ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

SCHOOL OF INFRASTRUCTURE AND PLANNING

Curriculum and Syllabus

(**2023-24 admitted students**)

School/ Department: SCHOOL OF SCHOOL OF INFRASTRUCTURE AND PLANNING
Course: B. Tech **Programme: Civil Engineering**
Abbreviation used:

AC	Audit course	LC	Laboratory Course	PA	Practical Assessment
PC	Professional Core	PR	Project/ Practical/ Internship	L	Lecture
PE	Professional Elective	SE	Seminar/ Expert Lecture/ Etc.	T	Tutorial
OE	Open Elective	IA*	Internal Assessment	P	Practical
MC/BS/HS	Mandatory/ Common Course	EA	End-Semester Assessment		
ACC	Advanced Competency Course				
*Internal Assessment Mark (40 marks) consists of (i) Mid Semester (20 marks) (ii) Quiz/ Assignment/Attendance (20 marks)					

5th Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC	IP3101	Hydrology & Water Resources Engineering	3	0	0	3	40	60	-	100
2	PC	IP3103	Structural Analysis- II	3	0	0	3	40	60	-	100
3	PC	IP3105	Structural Design-II	3	0	0	3	40	60	-	100
4	PE-I	IP3201	Transportation Engineering-II	3	0	0	3	40	60	-	100
		IP3203	Traffic Engineering and Transportation Planning								
		IP3205	Pavement Design								
5	HS	BH3401	Business Management	3	0	0	2	40	60	-	100
		BH3403	Entrepreneurship Development								
6	MC	IP3401	Environmental Engineering	3	0	0	2	40	60	-	100
		IP3403	Industrial Safety Engineering								
7	LC	IP3501	Computational Laboratory	0	0	3	1.5	-	-	100	100
8	LC	IP3503	Concrete Technology Laboratory	0	0	3	1.5	-	-	100	100
9	LC	IP3507	Design and Detailing of Steel Structure	0	0	3	1.5	-	-	100	100
10	PSI	EI3701	Seminar on SIRE-I	0	0	3	1.5	-	-	100	100
			Total	**18**	**0**	**12**	**22**	**240**	**360**	**400**	**1000**

6th Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC	IP3102	Hydraulics and Irrigation Engineering	3	0	0	3	40	60	-	100
2	PC	IP3104	Geotechnical Engineering-II	3	0	0	3	40	60	-	100
3	PE-II	IP3202	Estimation and Construction Management	3	0	0	3	40	60	-	100
		IP3204	Construction Equipment and Project Management								
		IP3206	Construction Engineering and Management								
4	PE-III	IP3208	Water and Waste Water Engineering	3	0	0	3	40	60	-	100
		IP3210	Air Pollution and Control								
		IP3212	Solid Waste and Hazardous Waste Management								
		IP3214	Noise Pollution and Control								
5	HS	BH3401	Business Management	3	0	0	2	40	60	-	100
		BH3403	Entrepreneurship Development								
6	MC	IP3401	Environmental Engineering	3	0	0	2	40	60	-	100
		IP3403	Industrial Safety Engineering								
7	PSI	IP3602	Project for Product Development-I	0	0	6	3	-	-	100	100
8	LC	IP3502	Design of Irrigation Structure	0	0	3	1.5	-	-	100	100
9	LC	IP3504	Environmental Engineering Laboratory	0	0	3	1.5	-	-	100	100
10	Summer Internship and Research Experience (SIRE - II) *										
			Total	**18**	**0**	**12**	**22**	**240**	**360**	**400**	**1000**

***Minimum 4 weeks of Summer Course / Training / Internship / Skill Course / etc. after 4th Semester**

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH
Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.
Syllabus (Admission Batch: 2023-24)

7th Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PE-IV	IP4201	1. Advance Concrete design	3	0	0	3	40	60	-	100
		IP4203	2. Bridge Engineering								
		IP4205	3. Prestressed Concrete Structure								
2	PE-V	IP4207	1. Finite Element Method	3	0	0	3	40	60	-	100
		IP4209	2. Earthquake Engineering								
		IP4211	3. Structural Dynamics								
3	OE		Open Elective—I	3	0	0	3	40	60	-	100
4	ACC	IP4101	**Advanced Competency Cputse-3 (Remote Sensing and GIS)**	3	0	0	3	40	60	-	100
5	PSI	EI4701	Seminar on SIRE – II	0	0	6	1	-	-	100	100
6	PSI	IP4601	Project for Product Development—II	0	0	4	2	-	-	100	100
		IP4603	Internship Project—I								
Total				**12**	**0**	**10**	**15**	**160**	**240**	**200**	**600**

8th Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	OE		Open Elective – II	3	0	0	3	40	60	-	100
2	OE		Open Elective – III	3	0	0	3	40	60	-	100
3	OE		Open Elective – IV	3	0	0	3	40	60	-	100
4	PSI	IP4702	Seminar on Project	0	0	6	1	-	-	100	100
5	PSI	IP4602	Project for Product Development – III	0	0	4	2	-	-	100	100
		IP4604	Internship Project – II								
Total				**9**	**0**	**10**	**12**	**12**	**180**	**200**	**500**

