristics.
CO2: To understand the dynamics of structure.
CO3: To evaluate Earth forces using IS 1893-2016(Part-I).
CO4: To understand the Earthquake resistant design of buildings.
CO5: To acquire knowledge of earthquake resistant earthen and masonry buildings.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	1	1	3	1	1	1	-	-	1	1	1	1	3	3	1	3
CO-2	1	1	3	1	2	1	-	-	1	1	1	1	3	3	1	3
CO-3	1	1	3	1	1	1	1	-	1	1	1	1	3	3	1	3
CO-4	2	1	3	1	2	2	1	-	2	2	2	1	3	3	1	3
CO-5	1	1	3	1	2	1	1	-	2	2	2	2	3	3	1	3
Average	1.2	1	3	1	1.6	1.2	1	-	1.4	1.4	1.4	1.2	3	3	1	3

MUNICIPAL SOLID WASTE MANAGEMENT

L T P C 3 1 0 4

Course Objective

To make the students conversant with different aspects of the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.

Syllabus

Unit 1

SOURCES AND TYPES

Solid Waste: Definitions, Characteristics, and Perspectives: Types of solid wastes, sources of solid wastes, properties of solid wastes, solid waste management: an overview, waste generation rates-factors affecting generation, characteristics-methods of sampling and characterization; Effects of improper disposal of solid wastes- Public health and environmental effects.

Unit II

Engineering Systems for Solid Waste Management

Solid waste generation; on-site handling, storage and processing; collection of solid wastes; transfer and transport; processing techniques; ultimate disposal; Integrated SW Management concepts

Unit III

Engineering Systems for Resource and Energy Recovery

Processing techniques; RRR approach, materials-recovery systems; recovery of biological conversion products; recovery of thermal conversion products; recovery of energy from conversion products; materials and energy recovery systems.

Unit IV

Engineering Disposal of SW

Dumping of solid waste; sanitary land fills – site selection, design and operation of sanitary landfills – Leachate collection & treatment. Identify methods of solid waste disposal during a site visit and follow safety precautions.

Unit V

Hazardous Waste Management

Introduction; Concern about Hazardous Waste Management; Characteristics of Hazardous Waste; Transportation and Disposal of Hazardous Waste; Industrial/biomedical waste, E- waste management

Text Books

1. Integrated Solid Waste Management, Engineering Principles and Management Issues, Tchobanoglous G, Theisen H and Vigil SA, McGraw Hill Education, 2014, Indian Edition.

2. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press, 2014, 2nd Edition

3. Solid Waste Engineering, Vesilind PA, Worrell W and Reinhart D, Brooks/Cole Thomson Learning Inc., 2010, 2nd Edition

References

1. Environmental Engineering, Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, McGraw Hill Education, 2017, 1st Indian Edition
2. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-Hill Education, 2002, 2nd Edition
3. Geotechnical Aspects of Landfill Design and Construction, Qian X, Koerner R M and Gray D H, Prentice Hall, 2002, 1st Edition
4. Hazardous Waste Management, LaGrega M.D., Buckingham P.L. and Evans J.C., Waveland Pr Inc., 2010, Reissue Edition 5. Hazardous Wastes - Sources, Pathways, Receptors, Richard J. Watts, John Wiley and Sons, 1998, 1st Edition.
5. Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, New Delhi, 2000.

Course Outcomes

After successful completion of this course, the students should be able to understand

CO1: Identify various types of solid wastes and their sources

CO2: Examine the physical and chemical composition of wastes

CO3: Analyze the activities associated with the management of solid waste

CO4: Evaluate the techniques and methods used in recovery of materials and energy from solid wastes

CO5: Categorize and manage the hazardous waste

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	3	-	2	1	3	3	3	3	2	2	3	1	-	1	1
CO-2	3	3	1	3	2	3	3	3	3	3	2	3	1	-	1	1
CO-3	3	3	3	3	3	3	3	2	3	2	3	3	1	-	1	1
CO-4	3	3	3	3	2	3	3	3	3	3	2	3	1	-	1	3
CO-5	2	3	1	2	3	2	3	3	3	3	3	3	1	-	1	1
Average	2.6	3	2	2.6	2.2	2.8	3	2.8	3	2.6	2.4	3	1	-	1	1.4

TRANSPORTATION SYSTEM AND PLANNING

L T P C 3 1 0 4

Course Objective

The aim of this course is to make the students understand and apply the concept of system analysis for solving transportation problems.

Syllabus

Unit I

Introduction**:** Overview of transportation system, nature of traffic problems in cities, Present Scenario of road transport and transport assets. Role of transportation: Social, Political, Environmental, Goals and objectives of transportation planning.

Unit II

Type of transportation system**:** Intermediate Public Transport (IPT), Public Transport, Rapid and mass transport system. Traffic Flow and traffic stream variables.

Current practice and methods for data collection and analysis, performance evaluation.

Unit III

Travel demand**:** Estimation and fore casting, trip classification, trip generation: factors and methods, multiple regression analysis.

Trip distribution methods, modal split, trip assignment. Use of software for transport planning

Unit IV

Evaluation of transport planning proposals**:** Land Use Transport Planning, Economic Evaluation methods, net-present-Value methods, Benefit Cost method, Internal rate of return method.

Unit V

Transportation Facilities**:** Pedestrian facilities, Bicycle facilities, parking and terminal facilities. Transport system management. Long term and short-term planning, use of IT in transportation.

Text Books

1. Adib Kanafani.(1983). Transportation Demand Analysis. Mc Graw Hill Series in Transportation, Berkeley.
2. Hutchinson, B.G. (1974). Principles of Urban Transport Systems Planning. Mc Graw Hill Book Company, New York.

References

1. John W.Dickey. (1975). Metropolitan Transportation Planning. Mc Graw Hill Book Company, New York.
2. Papacostas, C.S., and Prevedouros, P.D. (2002). Transportation Engineering and Planning. 3rd Edition, Prentice - Hall of India Pvt Ltd., 318-436

Course Outcomes

At the end of this course, the students will be able to:

CO1: Gain understanding of transportation system planning
CO2: Gain awareness about various transportation systems and carry out traffic flow analysis
CO3: Estimate travel demand using quantitative and regression methods
CO4: Evaluate transport planning proposals based on technical and financial criteria
CO5: Plan and design various Transportation facilities such as pedestrian, bicycle, parking, terminal and understand use of IT in Transportation

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	1	1	1	2	1	2	2	-	1	1	2	1	3	2	1	2
CO-2	1	2	3	3	2	2	1	1	2	2	2	2	3	2	1	2
CO-3	1	3	3	3	2	2	1	2	1	1	2	3	3	2	1	2
CO-4	2	3	3	3	2	2	2	2	3	3	3	2	3	2	1	2
CO-5	1	2	3	3	3	2	2	1	2	2	3	3	3	2	1	2
Average	1.2	2.2	2.6	2.8	2	2	1.6	1.5	1.8	1.8	2.4	2.2	3	2	1	2

BRIDGE ENGINEERING

L T P C 3 1 0 4

Course Objective

At the end of this course, the student should be able to design various commonly built bridges and prepare for the advanced knowledge in bridge engineering.

Syllabus

Unit I

Introduction: Definition, components of a bridge, classifications, importance of bridges. Investigation of Bridges: Need for investigations, selection of bridge site, preliminary data to be collected, design discharge and its determination, linear waterway, economical span, vertical clearance above H.F.L., scour depth, choice of bridge type.

Unit II

Standard specifications for road and railway bridges. R.C.C. Bridges: Slab culvert, skew slab culvert, T – beam bridge, prestressed concrete bridges

Unit III

Steel Bridges: Plate girder and truss bridges

Unit IV

Introduction to suspension bridges, cantilever bridges, cable – stayed bridges and Prestressed concrete Bridges.

Unit V

Sub-structure: Types of piers and abutments, design forces, design of piers and abutments. Bearing and joints, construction, inspection and maintenance of bridges.

Text Books

References:

1. Victor, D.J., ―Essentials of bridge engineering‖, Oxford & IBH Publishing co., New Delhi
2. Ponnuswamy, S., ―Bridge Engineering‖, McGraw Hill Education
3. IRC 24-1967 ―Standard specifications and code of Practice for road bridges, Section II, Steel Road Bridges, I.R.C. New Delhi. 4. IRC 5-1998 ―Standard specification and code of Practice for road bridges – General Features of Design

Course Outcomes

At the end of this course, the student will be able to
CO1: Categorize types of bridges, its components, and types of loads.
CO2: Understand components of R.C.C. Bridges.
CO3: Design steel bridges and its components.
CO4: Understand features and components of cable stayed bridges.
CO5: Design Sub- Structure components.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	1
CO-2	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	1
CO-3	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	1
CO-4	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	1
CO-5	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	1
Average	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	1

STOCHASTIC HYDROLOGY

L T P C 3 1 0 4

Course Objective

Students undergoing this course are expected to introduce the concepts of probability theory and stochastic processes with applications in hydrologic analysis and design.

Syllabus

Unit-I

Introduction to stochastic hydrology, environmental and social impact, deterministic and Stochastic Hydrology, review of concepts of probability, probability axioms, Random variables and their properties, probability distribution and probability density function,

Unit-II

Discrete and continuous probability distributions used in hydrology, moments and expectations of distributions, Parameter estimation, method of moments, maximum likelihood method and method of probability, weighted moments Hypothesis testing, goodness test of fit tests, Chi Square test and KS test

Unit-III

Analysis of hydrologic extremes, Frequency analysis of extreme events, extreme value distributions, analysis of floods, droughts and other natural hazards, Regional flood frequency analysis, Transformations, Modelling hydrologic uncertainty

Unit-IV

Correlation analysis and correlation coefficient, Simple linear regression, Multivariate regression analysis, Correlation coefficient and its significance in regional analysis, analysis of variance, applications – rainfall-runoff analysis, rating curves, water quality modeling, Multivariate analysis, principal component analysis, cluster analysis Hydrologic Time Series Analysis, Hydrologic time series, components of hydrologic time series, analysis of hydrologic time series, autocorrelation function, spectral density function

Unit-V

Modelling of Hydrologic Time Series, Time series models, autoregressive and moving average models, periodic models, Calibration and validation of hydrologic time series models, data generation techniques, simulation of hydrologic time series, streamflow forecasting, First order Markov process, Markov chain, Multi-site time series model, cross-correlation, spatial and temporal disaggregation models Theory of copula and its use in hydrology, commonly used copula functions, selection of best fit copula, uses of copula.

Text Books

1. Haan T. C., Statistical Methods in Hydrology, East West Publishers, 1998
2. Kotteguda, N.T., and Resso, R., Statistics, Probability and Reliability for Civil and Environmental Engineers, Blackwell Publishing, UK, 2008
3. Kotteguda, N.T., Stochastic Water Resources Technology, The Macmillan Press, New

York, 1982

References:

1. Rajib Maity, Statistical Methods in Hydrology and Hydroclimatology, Springer Nature Singapore Pte Ltd., 2018
2. Hoskings, J. R. M. and J. R. Wallis, 1997, "Regional Frequency Analysis, An Approach Based on L-Moments", Cambridge University Press, New York.
3. Maidment, D.R., “Handbook of Hydrology”, Mc Graw Hill Inc
4. Reddy, P. Jaya Rami. “Stochastic Hydrology” Laxmi Publications Pvt Limited
5. Viessman Jr., W., and G. L. Lewis, "Introduction to Hydrology", 4th ed., Harper-Collins, New York, 1996.

Course Outcomes

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

CO1: Analyse hydrologic data
CO2: Perform frequency analysis of hydrologic extremes
CO3: Apply multivariate analysis in hydrologic systems
CO4: Analyse hydrologic time series
CO5: Develop models for synthesis of hydrologic variables

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	2	2	2	3	2	2	1	1	2	1	3	2	2	2
CO-2	3	2	2	2	2	1	1	-	1	1	1	1	3	2	2	2
CO-3	2	2	2	1	1	1	1	-	1	1	1	1	3	2	2	2
CO-4	3	2	2	2	1	1	2	-	1	1	1	1	3	2	2	2
CO-5	2	2	1	2	1	1	1	-	1	1	1	1	3	2	2	2
Average	2.6	2.2	1.8	1.8	1.4	1.4	1.4	2	1	1	1.2	1	3	2	2	2

ADVANCED STEEL STRUCTURES

L T P C 3 1 0 4

Course Objective

At the end of this course, the student should be able to understand the design philosophies & methodologies to design and detail various steel structures using latest Indian codes of practice.