FIFTH SEMESTER

HYDROLOGY & WATER RESOURCES ENGINEERING					
CREDIT	3	Subject Code: IP3101	L-3	T-0	P-0
PREREQUISITES : Mathematics-III					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Interpret hydrological elements and their measurement procedures.				
CO2	Apply methods for measuring and analyzing hydrological variables using various hydrological models				
CO3	Evaluate rainfall-runoff models by using the concept of hydrograph and other approaches.				
CO4	Predict runoff by flood-frequency and flood routing methods.				
CONTENT					
Module1 (6 hours)	**Introduction** - History of hydrology, hydrologic cycle, water-balance equation applications of hydrology in engineering, sources of data. **Precipitation** - Forms of precipitation, characteristics of precipitation in India, measurement of precipitation, rain gauge network, mean precipitation over an area, Depth-Area-Duration (DAD) curve, Intensity-Duration-Frequency (IDF) relationship, Design storm, Probable Maximum Precipitation (PMP), Standard Project Storm (SPS)				
Module 2 (7 hours)	**Abstractions from Precipitation**: Evapotranspiration and its measurement - PET (Potential Evapotranspiration) & AET (Actual Evapotranspiration), Evaporimeters, analytical methods of evaporation estimation, reservoir evaporation, pan co-efficient. Infiltration and its measurement, effective rainfall, infiltration indices (ϕ – index, w-index). SCS-CN method of estimating runoff. **Stream flow measurement:** Measurement of stage and velocity, Area-velocity method, Indirect methods: flow measuring structures, slope area method. Measurement of Velocity using current meter and Floats.				
Module 3 (10 hours)	**Hydrograph:** Components of hydrograph, factors affecting runoff hydrograph, base flow separation, Unit Hydrograph (UH): assumptions and limitations, derivation of UH from isolated and complex storm, Computation of UH of different duration: Method of Superposition and S-curve technique. Synthetic Unit Hydrograph by Snyder's method, SCS dimensionless UH, IUH. Design flood: Rational and Empirical Formulae, SPF (Standard Project Flood), PMF (Probable Maximum Flood)				
Module4 (7 hours)	Flood frequency analysis by Gumbel's method and the confidence limit, Risk reliability and safety factor. Flood routing: Basic equations, hydrologic reservoir routing by Modified Pul's				

	method, hydrologic channel routing by Muskingum method, Introduction to hydraulic flood routing, Conceptual methods of flood routing (Nash's model), Reservoir Planning: Mass Curve, Sequent Peak algorithm.
Total Lecture hours- 30 hours	
TEXTBOOKS	
1.	K Subramanya, Engineering Hydrology, McGraw-Hill
2.	V.P. Singh, Elementary Hydrology, Prentice Hall Publication
3.	V. T. Chow, Handbook of applied hydrology, McGraw-Hill
4.	C S P Ojha, R Berndtsson and P Bhunya, Engineering Hydrology, Oxford.
5.	K C. Patra, Hydrology and Water Resources Engineering, Narosa Publications
REFERENCES	
1.	K Subramanya, Water Resources Engineering through Objective Questions, Tata McGraw-Hill
2.	V. T. Chow, Handbook of applied hydrology, McGraw-Hill

CO-PO-PSO MAPPING

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

Correlation Level 1: Slight 2: Moderate 3: High

STRUCTURAL ANALYSIS-II					
CREDIT	3	Subject Code: IP3103	L-3	T-0	P-0
PREREQUISITES: Solid Mechanics, Structural Analysis-I					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Compute internal forces components in beams and frames by applying slope-deflection and moment distribution methods.				
CO2	Analyze two-hinged arches and suspension bridges with two-hinged stiffening girders for forces, deflections, and influence line diagrams.				
CO3	Estimate the collapse load and plastic moment carrying capacity of simple beams and frames using principles of virtual work.				
CO4	Differentiate the stiffness and flexibility approach for beam & rigid jointed frame structure.				
CONTENTS					
Module 1 (10 hours)	Slope-Deflection Method of Analysis: Slope-deflection equations, equilibrium equation of slope-deflection method, application to beams (with and without joint translation and rotation, yielding of support) and non-sway rigid jointed rectangular portal frames, shear force and bending moment diagram. Moment Distribution Method of Analysis: Stiffness factor, carry over factor, distribution factor, application to beams (with and without joint translation and rotation, yielding of support) and non-sway rigid jointed rectangular portal frames, shear force and bending moment diagram.				
Module 2 (8 hours)	Analysis of two-hinged and fixed arches - Parabolic and circular arches for dead and live loads - influence lines for horizontal thrust, bending moment, normal thrust and radial shear for arches, rib shortening- Settlement and temperature effects. Analysis of suspension bridges - Unstiffened cables and cables with two hinged stiffening girders.				
Module 3 (6 hours)	Plastic Analysis: Concepts - Plastic hinges- mechanism- Plastic modulus, shear factor, plastic moment of resistance, Load factor, Plastic analysis of continuous beam and simple rectangular portals, Application of upper bound and lower bound theorems.				
Module 4 (8 hours)	Matrix methods of analysis: flexibility and stiffness methods; Application to simple trusses and beams. Matrix algebra, basic concepts of structural analysis.				
Total Lecture hours- 30 hours					
Test Books:					
1.	G.S. Pandit, S.P. Gupta and R. Gupta, Theory of Structures Volume I and II, McGraw-Hill Education, 2017, ISBN-10: 9780074634936.				
2.	S. Ramamrutham and R. Narayanan, Theory of Structures, Dhanpat Rai				

	Publishing Company Pvt Ltd,2017, ISBN-10: 9789352164752.
3.	V.N. Vazirani, M.M. Ratwani and S.K. Duggal, Analysis of Structures, Vol. I and Vol. II, Khanna Publisher, New Delhi, 1994.
4.	MATRIX ANALYSIS of FRAMED STRUCTURES, 3-rd Edition, by Weaver and Gere Publisher, Chapman & Hall, New York, New York, 1990
Reference Books:	
1	R.C. Hibbeler, Structural Analysis, Pearson, 2019, ISBN: 1292247134,9781292247137.
2	Menon, Devdas, Advanced Structural Analysis, Narosa Publication
3	S.S. Bhavikatti, Structural Analysis Vol. I and Vol. II, Vikas Publishing House Pvt, New Delhi, 4th Edition, 2013.
4	L. S. Negi, Theory and Problems in Structural Analysis, Tata-McGraw Hill
5	J. S. Kinney, Indeterminate Structural Analysis, Narosa Publishing House, 1991.
6	Junarkar, S. B. and Shah, H. J. (1999). Mechanics of Structures – Vol. II, Charotar Publishing House, Anand

CO-PO-PSO MAPPING

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	3	2		3	1						1	3	
CO2	2	3	2		3	1						1	3	
CO3	2	3	2		3	1						1	3	
CO4	2	3	1		2	1						1	3	

Correlation Level 1: Slight 2: Moderate 3: High

STRUCTURAL DESIGN-II

CREDIT	3	Subject Code: IP3105	L-3	T-0	P-0

PREREQUISITES: Strength of Materials,Structural Analysis-I

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Enumerate the specifications given in IS code and implement in design of various structural elements.
CO2	Summarize the properties of steel and design different types of connections as per limit state.
CO3	Analyze the Tension, Compression and Flexural Elements
CO4	Design the Tension, Compression and Flexural Elements.

CONTENTS (30 hours)

Module 1 (8 hours)	Introduction, advantages/disadvantages of steel, structural steel, rolled steel section, various types of loads, design philosophy. Limit state design method, limit states of strength and serviceability, probabilistic basis for design riveted, bolted, and pinned connections, Welded connections-assumptions, types, design of fillet welds, intermittent fillet weld, plug and slot weld, failure of welded joints, welded joints vs bolted and riveted joints
Module 2 (8 hours)	Tension members: types, net cross-sectional area, types of failure, slenderness ratio, design of tension members, gusset plate.
Module 3 (7 hours)	Compression members: effective length, slenderness ratio, types of cross-sections, classification of cross-section, design of axially loaded compression members, lacing, battening, design of column bases, and foundation bolts.
Module 4 (7 hours)	Design of beams: types of c/s, lateral stability of beams, lateral torsional buckling, bending and shear strength, web buckling and web crippling, deflection, design procedure. Plate girders- various elements and design of components. Eccentric and moment connections, roof trusses.

Total Lecture hours- 30 hours

Test Books:

1	S.K. Duggal, Limit State Design of Steel Structures, Tata McGraw Hill Education Private Limited, 2017. (ISBN: 9789351343493/9351343499).
2	V.L. Shah and V. Gore, Limit State Design of Steel Structures IS:800-2007, Structures Publication, 2012. (ISBN: 8190371754).

Reference Books:	
1	S.S. Bhavikatti, Design of Steel Structures, I.K. International Publishing House Limited, 2017(ISBN: 9789385909559/938590955X).
2	N. Subramanian, Design of Steel Structures, Oxford University Press, 2011. (ISBN: 9780198068815/0198068816).
3	L. S. Negi, Tata McGraw-Hill Publishing Company Limited, 2017 (ISBN: 978-0074623053)
4	M.L. Gambhir, Fundamentals of Structural Steel Design, Tata McGraw-Hill Publishing Company Limited,2017 (ISBN:978-1259006760)
5	IS 800 (2007), General Construction in Steel- Code of Practice, Ced 7: Structural Engineering and Structural Section, Published by Bureau of Indian Standard, Manak Bhavan, New Delhi.

CO-PO-PSO MAPPING

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	3	3	2	2	1				1	1	1	3	
CO2	3	3	3	2	2	1				1	1	1	3	
CO3	3	3	3	2	2	1				1	1	1	3	
CO4	3	3	3	2	2	1				1	1	1	3	

Correlation Level 1: Slight 2: Moderate 3: High

TRANSPORTATION ENGINEERING-II

CREDIT	3	Subject Code: IP3201	L-3	T-0	P-0

PREREQUISITES : Transportation Engineering-I

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Understand the concepts of permanent way section of Indian Railway
CO2	Ability to design the railway geometrical elements, railway turnout and signal for different conditions.
CO3	Ability to select feasible airport site, decide runway orientation, design geometric elements of runway and taxiway, holding apron along with knowledge of air traffic control
CO4	Understand the concepts of the dock , Harbour and Port

CONTENT

Module 1 (6 hours)	History of Indian railways and component parts of railway track: Problems of multi gauge system, coning of wheels, alignments and survey, permanent way, track components (details on ballast, sleeper , Rails- Type of rail sections, creep of rails, wear and failure in rails) , various train resistances, Stresses on railway track.
Module 2 (7 hours)	Geometric design: Gradients and grade compensation, various speeds on a railway track, superelevation, railway curves, Points and crossings, Design of simple turn-out, Signalling and interlocking.
Module 3 (10 hours)	Airport Engineering: Airport site selection, Aircraft characteristics, airport obstructions, Wind rose diagram, Basic runway length, airport classification, Geometric elements and design of run way, taxiway , holding apron, parking configuration, terminal building, apron, hanger, visual aids, air traffic control, airport marking and lighting.
Module4 (7 hours)	Harbour Engineering: Classification of Harbour basin, general layout of harbours, components of harbor, survey and site selection, Port, Breakwater and its design, Wharves, Quays, Jetties, Piers, Dolphins, Fenders, Docks, Different components of docks. Classification of waterways, water transportation in India, inland and ocean transportation, economics of inland waterways transportation, national waterways.