Syllabus

UNIT I

Design of Steel Structural Element Connections, Design of compression and tension members.

UNIT II

Flexural Member Design of rolled section beams and plate girder.

UNIT III

Tower & Chimney Analysis and design of steel towers. Design of self-supporting chimney.

UNIT IV

Industrial Building Analysis and design of industrial buildings and bents Design of bracings Design of crane and gantry girder

UNIT V

Plates Analysis & Design Plastic design of beams, shape factors, moment distribution. Plastic analysis of fixed and continuous beams, propped cantilevers, single bay and two bay portal frames

Text Books

1. Limit State Design of Steel Structures, S K Duggal, Tata Mc Graw Hill Publishers, 2019, 3rd Edition.
2. IS-800-2007, BIS Publication
3. Steel Structures: Design and Practice, N.Subramanian, Oxford Publishers, 2018.
4. Design of Steel Structures: By Limit State Method as per IS:800 – 2007, S.S. Bhavikatti, 2019, 5th Edition.

References

1. Design and Analysis Of Steel Structures, V. N. Vazirani and M. M. Ratwani, Khanna Publishers, 1988.
2. Design of Steel Structures, P Dayaratnam, S. Chand Publishers, 2012
3. Design of Steel Structures, L S Negi, Tata Mc Graw Hill Publishers, 2017

E-resources

1. https://nptel.ac.in/courses/105105162/

2. https://nptel.ac.in/courses/105106113/18

Course Outcomes

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

CO1: Understand the types and design requirement of tension and compression steel members, then they should be able to design them with connections for given conditions by following the guidelines of Indian codes.

CO2: Understand the behaviour of steel flexure member, then able to analysis and design them with connections for given conditions by following the guidelines of Indian codes

CO3: Know the structural behaviour of tower and chimney, then should be able to design self-supported steel chimney and tower as Indian code provisions.

CO4: Understand the requirement and behaviour of Industrial building and able to design elements of industrial building for given conditions by following guideline of Indian codes.

CO5: Apply concept of plastic analysis to analysed steel structures for given conditions.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	3	-	1	-	-	3	-	1	-	2	3	1	2	1
CO-2	3	3	3	-	1	-	-	3	-	1	-	2	3	1	2	1
CO-3	3	3	3	-	1	-	-	3	-	1	-	2	3	1	2	1
CO-4	3	3	3	-	1	-	-	3	-	1	-	2	3	1	2	1
CO-5	3	3	3	-	1	-	-	3	-	1	-	2	3	1	2	1
Average	3	3	3	-	1	-	-	3	-	1	-	2	3	1	2	1

ENVIRONMENTAL RISK ASSESSMENT

L T P C 3 1 0 4

Course Objective

Students undergoing this course are expected to identify and characterize environmental risks and, on the basis of that, make decisions with the purpose to prevent unacceptable harm to the environment

Syllabus

Unit I

Environmental risk, Definition, Types of environmental risk, Management risk, Need of environmental risk management, international collaborations in risk management. Establishing an overview of the problem, Models, Boundaries and contexts, Modelling the problem, setting boundaries to the risk system.

Unit II

Identifying and estimating risk selection of techniques, Environmental monitoring and health surveillance, Testing and screening, Modelling, Environmental models, Establishing the relationship between the dose and the effect.

Unit III

Risk evaluation and national policies, Policy considerations, Legislative considerations, Legal considerations, Economic considerations, Managing environmental risks.

Unit IV

Developing a national risk profile, Institutional arrangements, Risk management tasks, Environmental links, Socio-economic links, Common national problems, Emerging needs and suggested actions.

Unit V

Ecological risk assessment process and evaluation of human exposure, Case studies related to accidental discharge of pollutants and their impacts on the ecology and inhabitants of the surrounding areas.

References:

1. Whyte, A.V. & Burton, I. “Environment Risk Assessment (Scope 13-18)”, John Wiley.
2. Anjaneyulu, Y. & Manickam, V. “Environmental Impact Assessment Methodologies”, Taylor & Francis.

Course Outcomes

After completion of the course student will be able to:
CO1: Understand types of environmental risk and conduct modelling for the problem.
CO2: Understand environmental monitoring and health surveillance.
CO3: Conduct risk evaluation with help of national policies.
CO4: Understand emerging needs for common national problems.
CO5: Understand the risk assessment process for environment.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	-	-	2	-	1	3	2	3	2	3	3	1	1	2	1
CO-2	1	1	-	2	-	2	3	3	3	3	3	3	1	1	2	1
CO-3	1	1	-	2	-	1	3	2	3	2	3	3	1	1	2	1
CO-4	1	1	-	2	-	1	2	2	3	3	3	3	1	1	2	1
CO-5	1	1	-	2	-	2	3	3	3	2	2	2	1	1	2	1
Average	1.2	1	-	2	-	1.4	2.8	2.4	3	2.4	2.8	2.8	1	1	2	1

PEC-III (7th Semester)

DESIGN OF TANKS AND RESERVOIRS

L T P C 3 0 0 3

Course Objective

At the end of this course, the student should be able to understand to design of various RCC elements of Tanks and Reservoirs and to prepare the detailed structural drawings.

Syllabus

Unit I

Water tanks resting on ground (Working stress method) Introduction, Circular and Rectangular tanks.

Unit II

Elevated circular water tank (Working stress method) Introduction; Design of elevated circular water tank.

Unit III

Design of Intze tank (Working stress method) Calculation of dimensions; Design of top dome; Design of top ring beam; Design of cylindrical wall ; Design of bottom ring beam

Unit IV

Raft Foundations (Limit state method) Soil design; Design of slab; Design of beams

Unit V

Pile Foundations (Limit state method) Introduction; Loads on pile groups ; Soil design of a pile; Structural design of a pile.

Text Books

References:

1. Reinforced concrete, Vol.1 & 2 by H. J. Shah, Charotar publishing house Pvt. Ltd, 2011.
2. RCC Designs by BC Punmia et.al., 10th Edition, Laxmi Publications (P) Ltd. 2006.

Course Outcomes

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

CO1: Understand the codal recommendations for methods of design.
CO2: Design elevated circular water tank.
CO3: Design intz tank and its staging.
CO4: Design Raft Foundations.
CO5: Design Pile Foundations.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	1
CO-2	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	1
CO-3	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	1
CO-4	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	1
CO-5	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	1
Average	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	1

STRUCTURAL DYNAMICS

L T P C 3 0 0 3

Course Objective

To provide the necessary knowledge to establish the equations of motion and for the determination of structural response from dynamic loads and experience in the modeling and calculation of dynamic response for simple structural systems.

Syllabus

UNIT I

Introduction to structural dynamics, brief history of vibration, Basic definitions, vibration of SDOF (Single Degree of Freedom) systems, undamped, Damped, Free vibrations, equivalent viscous damping, Logarithmic decrement

UNIT II

Forced vibrations of SDOF system, Response of undamped and damped system subjected to harmonic loading, response to SDOF subject to harmonic base excitation, Duhamel's integral, response to general system of loading, dynamic load factor, response spectrum.

UNIT III

Free vibration of MDOF (Multi Degree Freedom System) Free vibration of MDOF (Multi Degree Freedom System), Natural frequencies, Normal modes, Orthogonality of normal modes, Eigen Values Shear buildings modelled as MDOF systems. Free vibrations, Natural frequencies,

UNIT IV

Forced vibrations Forced vibrations, Motion of shear buildings, Model Superposition Method, Response to shear buildings, Base motion, Harmonic fixed excitation. Damped motion of shear buildings, Equations for damped shear buildings, uncoupled damped equations, conditions for damping uncoupled.

UNIT V

Dynamic analysis of base stiffness matrices Dynamic analysis of base stuffiness matrices, Lumped mass and consistent mass formulation, Equations of motion.

Text Books

1. A. K. Chropra, *Dynamics of Structures: Theory and Applications to Earthquake Engineering*, Prentice Hall of India
2. R. W. Clough, J. Penzien, *Dynamics of structures*, McGraw-Hill

References

1. J. L. Humar, *Dynamics of Structures*, CRC Press
2. L. Meirovitch, *Elements of Vibration Analysis*, McGraw-Hill

E-resources

1. https://archive.nptel.ac.in/courses/105/106/105106151/urses/105105162/

Course Outcomes

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

CO1: Apply knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
CO2: Understand fundamental analysis methods for dynamic systems Interpret dynamic analysis results for design, analysis, and research purposes.
CO3: Apply structural dynamics theory to earthquake analysis, response, and design of structures.
CO4: Apply concept of Forced vibrations Forced vibrations.
CO5: Apply concept of Dynamic analysis of base stiffness matrices.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	3	-	1	-	-	3	-	1	-	2	3	1	2	2
CO-2	3	3	3	-	1	-	-	3	-	1	-	2	3	1	2	2
CO-3	3	3	3	-	1	-	-	3	-	1	-	2	3	1	2	2
CO-4	3	3	3	-	1	-	-	3	-	1	-	2	3	1	2	2
CO-5	3	3	3	-	1	-	-	3	-	1	-	2	3	1	2	2
Average	3	3	3	-	1	-	-	3	-	1	-	2	3	1	2	2

SOIL DYNAMICS

L T P C 3 0 0 3

Course Objective

To impart knowledge to students about the fundamental concepts, principles and applications of soil as engineering material with properties under static and dynamic or cycle time-dependent loading.

Syllabus

Unit I

Scope and objective; Nature and types of dynamic loading; Importance of soil dynamics. Vibration theory: Vibration of elementary systems; Degrees of freedom; Undamped and damped free and forced vibrations; Forced vibrations due to support motions; Rotating mass and constant force oscillators; Non harmonic forced vibrations; Duhamel's integral; Introduction to Fourier transform; Introduction to two and multi degrees of freedom systems; Response spectra.

Unit II

Wave Propagation: Elastic response of continua (one, two and three dimensional wave equations); Waves in unbound media; Waves in semi-infinite media; Waves in layered media. Stiffness, damping and plasticity parameters of soil and their determination (laboratory testing, intrusive and non-intrusive in-situ testing); Correlations of different soil parameters; Liquefaction (basics, evaluation and effects)

Unit III

Types of motion; MSD model and EHS theory; Vertical, sliding, torsional and rocking modes of oscillations; Coupled motion; Vibration control; Practical design considerations and codal provisions

Unit IV

Basic concept of soil improvement due to dynamic loading; Various methods; Mitigation of liquefaction. Basic concepts, mass-spring system; Lumped mass systems; Systems with distributed mass and elasticity; Rayleigh's method, shape function selection.

Unit V

Behaviour of shallow underground foundations due to dynamic loads; Response of pile foundations under dynamic loads; Design aspects for earth retaining structures subjected to dynamic loads; Slope stability due to dynamic loads; Behaviour of subgrade soil due to cyclic loads of railway, runway.

References:

1. S. Prakash – Machine Foundation. Tata McGraw Hill Education
2. B. B. Prasad – Fundamentals of Ground Vibration PHI Learning (P) Ltd. New Delhi
3. Richard, Hall and Wood – Vibrations of Soil and Foundations Dept. of Civil Engg University of Michigan 1968
4. Fundamental of Soil dynamics and earthquake engineering, PHI, By Bharat Bhushan Prasad, PHI New Delhi.
5. Shamsher Prakash, "Soil Dynamics", McGraw-Hill Book Company.
6. Braja M. Das, "Principles of Soil Dynamics", PWS-KENT Publishing Company.
7. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall Inc.
8. D. D. Barkan, "Dynamics of Bases and Foundations", McGraw-Hill Book Company.
9. E. E. Richart et al. "Vibrations of Soils and Foundations", Prentice Hall Inc.

Course Outcomes

At the end of this course, the student will be able to
CO1: identify the nature of loading and its importance to soil dynamics
CO2: understand the concept of dynamic loading under different soil conditions
CO3: apply the concepts of dynamic loading to soil engineering
CO4: analyse the modes of vibrations
CO5: Evaluate the behaviour of foundations under dynamic loading

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	1	3	3	3	3	3	3	1	3	3	1	3	3	1	2	2
CO-2	1	3	3	3	3	3	3	1	3	3	1	3	3	1	2	2
CO-3	1	3	3	3	3	3	3	1	3	3	1	3	3	1	2	2
CO-4	1	3	3	3	3	3	3	1	3	3	1	3	3	1	2	2
CO-5	1	3	3	3	3	3	3	1	3	3	1	3	3	1	2	2
Average	1	3	3	3	3	3	3	1	3	3	1	3	3	1	2	2

INDUSTRIAL WASTE WATER TREATMENT

L T P C 3 0 0 3

Course Objective

The objective of this course is to familiarize the students with the mechanisms and processes used to treat industrial wastewaters that have been generated due to any industrial or commercial activities prior to its release into the environment or its re-use.

Syllabus

Unit I

Introduction: Classification of Different Industrial Wastes (like soluble organics, suspended solids, acid/alkali, thermal discharge, inorganics, coloring substances, nutrients, heavy metals etc.), Industrial Waste Survey: possibility of minimization, variation of flow and characteristics, possibility of water conservation and reuse, strength to undergo different industrial waste treatment. Sampling Techniques: Techniques for ascertaining character (grab sample, composite sample)

Unit II

Pre and Primary Treatment: Equalisation Basin (objective, function, design principles), Neutralisation (equalization basin, limestone bed, limestone tower), Floatation techniques (gravity and DAF methods). Derivation of C/A ration for DAF systems Waste Reduction, Volume Reduction, Strength Reduction

Unit III

Waste Treatment Methods: Removal of organics (ASP, UASB), Nitrification and De-nitrification Process – Nitrogen and Phosphorous removal, Heavy metals (discussion and removal techniques), Cementation/Recovery techniques, chemical oxidation (chlorine, ozone, hydrogen peroxide), Membrane Separation Techniques (Osmosis and Reverse Osmosis), Air Stripping and Absorption Process Disposal of Treated Industrial Wastewater

Unit IV

Characteristics and Composition of Industrial wastewater generated from Dairy Industry Characteristicsand Composition of Industrial wastewater generated from Leather Industry

Unit V

Combined Treatment Systems of Industrial wastewater and domestic sewage – concept of Common Effluent Treatment Plants (CETP) – Location, Design, Operation and Maintenance

Problems, Economical aspects. Local, Regional, National and International Issues related to waste treatment.

Text Books

1. Eckenfelder, W.W. Jr., Industrial Water Pollution Control, 3rd Edition, McGraw Hill International Edition, Singapore, 2000.
2. Arceivala, S.J., Wastewater Treatment for Pollution Control, 2nd Edition, Tata McGraw Publishing Co. Ltd., New Delhi, 1998.
3. Metcalf & Eddy, "Wastewater engineering Treatment disposal reuse", 4th Edition, Tata McGraw Hill. Publishing Co. Ltd., New Delhi, 2004.

References:

1. Nemerow, N.L. Industrial Waste Treatment – Contemporary Practise and Vision forFuture. Latest Edition, Butterworth-Heinemann Publishers, UK, 2007.
2. Gurnham, C.F., ―Principles of Industrial Waste Treatment ―CRC Press, 1999.

E-resources

1. Link to YouTube Video (NPTEL Course – Industrial Waste Treatment) https://www.youtube.com/watch?v=in3GSRuooRs&t=12s&pp=ygUlaW5kdXN0cmlhbCB3YXN0ZXdhdGVyIHRyZWF0bWVudCBucHRlbA%3D%3D
2. Link to YouTube Video (Wastewater Treatment and Recycling) https://www.youtube.com/watch?v=fHRxhuMQQnE&list=PLbRMhDVUMngdeOSgQOe39 9aBKqdxkxNCp

Course Outcomes

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

CO1: To describe the different categories of industrial waste generated and to explain the different waste surveys and sampling techniques carried out for their assessment

CO2: To understand the different pre and primary treatment techniques and apply them for different industrial wastewater treatment systems

CO3: To assess and analyse the different treatment methods for industrial wastewater and their disposal.

CO4: To assess the characteristics and composition of industrial wastes generated from different industries

CO5: To ***plan*** and ***design*** for Common Effluent Treatment Plan for simultaneous treatment of industrial and domestic wastewaters.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	2	2	-	2	2	1	1	1	1	1	2	2	1	1
CO-2	3	3	3	3	-	2	2	1	1	1	1	1	2	2	1	1
CO-3	3	3	2	2	-	2	2	1	1	1	1	1	2	2	1	1
CO-4	3	3	2	2	-	2	2	1	1	1	1	1	2	2	1	1
CO-5	3	3	2	2	-	2	2	1	1	1	1	1	2	2	1	1
Average	3	3	2.2	2.2	-	2	2	1	1	1	1	1	2	2	1	1

ADVANCED HYDROLOGY

L T P C 3 0 0 3

Course objective

The course is aimed at making the students carry out hydrological investigations, flood frequency analysis and mathematical modelling of hydrological systems.

Syllabus

Unit I

Introduction: history, meteorology, hydrologic cycle, importance and application of hydrology.

Statistics and probability: parameters/elements, probability distribution, frequency analysis, flood frequency methods

Unit II

Precipitation: network design, data presentation, depth – area – duration curve, analysis of rainfall, moving average curve, design storm and PMP

Losses from precipitation: evaporation and its estimation, evapotranspiration, storages, infiltration and its estimation.

Unit III

Groundwater: zoning of subsurface, aquifer properties, flow equations, flow equations, well hydraulics, methods of groundwater investigations.

Stream flow: runoff, stage measurement, stage discharge relationship, runoff computations.

Unit IV

Design flood: peak flood estimation, flood frequency analysis, partial duration series, Regional flood frequency analysis, Nash conceptual model, Clarks model, Time Area Diagrams

Unit V

Mathematical models in Hydrology: Types, Method of determining IUH, S- curve, convolution integral, conceptual models, synthetic stream flow, flow at ungauged sites using multiple regression, reservoir mass curve, Sequent peak algorithm, Flood forecasting.

.

Reference

1. V.T. Chow, D.R. Maidment, L.W. Mays, “Applied Hydrology”, McGraw Hill, 1998.
2. V.P. Singh, “Elementary Hydrology”, Prentice Hall, 1993.
3. H.M. Raghunath, “Hydrology – Principles, Analysis and Design”, Wiley Eastern Ltd., 1986.
4. A.M. Michael, “Irrigation – Theory and Practice”, Vikas Publishing House, 1987.
5. D.K. Todd, “Groundwater Hydrology”, John Wiley & Sons, 1993.
6. K. Linsley, “Water Resources Engineering”, McGraw Hill, 1995.
7. K.C. Patra, “Hydrology and water resources engineering”, Narosa publishers

Course Outcomes

At the end of this course, the students will be able to:

CO 1: Analyze the flood frequency analysis
CO 2: Analyze the abstractions from precipitation, stream flow and runoff; develop rainfall-runoff models.
CO 3: Apply the groundwater flow equations for the solution of problems in confined and unconfined aquifers and well hydraulics and discharge measurement in rivers
CO 4: Understand and apply the concept of flood routing and carry out hydrograph analysis
CO 5: Understand and apply various hydrological models for solving the field problems.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	2	-	1	3	2	-	-	-	-	-	3	3	2	2
CO-2	1	2	2	3	1	2	-	-	-	-	-	-	3	3	2	2
CO-3	2	2	2	-	3	2	-	-	-	-	-	-	3	3	2	2
CO-4	2	2	2	3	3	2	-	-	-	1	-	-	3	3	2	2
CO-5	2	2	2	-	1	3	2	-	-	1	1	-	3	3	2	2
Average	1.8	2	2	3	1.8	2.4	2	-	-	1	1	-	3	3	2	2

INTRODUCTION TO INTELLIGENT TRANSPORTATION SYSTEMS

L T P C 3 0 0 3

Course Objective

Learn how Intelligent transport systems (ITS) involve the application of information technology and telecommunications to control traffic, inform travelers and drivers, operate public transport, automating payments, handle emergencies and incidents, operate Commercial fleets and freight exchange, and automate driving and safety.

Syllabus

Unit I

Basic elements of intelligent transportation systems (ITS), focusing on technological, systems and institutional aspects. Benefits of ITS -ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection

Unit II

Advanced traveller information systems; transportation network operations; commercial vehicle operations and intermodal freight.

Unit III

Public transportation applications, ITS and regional strategic transportation planning, including regional architectures.

Unit IV

ITS and changing transportation institutions, ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS and sustainable mobility.

Unit V

Travel demand management, electronic toll collection, and ITS and road-pricing. Automated Highway Systems- Vehicles in Platoons –ITS in World – Overview of ITS implementations in developed countries, ITS in developing countries.

Text books

1. Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House Publisher, 2003

References

1. Decision Support Systems and Intelligent Systems, 7th Edition, by Efraim Turban, Jay.E. Aronson, Pearson Publishers.
2. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles, Artech House Publisher.

Course Outcomes

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

CO1: Describe the different techniques adopted in the Intelligent Transportation systems (ITS).
CO2: Develop the appropriate system/s in various functional areas of transportation.
CO3: Establish the integration of various systems, plan and implement the applications of
CO4: Erudite the application of information technology and telecommunication systems to control traffic.
CO5: Afford advance information to the travellers, automatic handling of emergencies and to improve safety.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	1	1	1	-	2	-	-	1	1	1	1	3	2	1	2
CO-2	2	2	1	3	-	2	-	-	1	2	1	1	3	2	1	2
CO-3	2	3	1	2	3	2	1	-	2	3	2	1	3	2	1	2
CO-4	2	3	3	2	3	3	2	-	2	2	2	2	3	2	1	2
CO-5	3	3	3	3	2	3	2	-	3	3	3	3	3	2	1	2
Average	2.2	2.4	1.8	2.2	2.67	2.4	1.67	-	1.8	2.2	1.8	1.6	3	2	1	2

SOLID WASTE ENGINEERING

L T P C 3 0 0 3

Course Objective

In this course, the students are exposed to introduce the concepts and fundamentals of Integrated Solid Waste Management in a scientific way and to teach methods for planning and designing Solid Wastes Management Facilities based on the characteristics and scientific analysis.

Syllabus

Unit I
Solid waste
Public health and ecological impacts, Sources and types of solid wastes, material flow and waste generation, Functional elements: Waste generation, storage, collection, Transfer and transport, processing and recovery, disposal. Physical and chemical composition of municipal solid waste, integrated solid waste management, hierarchy of waste management options, different methods for generation rates. Storage: movable bins, fixed bins. Collection: home to home collection, community bin system. Theory and design of hauled container system, stationary container system.

Unit II
Transportation
handcart, tri-cycle, animal cart, tripper truck, dumper placer, bulk refuse carrier, railroad transport, water transport, conveyors, layout of routes. Engineering system for on-site handling and processing of solid waste: separators, size reduction equipments, screening equipments, densification, baling, cubing, pelleting equipments.

Unit III
Land filling
Site selection criteria, landfill layout, landfill sections, Occurrence of gases and leachate in landfills: composition and characteristics, generation factors, initial adjustment phase, transition phase, acid formation phase, methane formation phase, maturation phase of gases and leachate, Introduction to engineered landfills.

Unit IV
Composting
Introduction, types of composting, process description, design and operational consideration of aerobic composting, process description, design and operational consideration of anaerobic composting. Thermal conversion technologies: incineration and pyrolysis system, energy recovery, system. Overview of solid waste management practices in India.

Unit V
Hazardous Waste Management
Introduction to Hazardous wastes, Definition of Hazardous waste, The magnitude of the problem; Hazardous waste: Risk assessment, Environmental legislation, Characterization and site assessment, Waste minimization and resource recovery, Transportation of hazardous waste, Disposal of hazardous waste. Introduction to Electronic waste and Biomedical waste and their disposal.