Total Lecture hours- 30 hours

TEXTBOOKS

1.	A Text Book of Railway Engineering , By S.C.Saxena and M.G.Arora
2.	Railway Track Engineering, By J. S. Mundrey, Mc Graw Hill
3.	Railway Engineering by Satish Chandra & MM Agrawal, Oxford University Press.
4.	Transportation Engineering, Volume-II- Railways, Airports, Docks and Harbours, Bridgesand Tunnels by C. venkatramaih, UniversitiesPress
5.	Airport Engineering by S.K.Khanna and M.G.Arora

CO-PO-PSO MAPPING														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1		1	1				2	1	1	3	2
CO2	2	3	3	1	2				2	3	2	1	2	2
CO3	3	3	2	1	1	1			1	2	2	1	2	2
CO4	3	2	2	3	2				1	2	1	2	2	3
Correlation Level 1: Slight 2: Moderate 3: High														

TRAFFIC ENGINEERING AND TRANSPORTATION PLANNING

CREDIT	3	Subject Code: IP3203	L-3	T-0	P-0

PREREQUISITES : Transportation Engineering-I

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Apply knowledge of traffic engineering to design the geometrical elements of highway.
CO2	Apply knowledge for Proper junction design to ensure safe and easy traffic movement.
CO3	Able to understand and analyze traffic problems through models
CO4	Understand basic requirements and mechanisms for highway maintenance and planning with respect to traffic growth

CONTENT

Module 1 (6 hours)	**Traffic Engineering:** - Definition, Road user characteristics, Human factors governing road user behaviour,Vehicle characteristics, Traffic flow parameters, Analysis of speed, flow and density relationship, Greenshields' Model and Greenberg's model, On street and off street parking facilities
Module 2 (7 hours)	**Traffic management:** Traffic regulations, Traffic management measures, Types of at grade and grade separated intersections including their design.
Module 3 (10 hours)	**Urban and regional transportation system:** Definitions, System analysis –scope & limitations, Transportation planning as per system analysis - Systems approach to transport planning process, Stages of transport planning process, Economic evaluation of transportation plans
Module4 (7 hours)	**Transport models:** Trip generations, Trip distributions, Traffic assignments and Modal split

Total Lecture hours- 30 hours

TEXTBOOKS

1.	Highway Engineering, by S.K. Khanna and CEG Justo, Nem Chand &Bros.
2.	Traffic Engineering and Transportation Planning by Kadiyali, L.R.,Khanna Publisher
3.	Transportation Engineering and Planning by Papacostas, C.S. and Prevedouros, P.D. Prentice Hall.

REFERENCES

1.	Chakroborty, P. and Das, A., 2017. *Principles of transportation engineering*. PHI Learning Pvt. Ltd..

CO-PO-PSO MAPPING														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1		1	1				2	1	1	3	2
CO2	2	3	3	1	2				2	3	2	1	2	2
CO3	3	3	2	1	1	1			1	2	2	1	2	2
CO4	3	2	2	3	2				1	2	1	2	2	2
Correlation Level 1: Slight 2: Moderate 3: High														

PAVEMENT DESIGN

CREDIT	3	Subject Code: IP3205	L-3	T-0	P-0

PREREQUISITES : TransportationnEngineering-I

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Understand the concepts of pavement Layers and their testing
CO2	Ability to design the flexible pavements layers
CO3	Ability to design the Rigid pavements layers and their joints
CO4	Understand the concepts of Overlays

CONTENT

Module 1 (6 hours)	**Details on pavements**: Types,Function of various layers (subgrade, sub-base, base course and surface course), various factors considered in pavement design, Common types of Destructive and Non-destructive testing used for pavement evaluation
Module 2 (7 hours)	**Design of flexible pavement** : stresses on flexible pavements, application of CBR, Burmister, Asphalt Institute, AASHTO, and IRC methods
Module 3 (10 hours)	**Design of rigid pavements:** Load and temperature stresses in rigid pavements, Westergaard's, Bradburry's, Picket's concept; Design of rigid pavement by PCA, AASHTO and IRC Methods, Designs of joints in rigid pavements
Module 4 (7 hours)	**Overlay design:** Need for pavement strengthening, Pavement evaluation methods, Design aspects of flexible and rigid Overlays

Total Lecture hours- 30 hours

TEXTBOOKS

1.	Yoder, E.J. and Witczak, M.W. *Principles of pavement design*. John Wiley & Sons.
2.	Huang, Y.H. *Pavement analysis and design*.
3.	Chakroborty, P. and Das, A., 2017. *Principles of transportation engineering*. PHI Learning Pvt. Ltd..
4.	Croney, D. and Croney, P. *The design and performance of road pavements*, Mc Graw Hill Perofessional
5.	Salter, R.J. *Highway design and construction*. Palgrave Macmillan

REFERENCES

1.	Manuals and specifications: IRC (37,58), AASHTO CODES

CO-PO-PSO MAPPING														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1		1	1				2	1	1	3	2
CO2	2	3	3	1	2				2	3	2	1	2	2
CO3	3	3	2	1	1	1			1	2	2	1	2	2
CO4	3	2	2	3	2				1	2	1	2	2	2
Correlation Level 1: Slight 2: Moderate 3: High														

ENVIRONMENTAL ENGINEERING

CREDIT	2	Subject Code: IP3401	L-3	T-0	P-0

PREREQUISITES: Basic Physics, Basic Chemistry

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Understand the multidisciplinary nature of environmental science and ecosystem structure and functions
CO2	Analyze various forms of environmental pollution and assess their impact using scientific parameters
CO3	Demonstrate knowledge of water and wastewater treatment processes and air pollution control technologies
CO4	Evaluate the role of environmental policies, EIA, and sustainable practices in pollution control and resource conservation