Text Books

1. Integrated Solid Waste Management, Engineering Principles and Management Issues, Tchobanoglous G, Theisen H and Vigil SA, McGraw Hill Education, 2014, Indian Edition.
2. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press, 2014, 2nd Edition
3. Solid Waste Engineering, Vesilind PA, Worrell W and Reinhart D, Brooks/Cole Thomson Learning Inc., 2010, 2nd Edition

References

1. Environmental Engineering, Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, McGraw Hill Education, 2017, 1st Indian Edition
2. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-Hill Education, 2002, 2nd Edition
3. Geotechnical Aspects of Landfill Design and Construction, Qian X, Koerner R M and Gray D H, Prentice Hall, 2002, 1st Edition
4. Hazardous Waste Management, LaGrega M.D., Buckingham P.L. and Evans J.C., Waveland Pr Inc., 2010, Reissue Edition 5. Hazardous Wastes - Sources, Pathways Receptors, Richard J. Watts, John Wiley and Sons, 1998, 1st Edition.
5. Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, New Delhi, 2000.

Course Outcomes

At the end of this course students will demonstrate the ability to:

CO1: Understand the concept of solid waste management.
CO2: Explain handling and processing of solid waste.
CO3: Apply the concept of landfilling for disposal of solid waste.
CO4: Design composting and other solid waste conversion units.
CO5: Understand the various hazardous waste, risk assessment and legislation

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	1	2	3	1	3	3	2	3	3	2	3	1	1	1	-
CO-2	3	3	3	3	2	3	3	2	3	3	3	3	1	1	1	-
CO-3	3	3	3	3	2	3	3	2	3	3	3	3	1	1	1	-
CO-4	2	3	3	3	3	3	3	2	3	3	2	3	1	1	1	-
CO-5	1	1	-	3	2	3	3	3	3	3	3	3	1	1	1	-
Average	2.2	2.2	2.75	3	2	3	3	2.2	3	3	2.6	3	1	1	1	-

Course Objective

L T P C 3 0 0 3

ADVANCED STRUCTURAL ANALYSIS

To impart knowledge on the analysis of indeterminate structures like continuous beams, trusses and portal frames.

Syllabus

UNIT I

Introduction to matrix methods of analysis – static indeterminacy and kinematic indeterminacy – degree of freedom – coordinate system – structure idealization stiffness and flexibility matrices – suitability element stiffness equations – elements flexibility equations – mixed force – displacement equations – for truss element, beam element and tensional element. Transformation of coordinates – element stiffness matrix – and load vector – local and global coordinates.

UNIT II

Assembly of stiffness matrix from element stiffness matrix – direct stiffness method – general procedure – band matrix – semi bandwidth – computer algorithm for assembly by direct stiffness matrix method.

UNIT III

Analysis of plane truss – continuous beam – plane frame and grids by flexibility methods.

UNIT IV

Analysis of plane truss – continuous beam – plane frame and grids by stiffness methods.

UNIT V

Special analysis procedures – static condensation and sub structuring – initial and thermal stresses. Shear walls- Necessity – structural behaviour of large frames with and without shear walls – approximate methods of analysis of shear walls.

Text Books

1. Matrix Analysis of Frames structures by William Weaver J.R and James M. Gere, CBS publications.
2. Advanced Structural Analysis by Ashok. K. Jain, Nem Chand Brothers.

References

1. Basic Structural Analysis by C.S. Reddy, Tata Mc-Graw hill
2. Matrix Structural Analysis by Madhu B. Kanchi, John Willey publishers
3. Indeterminate Structural Analysis by K.U. Muthuet al., I.K. International Publishing House Pvt. Ltd.
4. Matrix Methods of Structural Analysis by J.L. Meek, Mc-Graw hill

E-resources

1. https://archive.nptel.ac.in/courses/105/106/105106050/

Course Outcomes

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

CO1: Understand the fundamentals of matrix methods of analysis.
CO2: Understand assembly of stiffness matrix from element stiffness matrix.
CO3: Analyse structure by flexibility methods.
CO4: Analyse structure by stiffness methods.
CO5: Understand concept of Special analysis procedures.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	2
CO-2	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	2
CO-3	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	2
CO-4	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	2
CO-5	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	2
Average	3	3	3	-	1	-	-	3	-	1	-	2	3	2	2	2

PEC - IV (7th Semester)

STRUCTURAL FIRE ENGINEERING

L T P C 3 0 0 3

Course Objective

The main objective of this course is to provide an overview of fire safety fundamentals,

and to introduce basic principles governing fire analysis and design of structures.

Syllabus

Unit I

Introduction to Structural Fire Engineering: Fire loads, ventilation effects, compartment geometry, Fire safety and fire-resistant tests

Unit II

Elements of construction for fire safety, protection for openings, selection of materials, site planning, Fire protection of tall buildings

Unit III

Architectural fire safety measures, Repair and rehabilitation of fire damaged structures. Non-Destructive testing, Condition survey

Unit IV

Design for Fire Resistance: Steel, Concrete. Lift design, Introduction to HVAC, Intelligent building

Unit V

Fire Safety: Urban Planning, Escape and Refuge, Internal planning, detection and suppression, Building Inspection

References:

1. Design of Fire-Resisting Structures, H.L. Malhotra, Surrey University Press 1982
2.Fire Protection Engineering in Building Design, Jane Lataille, Butterworth Heinemann 2002

Course Outcomes

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

CO1: Understand the fundamentals of Structural Fire Engineering.
CO2: Understand the elements of construction for fire safety.
CO3: Understand the Repair and rehabilitation of fire-damaged structures.
CO4: Design for Fire Resistance in different structural components.
CO5: Formulate a strategy for fire safety.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	3	-	1	-	-	3	-	1	-	2	2	1	1	1
CO-2	3	3	3	-	1	-	-	3	-	1	-	2	2	1	1	1
CO-3	3	3	3	-	1	-	-	3	-	1	-	2	2	1	1	1
CO-4	3	3	3	-	1	-	-	3	-	1	-	2	2	1	1	1
CO-5	3	3	3	-	1	-	-	3	-	1	-	2	2	1	1	1
Average	3	3	3	-	1	-	-	3	-	1	-	2	2	1	1	1

EARTHQUAKE RESISTANT DESIGN OF FOUNDATIONS

L T P C 3 0 0 3

Course Objective The course covers various types of soil investigations, soil parameters, foundations, and codes of practice and design considerations for seismic resistant design of foundations.

Syllabus

Unit I

Introduction: General requirements, types of shallow and deep foundations and their use; performance of various types of foundations during past earthquakes. Design seismic coefficients for various foundation soil systems, provisions of IS code and their limitations; Influence of local geology, depth & properties of soil cover on seismic coefficient and response spectra; Ground response magnification by wave propagation, predominant period of ground vibrations, approximate check for occurrence of resonance of structure foundation system, factors to be considered in foundation design.

Unit II

IS code for foundation design, allowable differential & total settlements, allowable bearing pressures, increase in permissible stress under earthquake type of loading; Transient loads, examples of transient loads, methods of analysis, experimental investigations, critical review of the state of art; Combined footings, raft foundation, modulus of subgrade reaction, Winkler model, beam on elastic foundation, soil line method.

Unit III

Bearing capacity of piles, dynamic pile formulae, group action, influence of pile cap; Laterally loaded piles, elastic analysis; Reese and Matlock approach, fixity of pile heads, dimensionless factors; Pile with dynamic loads, soil-pile analysis with spring-mass & FEM idealisation, slip elements, IS code of practice for design of pile foundations.

Unit IV

Types; casting, floating and sinking of caissons; Well sinking scour depth, depth & bearing capacity of wells, static forces considered in stability of wells; Pseudo-static analysis with earthquake induced loads, displacement dependent earth pressures for wells; Lateral load resistance of well foundation; IRC, IS and Indian Railway Codes,

their limitations; Dynamic analysis of wells, discretisation of soil-well, scour around wells in analysis. Unit V

Types of dynamic loads; Footing requirements to account for settlements and earthquake induced forces; Pseudo-Static analysis of footings with eccentric & inclined loads; Foundations of framed structures with isolated footings; Moments on connecting beams & columns due to differential settlements.

References

1. Prakash S.(1981),"Soil Dynamics", McGraw-Hill Company,New York.
2. Kramer S.L.(1996),“Geo technical-Earthquake Engineering”, Pearson Education Pvt. Ltd., Singapore.
3. Bowles J.E.(1997),“Foundation Analysis and Design”, McGraw Hill International Editions, Singapore.
4. Ranjan G. and Rao A.S.R.(2004),“Basic and Applied Soil Mechanics”, New Age Int. Ltd., New Delhi.
5. Saran S.(2006),“Soil Dynamics & Machine Foundation”, Galgotia Pub. Pvt. Ltd, New Delhi.

E-resources

1.. NPTEL :: Civil Engineering - NOC:Earthquake Resistant Design of Foundations

Course Outcomes

At the end of this course, the student will be able to
CO1: understand the concept of dynamic loading to soil behaviour
CO2: predict the settlement of the shallow foundations under earthquake loading conditions
CO3: analyse the behaviour of deep foundations under earthquake conditions
CO4: analyse the concepts of dynamic loading to well and caisson foundations
CO5: create and design the earthquake resistant foundations

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO-1	1	3	3	3	3	3	3	1	3	3	1	3	3	3	2	2
CO-2	1	3	3	3	3	3	3	1	3	3	1	3	3	3	2	2
CO-3	1	3	3	3	3	3	3	1	3	3	1	3	3	3	2	2
CO-4	1	3	3	3	3	3	3	1	3	3	1	3	3	3	2	2
CO-5	1	3	3	3	3	3	3	1	3	3	1	3	3	3	2	2
Average	1	3	3	3	3	3	3	1	3	3	1	3	3	3	2	2

SLOPE STABILITY ANALYSIS AND DESIGN

L T P C 3 0 0 3

Course Objective

At the end of this course, the student should be able to learn the concept of Reinforced Soil and its applications in the Civil Engineering field. They should be able to distinguish between different types and varied applications of Geosynthetics and design the Reinforced Soil Walls

Syllabus

Unit I

INTRODUCTION

Basic concept of the Reinforced soil, Mechanism Design principles, Materials used for Construction, Advantages of reinforced soil.

PRACTICAL APPLICATIONS

Reinforced soil in Civil Engineering structures, Basic components and strength characteristics of reinforced soil, Reinforced soil construction detailing.

Unit II

GEOSYNTHETICS

An overview of Geosynthetics, Description of Geotextiles, Geogrids, Geonets, Geomembranes, Geocomposites, Geocells- properties and test methods, Functions, Design methods for separation, stabilization, filtration, Drainage.

Unit III

RETAINING WALLS

Types of walls; Earth pressures for gravity/counterfort walls; structural design of wall and its foundation; stability of the wall-soil system; Slip circle analysis

REINFORCED SOIL WALLS

Stability Analysis and construction aspects of Reinforced Soil Walls, Effect of reinforced sloped backfill on Soil wall design, Drainage design procedure.

Unit IV

WALL WITH REINFORCED BACKFILL

Theoretical analysis, Pressure-Intensity on the wall, stability against sliding and overturning, Design procedure, Limitations of the analysis.

FOUNDATIONS ON REINFORCED SOIL

Brief overview, Analysis of strip footing, isolated- square and rectangular footing on reinforced soil bed, Determination of Pressure Ratio.

Unit V

SOIL NAILING AND ANCHORS

Applications of Soil Nailing, Its components, Advantages and Limitations, Design aspects.

References

1. "Designing with Geosynthetics," Robert M. Koerner, Prentice Hall. (2012)
2. "Engineering with Geosynthetics," G.V Rao & GVS Suryanarayana Raju, Tata Mc Graw Hill Publishing Co. New Delhi. (1990)
3. "Fundamentals of Geosynthetic Engineering," Shukla, S.K. and Yin, J.H., Taylor & Francis. (2006)
4. "Geotechnical Engineering," Gulati, S.K. and Datta, M. Tata Mc Graw Hill Publishing Co. New Delhi. (2005)
5. "Reinforced Soil and its Engineering Application," Swami Saran, New Age Publication. (2006)

E-resources

1. https://nptel.ac.in/courses/105/106/105106052/ NPTEL video course on Geosynthetics and Reinforced Soil Structures
2. https://nptel.ac.in/courses/105/101/105101143/ NPTEL video course on Geosynthetics Engineering: Theory and Practices

Course Outcomes

At the end of this course, the student will be able to
CO1: Learn the characteristics of the different types of Reinforcing material.
CO2: Understand the suitability of appropriate reinforcement material.
CO3: Design the structures using reinforced soil.
CO4: Construct the various structures using the appropriate materials.
CO5: Construct the foundations under sloping ground conditions

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	2	3	2	2	1	2	-	2	1	1	2	3	3	2	2
CO-2	3	3	2	2	1	1	2	-	2	1	1	2	3	3	2	2
CO-3	3	2	2	1	2	1	2	2	1	1	1	1	3	3	2	2
CO-4	2	2	1	1	1	1	1	-	1	1	1	2	3	3	2	2
CO-5	2	1	1	1	1	2	1	-	1	2	1	1	3	3	2	2
Average	2.6	2	1.8	1.4	1.4	1.2	1.6	2	1.4	1.2	1	1.6	3	3	2	2

WATER QUALITY MODELLING

L T P C 3 0 0 3

Course Objective

The course is aimed at making the students understand the concepts of water quality modelling (including surface and groundwater), with a focus on dissolved oxygen modelling.

Syllabus

Unit I

Introduction: Nature of problem, nature of input, mass loading rates-point and intermittent.

Overview of modeling: fundamentals, steps-conceptualization of problem, formulation of equation, coding, calibration, validation, sensitivity analysis

Unit II

River hydrology and flow: low flow frequency analysis, Morphometry (hydraulic geometry), travel time, depth and velocity estimates, effect of land use o river flow.

Discharge of residual matter into rivers: Assumptions, mass balance at discharge points, water quality downstream of point source, multiple sources-principles of superposition.

Unit III

Estuaries: physical aspects of estuaries, distribution of water quality in estuaries-water quality due to point source

Lake wide water quality response to input- lakes as completely mixed system, response to an impulse input, lakes in series.

Unit IV

Dissolved oxygen: Introduction, principal components of DO analysis, DO criteria and standards.

Sources and sinks of dissolved oxygen-oxygen demanding wastes, atmospheric reaeration, photosynthesis and respiration, sediment oxygen demand, oxidation of CBOD.

DO analysis in rivers: single point source, multiple point source

Unit V

Ground water: Subsurface processes, unsaturated zone properties

Ground water contamination: sources and causes, hydrodynamic dispersion, multiphase contamination DNAPL, NAPL, VOC, site specific ground water quality problems in India, numerical models, contaminant transport modeling, application of emerging techniques in groundwater management.

Introduction to water quality models: QUAL2E, QUAL2K, WASP4, MODFLOW, GMS

Text Books

1. Thomann, R.V. and Mueller, J.A. “Principles of Surface water quality modeling and control”, Harper & Row Publishers, New York

2. Chapra, S.C. (1997). “Surface water quality modeling”, The McGraw Hill Companies, Inc., New York. E-resources

Course Outcomes

At the end of this course, the student will be able to
CO1: understand the concepts and steps of water quality modeling
CO2: understand the concepts of flow and mass balance in river systems
CO3: model the water quality in estuary and lakes
CO4: understand the sources and sinks of dissolved oxygen in various surface water sources and model the same
CO5: develop contaminant transport model for natural systems

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	3	3	3	3	1	1	-	1	1	-	1	2	2	2	2
CO-2	3	3	3	3	3	1	1	-	1	1	-	1	2	2	2	2
CO-3	3	3	3	3	3	1	1	-	1	1	-	1	2	2	2	2
CO-4	3	3	3	3	3	1	1	-	1	1	-	1	2	2	2	2
CO-5	3	3	3	3	3	1	1	-	1	1	-	1	2	2	2	2
Average	3	3	3	3	3	1	1	-	1	1	-	1	2	2	2	2

PAVEMENT CONSTRUCTION AND MAINTENANCE

L T P C 3 0 0 3

Course Objective

On completion of this course student will be able to understand the basic components of pavement management systems and how they can be used to optimize funding expenditures and will be able to recognize and use current pavement design procedures

Syllabus

Unit I

Factors Affecting Pavement Design**:** Variables Considered in Pavement Design, Types of Pavements, Functions of Individual Layers, Classification of Axle Types of Rigid Chassis and Articulated Commercial Vehicles, Legal Axle and Gross Weights on Single and Multiple Units, Tire Pressure, Contact Pressure, EAL and ESWL Concepts, Traffic Analysis: ADT, AADT, Truck Factor, Growth Factor, Lane Distributions & Vehicle Damage Factors, Effect of Transient & Moving Loads.

Unit II

Pavement Inventories, Quality Control and Evaluation**:** Serviceability Concepts; Visual Rating; Pavement Serviceability Index; Roughness Measurements; Distress Modes – Cracking Rutting ; Pavement Deflection – Different Methods and BBD, Skid Resistance, Roughness, Safety – Aspects; Inventory System. Causes of Deterioration, Traffic and Environmental Factors, Pavement Performance Modeling Approaches and Methods of Maintaining WBM, Bitumen and Cement Concrete Roads, Quality Assurance; Quality Control – ISO 9000, Sampling Techniques – Tolerances and Controls related to Profile and Compaction

Unit III

Construction of Base, Sub base, Shoulders and Drain Roadway and Drain Excavation, Excavation and Blasting, Embankment Construction, Construction of Gravel Base, Cement Stabilised Sub- Bases, WBM Bases, Wet Mix Construction; Crushed Cement Bases, Shoulder Construction; Drainage Surface, Turfing, Sand Drains; Sand Wicks; Rope Drains, Geo- Textile Drainage; Preloading Techniques.

Unit IV

Bituminous Construction and Maintenance: Preparation and Laying of Tack Coat; Bituminous Macadam, Penetration Macadam, Built up Spray Grout, Open Graded Premix, Mix Seal, Semi-Dense Asphalt Concrete-Interface Treatments and Overlay Construction, IRC Specifications.

Unit V

Cement Concrete pavement Construction and Maintenance: Cement Concrete Pavement Analysis - Construction of Cement Roads, Manual and Mechanical Methods, Joints in Concrete and Reinforced Concrete Pavement and Overlay Construction.

Text Books

1. Pavement management systems – Haas and Hudson, W. R.-McGraw Hill publications
2. Pavement Analysis & Design, Yang H. Huang, Prentice Hall Inc
3. Sargious, M. A. – Pavements and surfacing for highways and airports – Applied Science Publishers ltd.

References

1. Design of Functional Pavements, Nai C. Yang, McGraw Hill Publications
2. Concrete Pavements, AF Stock, Elsevier, Applied Science Publishers
3. Principles of Pavement Design, Yoder.J. & Witzorac Mathew, W. John Wiley & Sons Inc
4. Pavement and Surfacing for Highway & Airports, Micheal Sargious, Applied Science Publishers Limited.
5. IRC: 37 & 58 Codes for Flexible and Rigid Pavements Design

Course Outcomes

At the end of this course, the student will be able to
CO1: To analyze the factors that affects the pavement design.
CO2: Understand the concepts of PMS (Pavement management system) evaluate strategies for pavement maintenance.
CO3: Understand constructions of Construction methods of Base, Subbase, Shoulders and drains.
CO4: To Understand constructions and maintenance of Bituminous pavements.
CO5: To Understand constructions and maintenance of Cement Concrete pavements.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	1	-	-	-	2	1	-	-	-	1	2	3	2	2	2
CO-2	1	2	3	-	2	2	1	-	-	-	1	1	3	2	2	2
CO-3	1	3	3	-	1	2	1	-	-	-	1	1	3	2	2	2
CO-4	2	3	3	1	2	2	1	-	-	-	1	1	3	2	2	2
CO-5	2	3	3	1	2	2	1	-	-	-	1	2	3	2	2	2
Average	1.6	2.4	3	1	1.75	2	1	-	-	-	1	1.4	3	2	2	2

URBAN HYDROLOGY

L T P C 3 0 0 3

Course Objective

Students undergoing this course are expected to develop intensity duration frequency curves for urban drainage systems.

Syllabus

Unit-I

Introduction

Urbanization and its effect on water cycle –urban hydrologic cycle –Effect of urbanization on hydrology, Responsibilities of an urban hydrologist, Precipitation Analysis: Importance of short duration of rainfall and runoff data, methods of estimation of time of concentration and design of urban drainage systems, Intensity-Duration -Frequency (IDF) curves, design storms for urban drainage systems.

Unit – II

Methods of Urban Drainage

Time of concentration, peak flow estimation approaches, rational method, NRCS curve number approach, runoff quantity and quality, wastewater and storm water reuse, major and minor systems. Drainage systems: Open channel, underground drains, appurtenances, pumping, source control.

Unit III

Analysis and Management

Storm water drainage structures, design of storm water Network-Best Management Practices– detention and retention facilities, swales, constructed wetlands, models available for storm water management.

Unit IV

Master drainage plans

Issues –typical urban drainage master plan, interrelation between water resources investigation and urban planning processes, planning objectives, comprehensive planning, use of models in planning.

Unit V

Hydrological models

General principles of hydrological modelling -The Rational Method -The time-area method - The unit hydrograph method -Physically based distributed models -Physically based partially distributed models -Hydraulic modelling -Model calibration and validation -Probabilistic models -Expert systems

Text Books

1. Akan A.O and R.L. Houghtalen, “Urban Hydrology, Hydraulics and Stormwater Quality: Engineering Applications and Computer Modelling (2006)”, Wiley International.
2. Hall M. J., Urban Hydrology (1984), Elsevier Applied Science Publisher

References

1. Geiger W. F., J Marsalek, W. J. Rawls and F. C. Zuidema, "Manual on Drainage in Urbanised area' (1987 –2 volumes)", Unesco,
2. Wanielista M. P. and Eaglin, Hydrology, "Quantity and Quality Analysis (1997)", Wiley and Sons.
3. Stahre P. and Urbonas B., "Stormwater Detention for Drainage (1990)", Water Quality and CSOManagement, Prentice Hall.
4. Maksimovic C. and J. A. Tejada-Guibert, "Frontiers in Urban Water Management",Deadlock orHope (2001), IWA Publishing.
5. Haan, C. T., Statistical Methods in Hydrology, Iowa State Univ. Press, 1977.
6. Zhang, Dongxiao, Stochastic Methods for Flow in Porous Media, Academic Press, 2002.
7. Bras, R.L. and Rodriguez-Iturbe, I., Random Functions and Hydrology, Dover Publications, 1994.
8. Gelhar, L.W., Stochastic Subsurface Hydrology, Prentice Hall, 1993.

Course Outcomes

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

CO1: To impart impact of urbanization on catchment hydrology.
CO2: To narrate the importance of rainfall runoff data for urban hydrology.
CO3: To teach techniques for peak flow estimation for storm water drainage system design.
CO4: To explain the design concepts of components in urban drainage systems.
CO5: To Train for preparation of master urban drainage system.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	2	1	1	2	2	2	2	1	1	1	3	2	2	2
CO-2	3	2	2	1	1	2	2	-	1	1	1	1	3	2	2	2
CO-3	3	3	3	2	2	1	2	-	2	1	1	2	3	2	2	2
CO-4	3	3	3	2	2	2	2	-	1	1	2	2	3	2	2	2
CO-5	3	2	2	2	2	2	2	-	2	1	2	2	3	2	2	2
Average	2.8	2.4	2.4	1.6	1.6	1.8	2	2	1.6	1	1.4	1.6	3	2	2	2

HIGHWAY SOIL MECHANICS

L T P C 3 0 0 3

Course Objective

The objective of this course is to impart knowledge and importance of soil mechanics in highway engineering.

Syllabus

Unit I

Importance of soil mechanics in road and airfield structures, embankments, cutting, base, subgrade, nature of soil, identification and classification tests for soils, chemical tets for soils, road making aggregates. Chalk embankments and subgrades.