CONTENT

Module 1 (10 hours)	**Fundamentals of Environment and Ecosystem:** Multidisciplinary nature of environmental Engineering. **Study of Ecosystem:** Definition, Properties, Structure and Function of an ecosystem. Food chains, food webs, Flow of Energy, Ecological Pyramids, Biogeochemical cycles, Types of ecosystems, Bioaccumulation, Bio magnification, ecosystem value, Degradation of Ecosystem. **Concept of Environment and pollution:** Atmospheric chemistry, soil chemistry, water quality characteristics, DO, BOD and COD, water pollution, Marine Pollution, soil pollution, thermal pollution, nuclear hazard, Air Pollution: Air Quality, cause and effects of air pollution, Water and air quality standards, and Index, Noisepollution: Introduction, Noise standards, measurement, Ln Concept and control
Module 2 (8 hours)	**Water treatment process**: Pre-treatment of water, conventional process, advanced water treatment process. **Waste water treatment process**: Natural Treatment, Engineering Treatment -Pre-treatment, primary and secondary waste water treatment process **Air Pollution Control**: The natural self-cleansing properties of Environment, Air pollution meteorology, Atmospheric dispersion, Diffusion equation, ground level emission, plume rise, Effective stack height, Air Pollution control from stationarysources by installing Engineering devices, Flue gas desulphurisation, NOX removal.
Module 3 (8 hours)	**Solid waste management:** Source, classification, separation, storage and transportation of solid wastes, Waste minimization techniques, Benefits of waste minimization, reuse, recycle, thermal and biological treatment, secure land fill technique. **Impact of Environmental pollution and related issues:** Global climate change, global warming and greenhouse gases, Acid rain, ozone layer depletion, healthissues.
Module4 (4 hours)	**Environmental Impact Assessment:** EIA procedure, Preparation of an EIS From unsustainable to sustainable development, circular economy, Environmental Protection Act, Air (Prevention and Control of Pollution) Act, Water (Preventionand Control of

	Pollution) Act, Wildlife Protection Act.
Total Lecture hours- 30 hours	
TEXTBOOKS	
1.	Fundamentals of Ecology, M.C.Dash, Tata McGraw Hill, 2006.
2.	Environmental Pollution Control Engineering, C.S. Rao, New Age International Publishers, 2018
3.	Environmental Engineering, G. Kiely, TMH, 2007
REFERENCES	
1.	Environmental Engineering, H.S. Peavy, D.R. Rowe and G. Tchobanoglous, McGraw Hill.
2.	Introduction to Environmental Engineering and Science, G.M. Masters, Pearson, 2015
3.	Integrated Solid Waste Management, G. Tchobanoglous, McGraw Hill, 2014
4.	Water Supply Engineering, S.K. Garg; Khanna Publishers, 37th Edition

CO-PO-PSO MAPPING

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	1	1	1	2	3	1	1	2	1	2	2	2
CO2	3	3	2	2	2	2	3	1	1	2	1	2	2	2
CO3	3	3	3	2	2	2	3	1	2	2	2	3	3	3
CO4	2	2	2	2	1	3	3	2	2	2	2	3	3	3

Correlation Level 1: Slight 2: Moderate 3: High

BUSINESS MANGEMENT

CREDIT	2	Subject Code: BH3401	L-3	T-0	P-0

PREREQUISITES: Basic Physics, Basic Chemistry

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Comparing and contrasting efficient functional models of business management by integrating the three core areas such as Finance, Human Resource and Marketing Management.
CO2	Executing the Management principles in all the functional areas of business.
CO3	Correlating the interrelations and interdependence of the areas of Management in a business organization.
CO4	Assessing the functional and managerial practices in business organizations.

CONTENT

Module 1 (8 hours)	**Management Principles** Management Concepts, Nature and Functions, Management Process and Roles of Managers, Levels of Management and Managerial Skills, Theories of Management – Contributions of F.W.Taylor, Henry Fayol, Elton Mayo, Line and Staff Relationship, Centralisation and Decentralisation, Delegation of Authority , Management thoughts in Modern Trend –Systems Approach
Module 2 (8 hours)	**Financial Management** Concept, Financial function and Role of Financial Managers, Instruments of raising short-term and long-term funds, Capital Structure, Techniques of Project Appraisal, Components of Working Capital, Operating Cycle, Factors affecting requirement of Working Capital.
Module 3 (7 hours)	**Human Resource Management** Nature and Scope of Human Resource Management, Manpower Planning, Recruitment and Selection Methods, Performance Appraisal, Need, Objectives, Modern methods of Appraisals: 720 degree, MBO, Assessment Centre Method, Talent Acquisition, Training Need Analysis, Career Planning, Organisational Citizenship Behaviour.
Module4 (7 hours)	**Marketing Management** Concept, Nature, Scope and Importance, Marketing Mix and 7P's of Marketing, Segmentation, Targeting, Positioning, Factors influencing consumer decision-making, e-marketing and Green Marketing

Total Lecture hours- 30 hours

TEXTBOOKS

1.	Modern Business Organisation and Management, S.A. Sherlekar, Himalaya Publishing House, 2016.
2.	Essentials of Management, Stephen P. Robbins, 6th Edition, Pearson, 2010.
3.	Financial Management, Sheeba Kapil, 1st Edition,Pearson, 2013.
REFERENCES	
1.	Marketing Management, Rajan Saxena, 6th Edition, TMH publishing house, 2022.
2.	Principles of Management, Dipak Kumar Bhattacharyya, 1st Edition, Pearson, 2011
3.	Mgmt (Principles of Management), Willium& Tripathy, 1st Edition, Cengage Learning, 2016

CO-PO-PSO MAPPING

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	-	2	-	2	-	2	2	3	3	3	3	3	-	-
CO2	-	-	-	-	-	1	3	3	3	3	3	3	-	-
CO3	-	-	-	-	2	2	1	3	3	3	3	3	-	-
CO4	-	-	-	-	-	1	1	3	3	3	3	3	-	-

Correlation Level 1: Slight 2: Moderate 3: High

ENTREPRENEURSHIP DEVELOPMENT

CREDIT	2	Subject Code: BH3403	L-3	T-0	P-0

PREREQUISITES:

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Exemplifying the business opportunities, social responsibilities and the support system for setting up an enterprise.
CO2	Determining stages of Entrepreneurial Process starting from idea generation, developing a business plan and operational aspects of an Enterprise.
CO3	Appraising the different funding options and Financial Management of an enterprise.
CO4	Assessing the Start-up management practices like incubation, mentorship and Government initiatives.