Unit II

Soil Survey procedure, Compaction of soil, consolidation of compressible soils, settlement of embankments, road construction with soil and low-grade aggregates

Unit III

Mechanical stabilization, stabilization of soil with cement, bituminous materials, resinous materials, constructional methods in soil stabilization

Unit IV

Soil moisture and the governing factors, subsoil drainage and moisture control, frost damage to road foundations

Unit V

Measurement of soil strength, stresses in soils and bearing capacity of ground, pavement design, investigation of foundation failures, Stability of Clay Slopes

References:

1. "Soil Mechanics for Road Engineers" Department of Scientific and Industrial Research Road research Laboratory.
2. "Soil Mechanics of earthworks, Foundations and Highway Engineering" , Handbook of Soil Mechanics, Volume 3, Arpad Kezdi and Laszlo Rethati.
3. "Soil Mechanics in Highway engineering", A. Rico Rodriguez, H. Del Castillo, G. F. Sowers Published by Trans Tech Publications. 2nd Edition.

Course Outcomes

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

CO1: understand the importance of soil mechanics for highway engineers
CO2: understand the behaviour of soil under field conditions
CO3: apply the concept of soil stabilization for highway related problems
CO4: understand the soil moisture and its governing factors
CO5: understand and analyse the strength behaviour of soil under highway pavements

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	1	3	3	3	3	3	3	1	3	3	1	3	2	2	1	1
CO-2	1	3	3	3	3	3	3	1	3	3	1	3	2	2	1	1
CO-3	1	3	3	3	3	3	3	1	3	3	1	3	2	2	1	1
CO-4	1	3	3	3	3	3	3	1	3	3	1	3	2	2	1	1
CO-5	1	3	3	3	3	3	3	1	3	3	1	3	2	2	1	1
Average	1	3	3	3	3	3	3	1	3	3	1	3	2	2	1	1

PEC – V (8TH SEMESTER)

GEO-ENVIRONMENTAL ENGINEERING

L T P C 3 1 0 4

Course Objective
To learn concepts of geo-environmental engineering and planning and designing of waste in landfills, ash ponds, and tailing ponds.

Syllabus

Unit I

INTRODUCTION

Sources and effects of subsurface contamination; Waste characteristics; Soil-water-waste interaction: Contaminant transport; Laboratory and field evaluation of permeability

WASTE DISPOSAL FACILITIES

Types, Siting criteria, Waste containment principles, Types of barrier materials.

Unit II

PLANNING AND DESIGNING

Planning and design aspects relating to waste disposal in landfills, ash ponds, tailings ponds, and rocks.

Unit III

ENVIRONMENTAL MONITORING

Environmental monitoring around landfills. Detection, control, and remediation of subsurface contamination

Unit IV

ENGINEERING PROPERTIES

Engineering Properties of Waste materials and their geotechnical reuse: coal ash, mining waste, demolition waste

Unit V

SOIL EROSION

Erosion: causes and techniques for control

SOIL SUSTAINABILITY

Introduction, Exploitation and state of renewable natural resources, water and soil quality indicators, sustainability attempts

ENERGY GEOTECHNICS

Energy Geotechnics

References

1. "Geotechnical aspects of landfill design and construction," Qian, X., Koerner, R., and Gray, D.H., Prentice Hall, (2002).
2. "Geotechnical practice for waste disposal," Daniel, D.E., Chapman, and Hall, (1993).
3. "Environmental Geotechnics," Sarsby, R., Thomas Telford, (2000).
4. "Design, construction, and monitoring of landfills," Bagchi, A., Wiley Interscience, (1994).
5. "Waste disposal in Engineered landfills," Datta, M., Narosa Publishers, (1998).
6. "Geotechnical Engineering," Gulhati, S.K. and Datta M., Mcgraw Hill, (2005).
7. "Planning, analysis, and design of tailings dams," Vick, S.G., John Wiley & Sons, (1970).
8. "Geoenvironmental Sustainability," Yong, R. N., Catheriene, M and Fukue, M, CRC Press, (2007).

E-resources

1. https://nptel.ac.in/courses/105/102/105102160/ Video Course on Geoenvironmental Engineering

Course Outcomes

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

CO1: Understanding soil-water-waste interaction
CO2: Planning, design, and construction of waste disposal facilities
CO3: Reuse the waste material.
CO4: apply the concept of Sustainability for infrastructural development
CO5: apply energy geotechnics for sustainable environment

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	2	3	2	2	1	2	-	2	1	1	2	2	1	1	1
CO-2	3	3	2	2	1	1	2	-	2	1	1	2	2	1	1	1
CO-3	3	2	2	1	2	1	2	2	1	1	1	1	2	1	1	1
CO-4	2	2	1	1	1	1	1	-	1	1	1	2	2	1	1	1
CO-5	2	1	1	1	1	2	1	-	1	2	1	1	2	1	1	1
Average	2.6	2	1.8	1.4	1.4	1.2	1.6	2	1.4	1.2	1	1.6	2	1	1	1

PLANNING AND MANAGEMENT OF BUILDINGS

L T P C 3 1 0 4

Course Objective

The course is aimed at making the students understand the neighborhood concept, planning and design of building and various engineering services such as lift, hot and cold water systems, electrical systems etc.

Syllabus

Unit I

Components of urban forms and their planning, concept of neighbourhood unit, street system and layout in neighbourhood, housing pattern in ancient India and rural areas

Unit II

Functional Planning of Buildings: Principles of planning, factors - aspect, prospect, privacy, grouping, roominess, water supply and sanitation, flexibility, circulation

Unit III

Planning and design of public buildings such as residential, offices, schools, hospitals, theatres, and industrial buildings, preliminaries of vastu

Unit IV

Standard fire, fire list, fire resistance, classification of buildings, means of escape, alarms. Fire hydrants, design criteria of fire hydrant system

Unit V

Engineering Services in a Building as a System: Lifts, escalators, cold and hot water systems, water supply system, wastewater collection systems, electrical system

References:

1. Building Planning and Drawing by Dr.N.Kumara Swamy and A. Kameswara Rao, Charotar publishers, Anand.
2. Building Drawing by Shah, Kale and Patki, Tata McGraw Hill Education
3. Instructional Sketches for Civil Engineering Drawing – A series & B series.
4. Building Planning and Design and Scheduling by Gurucharan Singh & Jagadish Singh, Standard Publishers and Distributors.

Course Outcomes

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

CO1: understand the concept of neighbourhood and plan various land uses.
CO2: apply the principles of planning for design of buildings
CO3: plan the various public buildings
CO4: understand and plan the fire resistant measures in buildings
CO5: understand and plan various engineering services in a building

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	-	-	2	-	2	2	2	2	2	1	-	-	3	2	1	1
CO-2	-	-	2	-	2	2	2	2	2	1	-	1	3	2	1	1
CO-3	-	-	2	-	2	2	2	2	2	1	-	1	3	2	1	1
CO-4	-	-	2	-	2	2	2	2	2	1	-	1	3	2	1	1
CO-5	-	-	2	-	2	2	2	2	2	1	-	1	3	2	1	1
Average	-	-	2	-	2	2	2	2	2	1	-	1	3	2	1	1

ENVIRONMENTAL POLLUTION AND CONTROL

L T P C 3 1 0 4

Course objective

The course is aimed at making the students understand the neighborhood concept, planning and design of building and various engineering services such as lift, hot and cold water systems, electrical systems etc

Unit I

Impact of man on environment: Biosphere, biogeochemical cycles, ecosystem, consequence of population growth, Population ecology, population growth models, competition, predation, succession

Global environmental issues: energy problem, ozone layer depletion, acid rain, land degradation.

Unit II

Water pollution: Sources and classification of water pollutants, water quality standards, wastewater sampling and analysis, Eutrophication of lakes, Control strategies: self purification capacity of streams,waste load allocation, recent treatment technologies-phyto-remediation, bio-remediation, river bank filtration, zero valent iron etc,.

Thermal pollution: Sources, effects and control measures

Unit III

Air pollution: Sources and effects, meteorological aspects, air pollution sampling and measurement, control methods and equipments, control of specific air pollutants, air quality standards, Indoor air quality control, statistical analysis of air quality data.

Unit IV

Solid waste management: solid waste characteristics, collection and transport-hauled and stationary container systems, processing and recovery, disposal of waste- landfills, basic aspects of landfill design, leachate transfer through landfills.

Hazardous waste management and risk assessment- types of hazardous waste, health effects, treatment methods, final disposal, risk assessment

Unit V

Noise pollution: Sources, effects, sound pressure, power and intensity, measure of noise, loudness, outdoor noise propogation, preventive and control measures, standards/limits.

Environmental impact assessment and audit.

Environmental legislation at National and international level.

References

1. Principles of environmental studies (Ecology, economics, management and law) by C. Manoharachary and P. Jayarama Reddy, B.S. Publications.
2. Text of Environmental Engineering by P.V. Rao, Prentice Hall pvt ltd., Delhi
3. “Environmental Engineering: A Design Approach” by Sincero Sr, A.P. and Sincero, G.A., Prentice Hall of India Private limited, New Delhi, 1996
4. “Ecology”, E.P. Odum. (Second edition), Oxford and IBH publishing Co. Pvt. Ltd, 1975.

5. Environmental Engineering by Peavy and Rowe, Tata McGraw Hill Education
6. Metcalf & Eddy
7. Environmental Pollution Control Engineering by C.S. Rao, New Age International Publisher

Course Outcomes

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

CO1: understand the concept of population ecology and biogeochemical cycles
CO2: understand the natural processes in water pollution and the control strategies
CO3: understand the natural processes in air pollution, control measures and statistical analysis of air quality data
CO4: understand the solid and hazardous waste management and carry out the design a landfill risk assessment
CO5: understand the environmental legislations at national and global level

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	2	2	-	3	3	2	1	-	-	-	1	1	1	1
CO-2	2	2	2	2	2	3	3	2	1	-	-	1	1	1	1	1
CO-3	2	2	2	2	2	3	3	2	1	-	-	1	1	1	1	1
CO-4	1	1	1	1	-	3	3	2	1	-	-	1	1	1	1	1
CO-5	1	1	1	1	-	3	3	2	1	-	-	1	1	1	1	1
Average	1.6	1.6	1.6	1.6	2	3	3	2	1	-	-	1	1	1	1	1

GROUND WATER FLOW AND POLLUTION MODELLING

L T P C 3 1 0 4

Course Objective
Students undergoing this course are expected to introduce the methods commonly used to model groundwater flow and solute transport in the subsurface of the Earth.

Syllabus

Unit I
Introduction to Groundwater: Ground water availability in local and global scenario, Groundwater in the hydrologic system, Hydrologic budget, Vertical distribution of subsurface strata, Types of aquifers, Aquifer characteristics.
Groundwater Movement: Darcy's law, Hydraulic conductivity and intrinsic permeability, Transmissivity, Homogeneity and isotropy, Stream function, Flow net

Unit II
Groundwater Flow Hydraulics: Well hydraulics, partial differential equations governing groundwater flow in aquifers estimation of aquifer parameters by different methods, steady groundwater flow analysis for multiwall systems, Well flow near different boundary conditions, Method of images

Groundwater Modelling: Groundwater modelling, formulation of anisotropic and nonhomogeneous flow of groundwater, finite difference methods for solving groundwater flow problems, regional groundwater flow modelling, responsibilities of a groundwater hydrologist

Unit III

Groundwater Prospecting: Geologic method, Remote sensing, Geophysical exploration, Electric resistivity method, Seismic method, Gravity and magnetic methods

Well Logging and Construction: Type of wells, Selection of well site, Well logging, Well construction techniques, Well completion

Unit IV

Groundwater Management: Concept of basin management, Conjunctive use of surface water and groundwater, Groundwater management techniques

Managed Groundwater Recharge: Objective and purpose of MGR, Methods of MGR

Unit V

Climate Change Impacts on Groundwater: Hydrological components affecting the groundwater, Direct impacts of climate change on groundwater, Indirect impacts of climate change on groundwater, Climate change impacts on water availability in an aquifer, artificial recharge systems.

Text Books

1. Groundwater Hydrology: Engineering, Planning and Management, Karamouz, M.,Ahmadi, A., and Akhbari, M., CRC Press, Taylor et Francis Group, 2020
2. Groundwater Hydrology, Todd, D. K., and Mays, L. W., John Wiley & Sons, Singapore, 2018
3. Numerical Groundwater Hydrology, Rastogi, A.K., Penram International Publishing Pvt. Ltd., 2012

References:

1. Hydrogeology, Davis, S. N., and De Weist, R. J. M., John Wiley & Sons, New York, 2013
2. Groundwater Hydrology, Chahar, B. R., McGraw Hill Education (India) Private Limited, New Delhi, 2015

Course Outcomes

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

CO1: Assessment of groundwater flow and regional groundwater flow modelling
CO2: Understand the flow hydraulics and modelling of groundwater flow & transport
CO3: Design water wells
CO4: Manage groundwater resources
CO5: Plan and design artificial recharge systems

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	2	2	2	2	2	2	-	2	1	2	2	3	2	2	2
CO-2	3	2	2	3	3	2	2	2	1	1	2	2	3	2	2	2
CO-3	3	2	2	1	2	1	1	-	2	1	1	1	3	2	2	2
CO-4	2	2	2	1	1	1	2	-	1	1	1	1	3	2	2	2
CO-5	2	1	2	2	1	2	2	-	1	2	1	1	3	2	2	2
Average	2.6	1.8	2	1.8	1.8	1.6	1.8	2	1.4	1.2	1.4	1.4	3	2	2	2

CONSTRUCTION AND CONTRACT MANAGEMENT

L T P C 3 1 0 4

Course Objective

On completion of this course the students will be able to know the construction contracts and their legal aspects and provisions, material management, quality management and improvement techniques.

Syllabus

Unit I

Construction Contracts, Tendering and contractual procedures, Legal Requirements, Claims, compensation and disputes, dispute resolution techniques, Labour Regulations.

Unit II

Material Management: purchases management and inventory control, ABC analysis
Human resource management, statistical quality control at site, management information system.

Unit III

Quantitative Methods in Construction: Linear programming, transportation and assignment problems, Queuing theory, decision theory, game theory.

Unit IV

Quality in Construction: Quality management, Quality systems, Quality planning, Quality assurance and quality control at site, Quality standards/codes in design and construction, Concept and philosophy of total quality management, Quality improvement techniques.

Unit V

Safety in Construction: Concept of safety, factors affecting safety, structural safety, safety consideration during construction, demolition and during use of equipment, safety manuals, safety legislation, standards/codes, rehabilitation and strengthening techniques.

Text Books

1. Construction Project Scheduling and Control by Salah Mubrak. Wiley Publications
2. Kumar Neeraj Jha, Construction and Contract Management, Pearson, 2nd edition, 2019
3. B Sengupta & H Guha, Construction Management and Planning,9th edition Mc-Graw-Hill Publications,2014
4. S.C. Sharma, Construction Engineering & Management of Projects, 3rd edition Khanna Publication, 2016

5. Shashi Bhushan Suman, Construction Technology & Management, 1st edition, Krishna Prakashan, 2017
6. S Kalavathy, Operations Research, 4th edition, Vikas publication,2018
7. Hamdy A. Taha, Operations Research, 9thedition, Pearson, 2013

References:

1. Mandhar Mahajan, Operations Research, 2nd edition, Dhanpat Rai & Co. Publication,2014
2. Jimmie Hinze, "Construction Contracts", McGraw Hill, 2001.
3. Joseph T. Bockrath, "Contracts and the Legal Environment for Engineers and Architects", McGraw Hill, 2000.
4. Juran Frank, J.M. and Gryna, F.M. "Quality Planning and Analysis", McGraw Hill, 2001

Course Outcomes

At the end of this course, the students will be able to:
CO 1: To gain an understanding of tendering & contractual process and to analyze a conflict situation and their dispute resolution techniques.
CO 2: To acquire knowledge of material management, purchase management concepts and use of best methods of inventory analysis.
CO3: Understand the mathematical tools that are needed to solve optimization problems.
CO4: Analyze how quality assurance & TQM will provide an insight into strategic management.
CO5: Understand legal aspects and standards of safety in construction.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO-1	-	1	3	2	1	1	-	-	-	-	-	-	2	1	1	1
CO-2	1	2	2	2	-	1	-	-	-	-	-	-	1	1	1	2
CO-3	-	1	2	1	2	1	-	-	-	-	-	-	1	1	3	3
CO-4	-	2	3	3	2	1	-	-	-	-	-	-	2	2	1	1
CO-5	1	1	2	1	-	1	1	-	-	-	-	-	2	2	2	2
Average	1	1.4	2.4	1.8	1.67	1	1	-	-	-	-	-	1.6	1.4	1.6	1.8

SUSTAINABLE TRANSPORT SYSTEM

L T P C 3 1 0 4

Course Objective

The objective of the course is to impart knowledge and skills of environmental issues related to transportation systems, concept of sustainability and related issues

Syllabus

Unit I

Introduction to Transportation Systems, Concept of Sustainability, Current Scenario of Transportation in India, Climate Change: Indicators and Impacts, Impacts of Transportation Systems.

Unit II

Introduction to Environment Impact Assessment (EIA), EIA Processes, Methodologies of EIA, EIA Process in India, Global practices in EIA process, EIA Case Study, Introduction of Land use, Land use Planning & Zoning, Transit Oriented Development (TOD), TOD Implementation, TOD Case study.

Unit III

Introduction to Sustainable Transport Planning, Sustainable Transport Planning & Approaches (Traditional Transport Planning Process & Contemporary Planning Process), Management Strategies.

Unit IV

Concept of Circular Economy, Circular Economy in Transport Sector, Modelling of Transport Emissions, Dispersion Models for Transport Emissions, Traffic Noise Emission Models, Initiatives & Policies for Environmental Sustainability, National Clean Air Programme & Transport Sector.

Unit V

Decarbonizing the Transport Sector, Alternate Fuels and Sustainable Transportation, Electric Vehicles and Sustainability, Emerging Transport Technology, Sustainable Transport Appraisal Rating (STAR).

Text Books

1. Introduction to Sustainable Transportation: Policy, Planning and Implementation by Preston L Schiller, Jeffrey R Kenworthy, Routledge publisher.

References:

1. Sustainable Transportation Planning: Tools for Creating Vibrant, Healthy, and Resilient Communities by Jeffrey Tumlin Wiley & Sons Publisher.

Course Outcomes

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

CO1: To understand the Concept of Sustainability and affect of Climate Change on Transportation Systems.
CO2: To analyse the concept of Environment Impact Assessment (EIA).
CO3: To apply the concepts of Sustainable Transport Planning.
CO4: To understand the concept of Circular Economy and modelling of transport emission.
CO5: To identify the Alternate Fuels and Emerging Transport technology.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	-	2	1	1	-	2	3	-	-	-	-	2	1	2	1	1
CO-2	1	2	2	3	2	2	3	-	-	-	-	2	1	2	1	1
CO-3	1	2	2	3	3	2	3	-	-	-	-	2	1	2	1	1
CO-4	1	2	2	3	3	3	3	-	-	-	-	2	1	2	1	1
CO-5	2	3	3	2	3	3	3	-	-	1	-	2	1	2	1	1
Average	1.25	2.2	2	2.4	2.75	2.4	3	-	-	1	-	2	1	2	1	1

PRECAST AND MODULAR CONSTRUCTION PRACTICES

L T P C 3 1 0 4

Course Objective

The objective of this course is to enhance the knowledge of students about precast and prefabricated building construction.

Syllabus

Unit I

Overview of reinforced and pre-stressed concrete construction Design and detailing of precast/prefabricated building components.

Unit II

Structural design and detailing of joints in prefabricated structures.

Unit III

Production of ready mixed concrete, quality assurance, Use of equipment in precast prefabricated structure, Productivity analysis, economics of formwork, design of formwork and their reusability

Unit IV

Modular construction Practices, Fibonacci series, its handling and other reliable proportioning concepts, Modular coordination, standardisation, system building, Lamination and advantages of modular construction

Unit V

Project work involving analysis, design, and estimation of a dwelling unit constructed with Precast and modular construction Practices. Comparison of cost with traditional construction

References:

1. Handbook of low-cost housing by A K Lal, New Age International Pvt. Ltd.
2. Precast Concrete Structures by Kim Elliot, Butterworth Heinemann Publications.

Course Outcomes

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

CO1: Understand the Design and detailing of precast/prefabricated building components.
CO2: Understand the Structural design and detailing of joints in prefabricated structures.
CO3: Apply the concept of productivity analysis.
CO4: Understand the features of Modular construction Practices.
CO5: Apply the concept of Precast and modular construction in a dwelling unit.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	2	3	2	2	1	2	-	2	1	1	2	3	2	2	2
CO-2	3	3	2	2	1	1	2	-	2	1	1	2	3	2	2	2
CO-3	3	2	2	1	2	1	2	2	1	1	1	1	3	2	2	2
CO-4	2	2	1	1	1	1	1	-	1	1	1	2	3	2	2	2
CO-5	2	1	1	1	1	2	1	-	1	2	1	1	3	2	2	2
Average	2.6	2	1.8	1.4	1.4	1.2	1.6	2	1.4	1.2	1	1.6	3	2	2	2

PRE-STRESSED CONCRETE DESIGN

L T P C 3 1 0 4

Course Objective

To understand the concept of prestressing its application and analysis & design of prestresses concrete sections.

Syllabus

Unit I

Introduction: Basic concepts of prestressing, advantages and applications of prestressed concrete.

Materials for prestressed concrete: high strength concrete, permissible stresses in concrete, high strength steel, permissible stresses in steel

Prestressing Systems: Pre tensioning and post tensioning systems, methods of prestressing

Losses of Prestress: Types of losses of prestress, loss due to elastic deformation of concrete, loss due to shrinkage of concrete, loss due to creep of concrete, loss due to relaxation of stress in steel, loss due to friction, loss due to anchorage slip, total loss in pre-tensioned and post tensioned members.

Unit II

Analysis of Prestress and Bending Stresses: Basic assumptions, analysis of prestress, resultant stresses at a section, concept of load balancing, stresses in tendons, cracking moment.

Deflections: Importance of control of deflections, factors influencing deflections, short term deflections of un-cracked members, deflections of cracked members, prediction of long term deflections.

Shear and Torsional Resistance: Ultimate shear resistance of prestressed concrete members, prestressed concrete members in torsion, design of reinforcements for torsion, shear and bending.

Unit III

Design of Prestressed Concrete Sections: Dimensioning of flexural members, design of pre-tensioned and post tensioned beams, design of partially prestressed members, design of one way and two way slabs, continuous beams. Design for axial tension, compression and bending, bond and bearing.

Unit IV

Limit State Design: Review of limit state design concepts, criteria for limit state, design loads and strengths, strength and serviceability in limit state, crack widths in prestressed members, principles of dimensioning prestressed concrete members.

Unit V

Introduction to Optimum Design of Prestressed Concrete Structures:Principles of optimization, methods of optimization, optimization techniques, application to prestressed concrete structures.

References:

1. Raju, N.K., "Prestressed Concrete". McGraw Hill Education
2. IS:1343-2012

Course Outcomes

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

CO1: Understand the basic concepts of pre-stressing and losses in pre-stress.
CO2: Analyse the pre-stress and bending stress.
CO3: Design of pre-stressed concrete sections.
CO4: Understand the limit state design concept of pre-stressed concrete members.
CO5: Understand the optimum design of pre-stressed concrete structures**.**

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	2	2	-	-	-	-	-	-	-	1	3	1	2	-
CO-2	-	-	-	2	-	2	2	-	-	-	-	1	-	3	2	2
CO-3	2	2	3	3	3	-	-	-	-	-	-	1	3	3	1	2
CO-4	2	2	3	3	3	-	-	-	-	-	-	1	-	2	-	-
CO-5	3	3	3	2	3	-	-	-	-	-	-	1	1	1	1	-
Average	2.25	2.25	2.75	2.4	3	2	2	-	-	-	-	1	2.33	2	1.5	2

OPEN ELECTIVES

ENVIRONMENT AND ECOLOGY (OEC – I)

L T P C 2 0 0 2

Course Objective:

The students will be introduced to a wide range of concepts and theories connected to evolutionand ecology and to impart knowledge about the ecological interactions that drive the abundanceand distribution of various species.