CONTENT

Module 1 (8 hours)	**Introduction to Entrepreneurship** Concept, Functions of an Entrepreneur, Entrepreneurial Process, Entrepreneurial Motivation and Barriers, Traits to be a successful Entrepreneur, Creativity and scope of Entrepreneurship in India: Types of new age business (FinTech, EdTech, Healthcare, Agripreneurship, Defence, Drone, Space, IT, Robotics, Digital Transformation, Women-Entrepreneurship, Social Entrepreneurship, Corporate Social Responsibility, Business Ethics – Role of Values in Management
Module 2 (8 hours)	**Entrepreneurial Idea into Action** Developing a Business Idea; Opportunity, Methods and Creativity, Deciding to set up a start-up, Forms of business organisations (Sole tradership/propreitorship, Partnership, Joint-Stock Company) and MSMEs (Micro, Small and Medium enterprises), Size and Location of the enterprise, Feasibility Study: Market Survey, Techno-economic feasibility and preparing a Project Report.
Module 3 (7 hours)	**Entrepreneurial Finance and Funding** Sources of funding (Bootstrapping, Angel Investors, Venture Capital, Crowdfunding etc.) Project Investment Analysis, Break-Even Analysis, ROI Analysis, Basics of Income Statement and Balance Sheet.
Module4 (7 hours)	**Managing an Enterprise** The Start-up ecosystem, Business Incubators, Start-up Accelerators, Mentorship and Networking, Failure and Resilience, Risk Management, Ethical dilemmas and Exit Strategies, Start-up Policy and Initiatives of the Government

Total Lecture hours- 30 hours

TEXTBOOKS

1.	Entrepreneurship: Successfully Launching New Ventures, B.R. Barringer, 6th, Pearson, 2020

2.	Fundamentals of Entrepreneurship and Project planning, Madhurima Lall, 1st, Sultan Chand & Sons, 2021
3.	Entrepreneurial Development,S.S. Khanka, 1st Edition, S Chand and Company, 1999
4.	Entrepreneurship Development and Small business enterprises, P.M. Charantimath, 3rd Edition, Pearson, 2019
REFERENCES	
1.	Entrepreneurship: Theory, Process and Practice, Donald F Kuratco, 11th, Cengage, 2023
2.	Entrepreneurship, Robert. D. Hisrich & Sabyasachi Sinha, 11th Edition, TMH, 2020

CO-PO-PSO MAPPING

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	-	-	-	-	2	3	3	3	3	3	3	3	-	-
CO2	-	2	2	2	2	3	3	3	3	3	3	3	-	-
CO3	-	-	-	-	2	3	3	3	3	3	3	3	-	-
CO4	-	-	-	-	2	3	3	3	3	3	3	3	-	-

Correlation Level 1: Slight 2: Moderate 3: High

INDUSTRIAL SAFETY ENGINEERING

CREDIT	2	Subject Code: IP3403	L-3	T-0	P-0

PREREQUISITES: NA

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Apply safety principles in various work environments, especially in construction and machine operations.
CO2	Identify safety hazards, implement safety measures,
CO3	Analyse risks to prevent accidents and injuries.
CO4	Understand of safety protocols, policies, and the responsibilities of individuals and organizations in ensuring a safe working environment.

CONTENT

Module 1 (6 hours)	**Safety Introduction:** Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization-objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.
Module 2 (7 hours)	**Personal Protection in work environment:** Personal protection in the work environment, Types of PPEs, Personal protective equipment- respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.
Module 3 (7 hours)	**Safety issues in Construction:** Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space – Temporary Structures. Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.
Module4 (12 hours)	**Safety Hazards in Machines and Hazard identification and analysis:** Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices.Safetyinturning,and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding. Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance.

	Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard and Operability study (HAZOP))–methodology, criticality analysis, corrective action and follow-up. Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets (MSDS).
Total Lecture hours- 30 hours	
TEXTBOOKS	
1.	R.K Jain (2000) Industrial Safety, Health and Environment management systems, Khanna Publications.
2.	Paul S V (2000), Safety management System and Documentation training Programme handbook, CBS Publication.
3.	Krishnan, N.V. (1997).Safety management in Industry. Jaico Publishing House, New Delhi.
REFERENCES	
1.	John V. Grimaldi and Rollin H.Simonds. (1989) Safety management. All India Traveller Book Seller, Delhi.
2.	Ronald P. Blake. (1973). Industrial safety. Prentice Hall, New Delhi.
3.	Alan Waring. (1996). Safety management system. Chapman & Hall, England.
4.	Vaid, K.N., (1988). Construction safety management. National Institute of Construction Management and Research, Mumbai

CO-PO-PSO MAPPING

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	3	2	2	2		3					3	2
CO2	3	3	3	2				3	2				3	2
CO3	3	3	3	2				3					3	2
CO4	2	2	1	2		3		3	2	2			2	2