Unit-I

Definition, Scope and importance, Need for Public awareness, Ecosystem, Concept of ecosystem, Structure and function of an ecosystem, Energy flow in ecosystem, Ecological succession, Balanced ecosystem, Human activities, Food shelter, Economic and Social security.

Effects of Human Activities on Environment: Agriculture, Housing industry, Mining and transportation activities, Basic of Environmental Impact Assessment, Sustainable development.

Unit-II

Natural Resources: Water Resources – Availability and quality aspects, Conservation of water, Water borne diseases, Water induced diseases, Fluoride problems in drinking water, Mineral resources, Forest wealth, Material cycles-carbon, Nitrogen and Sulphur cycles.

Energy-Different types of energy, Electro-magnetic radiation, Conventional and Non-conventional sources, hydro-electric fossil fuel based, Nuclear, Solar, Biomass, Bio-gas, Hydrogen as an alternative future source of energy.

Unit-III

Environmental Pollution: Water pollution, Land pollution, Noise pollution, Public health aspects, Air pollution, Soil pollution, Marine pollution, Thermal pollution, Nuclear hazards.

Solid Waste Management: Cause, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies, Disaster management: Floods, earthquake, cyclone and landslides.

Unit-IV

Current environmental issue of importance, Population growth, Variation among nations, Population explosion, Family welfare programme, Climate change and Global warming-effects, Urbanization, Automobile pollution, Acid rain, Ozone layer depletion.

Unit-V

Environmental Protection-Role of government, Legal aspects, Initiatives by Non-Government Organizations (NGO), Environmental education, Value education, Human rights, HIV/AIDS, Women and child welfare, Case studies.

References

1. Dhamija, S.K. (2006). “Environmental Studies”, S.K. Katariya and Sons, New Delhi.
2. Anjanayelu, Y. (2002). “Environmental Studies” B.S. Publishers, Hyderabad.

Course Outcomes

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

CO1: Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
CO2: Estimate the population - economic growth, energy requirement and demand.
CO3: Analyze material balance for different environmental systems.
CO4: Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
CO5: Identify the major pollutants and abatement devices for environmental management and sustainable development

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	1	-	2	3	-	3	3	3	2	2	2	2	2	-	1	-
CO-2	-	-	2	2	-	3	3	2	3	2	-	2	2	-	-	-
CO-3	1	-	2	1	1	2	2	-	2	-	-	-	2	-	-	-
CO-4	-	-	-	1	3	3	2	2	2	-	-	1	2	-	1	-
CO-5	1	2	3	2	2	1	2	-	2	-	1	2	2	-	-	-
Average	1	2	2.25	1.8	2	2.4	2.4	2.33	2.2	2	1.5	1.75	2	-	1	-

ENVIRONMENTAL POLLUTION AND MANAGEMENT (OEC – II)

L T P C 2 0 0 2

Course Objective:

The objective of this course is to impart knowledge to students about the air and water pollution control techniques and solid waste management.

Unit I

Impact of man on environment, consequence of population growth, energy problem, pollution of air, water and land. Local, Regional, National and Global environmental issues.

Unit II

Water Pollution: Sources and classification of water pollutants, wastewater treatment, control strategies, Eutrophication of lakes, self-purification capacity of streams. Waste load allocation.

Thermal Pollution: sources, effects and control measures.

Unit III

Air Pollution: Sources and effects, meteorological aspects, control methods and equipment.

Land Pollution: Types of land pollution, solid waste management – generation, storage, collection, transport, processing and disposal.

Noise Pollution: Sources, effects, preventive and control measures.

Unit IV

EIA: Planning and management of Environmental impact studies; Impact evaluation methodologies: baseline studies, screening scoping, checklist, overlays, Environmental Impact Assessment of water resources and environmental projects, Case study of power plant.

EA: Meaning, audit items, audit procedure, safety audit.

Unit V

Contemporary Issues: Emission trading, discharge permits, international resource sharing issues, climate change, international environmental treaties and protocols.

Environmental Legislation: Introduction to various legislations related to water, air, biodiversity, ozone depletion, etc. at National and International level; Institutions for governance. Global and national Legislations.

Text Books

1. Principles of environmental studies (Ecology, economics, management and law) by C. Manoharachary and P. Jayarama Reddy, B.S. Publications

2. Textbook of Environmental Engineering by P.V.Rao, Prentice Hall Pvt. Ltd., Delhi

References

1. Environmental Impact assessment methodologies by Y. Ananayulu and C.A. Sastry, B.S. Publications

E-Resources

1.Link to YouTube Video (Short Video – Environmental Pollution)

https://www.youtube.com/watch?v=qS8mfAX1tAk&pp=ygUmZW52aXJvbm1lbnRhbCBwb2xsdXRpb24gYW5kIG1hbmFnZW1lbnQ%3D

2. Link to YouTube Video (NPTEL –Basic EE and Pollution Abatement) https://www.youtube.com/watch?v=NRoFvz8Ugeo&list=PLLy_2iUCG87Cr__rs9sS1zSaR62imd0uB

3. Link to YouTube Video (Long Video –Environmental Laws in India)

https://www.youtube.com/watch?v=Lq4suQu6FPo&pp=ygUiZW52aXJvbm1lbnRhbCBsZWdpc2xhdGlvbiBpbiBJbmRpYQ%3D%3D

Course Outcomes

At the end of this course, the student will be able to
CO1: To define and understand the impact of man on environment in terms of population and pollution.
CO2: To understand the sources, classification, processes and remedial measures of water pollution.
CO3: To understand air, land and noise pollution
CO4: To understand the techniques involved in Environmental Impact Assessment and Environmental Audit of various projects.

CO5: To understand various contemporary issues and environmental legislations pertaining to environmental pollution.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	2	2	3	2	2	2	1	-	-	2	1	2	1	1	1
CO-2	2	2	3	3	2	2	2	-	-	-	1	1	2	1	1	2
CO-3	2	2	2	2	2	2	2	-	-	-	1	2	2	1	1	2
CO-4	2	3	3	3	3	2	2	-	-	-	1	3	2	1	1	1
CO-5	2	2	3	2	2	2	1	1	-	-	1	2	2	1	1	1
Average	2	2.2	2.6	2.6	2.2	2	1.8	1	-	-	1.2	1.8	2	1	1	1.4

DISASTER MANAGEMENT (OEC – III)

L T P C 2 0 0 2

Course Objective

At the end of this course, the student will understand the causes and effects of various natural and man-made disasters like earthquakes, floods, Landslides, Tsunamis, Oil spillage, gas leakage, etc. The student will also be able to plan various mitigation measures and design infrastructure for disaster management.

Unit I

INTRODUCTION TO DISASTER MANAGEMENT

Natural Disasters, Man-made hazards, causes, consequences, earthquakes, Floods, Drought, Coastal Hazards, Landslides, rockslides and Forest Fires, Tsunamis, Oil spillage, Gas leakage, etc.

DISASTER MITIGATION AND PREPAREDNESS

Mitigation measures for natural disasters-earth quakes, tsunamis, cyclones, floods, landslides, etc., Mitigation measures for various industrial hazards/disasters, Preparedness for natural disasters.

Unit II

HAZARD AND RISK ASSESSMENT

Assessment of capacity, vulnerability, risk, vulnerability and risk mapping, stages in disaster recovery, and associated problems.

Unit III

EMERGENCY MANAGEMENT SYSTEMS

Emergency medical and essential public health services, response and recovery operations, reconstruction, and rehabilitation.

CAPACITY BUILDING

Disaster management approach to inculcate new skills and sharpen existing skills of government officials, voluntary activists, development of professional and elected representative for effective disaster management, an overview of disaster management in India.

Unit IV

INTEGRATION OF PUBLIC POLICY

Planning and design of infrastructure for disaster management, Community based approach in disaster management, methods for effective dissemination of information, ecological and sustainable development models for disaster management.

Unit V

ROLE OF REMOTE SENSING IN DISASTER MITIGATION

Importance of Remote Sensing in disaster mitigation, Case studies

References

1. "Natural Hazards in the Urban Habitat," Iyengar, C.B.R.I., Tata McGraw Hill. Publications. (1997)
2. "Natural Disaster Management," Jon Ingleton (Ed), Tudor Rose, Leicester. (1999)
3. "Disaster Management," R.B. Singh (Ed), Rawat Publications. (2006)
4. "Disaster Management –Future Challenges & Opportunities," Jagbir Singh, I.K. International Publishing House. (2007)
5. "Elements of Earthquake Engineering," Jai Krishna, Chandrasekharan and B. Chandra, South Asian Publishers, New Delhi. (2000)
6. "Earthquake Resistant Design of Structures," Pankaj Agarwal and Manish Shrikhande, Prentice Hall of India Pvt. Ltd. (2006)

E-Resources

1. https://onlinecourses.nptel.ac.in/noc20_ce07/preview Video Course on Natural Hazards

Course Outcomes

At the end of this course, the student will be able to
CO1: Understand the causes and effects of various disasters.
CO2: Plan risk management/disaster mitigation techniques.
CO3: Case studies to understand the mitigation measures
CO4: Understand the public policy
CO5: Understanding the role of Remote Sensing in Disaster mitigation

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	3	2	3	2	2	1	2	-	2	1	1	2	1	2	1	1
CO-2	3	3	2	2	1	1	2	-	2	1	1	2	1	2	1	1
CO-3	3	2	2	1	2	1	2	2	1	1	1	1	1	2	1	1
CO-4	2	2	1	1	1	1	1	-	1	1	1	2	1	2	1	1
CO-5	2	1	1	1	1	2	1	-	1	2	1	1	1	2	1	1
Average	2.6	2	1.8	1.4	1.4	1.2	1.6	2	1.4	1.2	1	1.6	1	2	1	1

INTRODUCTION TO INFRASTRUCTURE ENGINEERING (OEC – III)

L T P C 2 0 0 2

Course Objective

This course explores the central role of infrastructure in society, both locally and globally. It examines the different elements of infrastructure and incorporates links with industry and real life experience from technical, social, environmental, economic and sustainability perspectives.

Unit I
Building-
Elements- slab, beam, column, footing
Types- Residential, Institutional, Commercial, Industrial
Types of structure- Load bearing, framed, combined

Unit II
Water Supply and Wastewater Infrastructure
Water Supply- Source, demand, intake, transport, conduits, treatment, distribution, household plumbing
Waste Water- Collection, transport, treatment and disposal

Unit III
Transport Infrastructure: Road, rail and air
Road- Elements, types, traffic studies
Rail- Gauge, components
Air- Runway, planning, helipad

Unit IV
Irrigation, hydropower and navigation
Dam, canal, port, harbor, hydroelectric projects

Unit V
Miscellaneous
Introduction to architecture, land use planning

References

1. Peurify, RL, "Construction, Planning, Equipment and Methods", Tata McGraw Hill Education
2. NPTEL E Learning course on Infrastructure Planning &Management.

Course Outcomes

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

CO1: To understand the functional elements and types of a building.
CO2: To understand the water supply and wastewater infrastructure in a city.
CO3: To understand the basic of Transport infrastructure – road, rail and air.
CO4: To understand the basic of irrigation and hydropower infrastructure
CO5: To understand the basics of architecture and land use planning.

CO- PO Articulation Matrix

	Program Outcomes												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO-1	2	-	-	-	-	2	-	-	-	-	-	1	1	-	1	1
CO-2	2	-	-	-	-	2	3	-	-	-	-	1	1	-	1	1
CO-3	2	-	-	-	-	2	3	-	-	-	-	1	1	-	1	1
CO-4	2	-	-	-	-	2	3	-	-	-	-	1	1	-	1	1
CO-5	2	1	1	-	-	2	1	-	-	-	-	1	1	-	1	1
Average	2	1	1	-	-	2	2.5	-	-	-	-	1	1	-	1	1