Correlation Level 1: Slight 2: Moderate 3: High

COMPUTATIONAL LABORATORY					
CREDIT	1.5	Subject Code: IP3501	0	0	3
PREREQUISITES: Structural Analysis-1, Structural Design -I, Transportation Engineering-I, Geotechnical Engineering-I, Environmental Engineering					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Illustrate MATLAB's application in Civil Engineering.				
CO2	Explain MS Excel in Civil Engineering applications.				
CO3	Develop code using MATLAB for analysis of basic Civil Engineering structures.				
CO4	Analyze Basic Civil Engineering problems using MS Excel.				
CONTENT					
1	Introduction to MS Excel/ MATLAB.				
2	Development of code using MATLAB/MS Excel for designing structural elements (Beam, Column, Slab etc) in concrete and steel.				
2	Development of code using MATLAB/MS Excel for designing flexible and rigid pavements.				
3	Application of MS Excel/MATLAB in computing active and passive earth pressure using Rankine and Coulomb's theory.				
4	Application of MS Excel/MATLAB for water distribution network analysis.				
Test Books:					
1	Kattan P., MATLAB Guide to Finite Elements, An Interactive Approach, Lulu.com Publisher, 1435726979, 978-1435726970				
2	Rajasekaran S, Computational Structural Mechanics, Prentice Hall of India,New Delhi, 2001				
3	Manickaselvam V.K., Elements of Matrix and Stability Analysis of Structures,Khanna Publishers, New Delhi, 1998.				
4	Attaway S., MATLAB: A Practical Introduction to Programming and Problem Solving, Elsevier, Amsterdam, 2018.				
Reference Books:					
1	Pillai S. Unnikrishna& Menon D., Reinforced Concrete Design, McGraw Hill Education, New Delhi, 2020.				
2	Nilson A.H., Darwin D. & Dolan C.W., Design of Concrete Structures, McGraw Hill Education, New York, 2010.				
3	Khanna S.K. & Justo C.E.G., Highway Engineering, Nem Chand & Bros, Roorkee, 2021.				
4	Punmia B.C., Soil Mechanics and Foundations, Laxmi Publications, New Delhi, 2017				
5	Mays L.W., Water Resources Engineering, Wiley India Pvt. Ltd., New Delhi,				

	2011.

CO-PO MAPPING														
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	**2**	**2**			**3**						**1**		**3**	**2**
CO2	**2**	**2**			**3**						**1**		**3**	**2**
CO3	**2**	**2**			**3**						**1**		**3**	**2**
CO4	**2**	**2**			**3**						**1**		**3**	**2**
Correlation Level 1: Slight 2: Moderate 3: High														

CONCRETE TECHNOLOGY LABORATORY					
CREDIT	1.5	Subject Code: IP3503	L-0	T-0	P-3
PREREQUISITES: Material Testing and Evaluation					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Summarize the properties of the fresh and hardened concrete.				
CO2	Evaluatevarious properties of aggregate.				
CO3	Design concrete mixes according to the Indian Standard Method.				
CO4	Assess the strength and quality of hardened concrete using NDT test.				
CONTENT					
Exp.1	To determine the workability test of concrete: Slump test, compaction factor test				
Exp.2	To determine the workability of concrete by flow table test through box or V-funnel.				
Exp.3	Compressive strength Test of concrete by cube specimen (Nominal Mix)				
Exp.4	Compressive strength Test of concrete by cylindrical specimen (Nominal Mix):				
Exp.5	Determination of axial stress, longitudinal strain, lateral strain, and Poisson's ratio. Plotting of stress-strain curve and determination of modulus of elasticity.				
Exp.6	Split Tensile Strength Test of Concrete				
Exp.7	Prism test for determining modulus of rupture of concrete				
Exp.8	. Design of concrete mix (As per Indian Standard Method)				
Exp.9	Failure of RC beams in bending and shear (two-point and one-point loading)				
Exp.10	To determine the quality of concrete by non-destructive test (NDT) of concrete				
REFERENCES/CODE					
1	IS: 516-2021				
2	IS:10262-2019				

CO-PO MAPPING														
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	**2**	**2**	**2**	**1**	**3**						**1**	**3**	**2**	**3**
CO2	**1**	**2**	**2**		**3**						**1**	**3**	**1**	**3**
CO3	**2**	**2**	**3**	**1**	**3**						**1**	**1**	**3**	**1**
CO4	**2**	**1**	**3**		**2**						**3**	**2**	**1**	**2**
Correlation Level 1: Slight 2: Moderate 3: High														

DESIGN AND DETAILING OF STEEL STRUCTURE LABORATORY

CREDIT	1.5	Subject Code: IP3507	L-0	T-0	P-3

PREREQUISITES: Structural design-II

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Compute the design loads on various structural steel systems
CO2	Illustrate principles and relevant codal provisions foranalysis and design of various structural steel components.
CO3	Use commercial software for analysis and design of steel structures
CO4	Prepare detailed structural drawings for any given design.

CONTENT

Exp.1	Design and detailing of bolted connections in structural steel systems.
Exp.2	Design and detailing of welded connections in structural steel systems.
Exp.3	Design and detailing of tension members.
Exp.4	Design and detailing of compression members with lacing and battening.
Exp.5	Design and detailing of column bases.
Exp.6	Design and detailing of flexural members.
Exp.7	Design and detailing of plate girder.
Exp.8	Design and detailing of roof trusses.

REFERENCES

1	IS 800: 2007

CO-PO MAPPING

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	3	3	2	3	1						1	3	
CO2	3	3	3	2	3	1						1	3	
CO3	3	3	3	2	3	1						1	3	
CO4	3	3	3	2	3	1						1	3	

Correlation Level 1: Slight 2: Moderate 3: High

SIXTH SEMESTER

HYDRAULICS AND IRRIGATION ENGINEERING					
CREDIT	3	Subject Code: IP3102	L-3	T-0	P-0
PREREQUISITES: Fluid Mechanics, Water Resources Engineering					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Describe various terminologies related to irrigation engineering				
CO2	Interpret the theories and its applications in Hydraulic and Irrigation Engineering				
CO3	Design of Hydraulic structures like various types of Dams, Weir & Barrage and Canal structures				
CO4	Plan, formulate and evaluate the project proposals relating to Hydraulic and Irrigation structures.				
CONTENTS					
Module 1 (4 hours)	**Introduction**: Necessity of Irrigation with its advantages and disadvantages, Irrigation Techniques and Quality of irrigation water. **Water requirements of Crops:** Crops and Crop season, Duty and Delta, Consumptive use, Irrigationrequirements, Estimation of consumptive use of water, Irrigation efficiencies, Soil moisture. **Water Logging and Reclamation of Soils:** Causes and control of water logging. Reclamation of saline and alkaline land, Surface and Sub-surface drainage.				
Module 2 (10 hours)	**Introduction to Open Channel Flow:** Comparison between open channel flow and pipe flow, Classification of open channel flow, Economical and Efficient Section. Specific energy curve, Introduction to Gradually Varied Flow (GVF) and Rapid Varied flow (RVF), Hydraulic Jump. **Canal Irrigation:** Classification of canals, Canal losses, Alignment of canals, Design of stable channels using Kennedy's and Lacey's theory, Garret's diagram, Shield's diagram, Cross section of irrigation canals. **Lining of Irrigation Canals:** Necessity and economical lining, Various types of lining, Design of lined canals.				
Module 3 (8 hours)	**Diversion Head works:** Introduction, Types, Layout of a diversion head Works with its components. **Theories of Seepage and Design of Weirs and barrages:** Bligh's creep theory, Design of concepts of weir and barrages using Bligh's theory, Lane's weighted creep's theory, Khosla's theory, Khosla's method of independent variables, Exit gradient.				

	Introduction to Canals Regulation Works: Canal Falls, Head regulator, Cross regulator, Canal Escape with its design principles. **Cross-Drainage Works:** Necessity, Types of CD works, Locations, Selection of a suitable types with its design consideration.
Module 4 (8 hours)	**Gravity Dams:** Typical cross section, Various forces acting on gravity dam, Combination of forces for design, Modes of failure and Criteria for structural stability, Types of spillways, Energy dissipation and Stilling basin. **Earth Dams:** Types, Causes of failure, Preliminary section of an earth dam, Seepage control and Stability analysis of earth dams **River Training Work:**Guide bank system,Groynes, Launching apron, Levees, Pitched Island
Total Lecture hours- 30 hours	
Test Books:	
1.	Irrigation Engineering and Hydraulic Structures by S. K. Garg, Khanna Publication, New Delhi
2.	Irrigation Engg. By Birdie and Das, Dhanpat Rai, New Delhi
3.	Irrigation and Water Power Engineering by Dr. B.C Punmia&Dr. Pande B.B. Lal, Laxmi Publication.
REFERENCES	
1	Irrigation Engg. By Sharma and Sharma, S. Chanda and Company, New Delhi
2	Irrigation Engg. By Birdie and Das, Dhanpat Rai, New Delhi.

CO-PO-PSO MAPPING

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	**3**	**3**	**3**	**3**	**3**	**2**			**2**			**2**		
CO2	**3**	**2**	**2**	**1**	**3**						**1**		**1**	
CO3	**3**	**3**	**2**	**1**	**3**	**2**		**1**		**2**			**2**	
CO4	**3**	**3**	**3**	**1**	**3**				**2**					

Correlation Level 1: Slight 2: Moderate 3: High

GEOTECHNICAL ENGINEERING–II

CREDIT	3	Subject Code: IP3104	L-3	T-0	P-0

PREREQUISITES: Geotechnical Engineering – I

COURSE OUTCOMES

At the end of the course a student will be able to

CO1	Explain the earth pressure theory in relation to different loading conditions and the design of retaining structures.
CO2	Analyze the bearing capacity of shallow foundations using various theories and evaluate the allowable bearing capacity and settlement.
CO3	Evaluate the pile and pile group capacity using both static and dynamic formulae, and discuss the different components of well foundation, its construction, and stability.
CO4	Identify an appropriate soil investigation/testing technique/method and get true subsoil parameters used for any civil Engineering structure, and understand basic rock mechanics and rock mass classification.

CONTENT

Module 1 (7 hours)	**Earth Pressure and Retaining Walls:** Effect of wall movement on earth pressure, Earth pressure at rest, Active and passive earth pressure theory, Rankine's theory of earth pressure, Coulomb's theory of earth pressure, Coulomb's equation for c=0 back fills, Rebhann's and Culman's graphical method, Design considerations retaining walls.
Module 2 (9 hours)	**Bearing Capacity of Shallow Foundations:** Introduction, Basic definitions, Principal modes of soil failures, Terzaghi's bearing capacity theory/ equation and its modifications for square, rectangular and circular foundation, Skempton's bearing capacity analysis for clays, Meyerhof's analysis, Hansen's bearing capacity theory, Vesic's bearing capacity theory, IS code recommendations for bearing capacity, SPT, CPT, plates load tests methods for ultimate bearing capacity based on in situ tests, Bearing capacity of footings on layered soils, Factors influencing bearing capacity, Allowable bearing pressure. General requirements of foundations, Factors affecting location and depth of foundation, Choice and type of foundations, and settlement of footings.
Module 3 (8 hours)	**Pile Foundations:** Use of piles, Types of piles, Construction, Selection of pile type, Pile load capacity, Static formulae, Dynamic formulae, Load tests on piles, Negative skin friction, Group action of piles, Load carrying capacity of pile groups, Settlement of pile group, Piles subjected to uplift loads. **Well Foundations:** Types of wells and caissons, components of well foundation, shapes of wells, depth of a well foundation, forces acting on a well foundation, lateral stability of well foundation, construction and sinking of a well.
Module 4 (6 hours)	**Subsoil Exploration:** Necessity and planning for subsoil exploration, direct, semi-direct, and indirect methods. Sampling procedures, disturbed and undisturbed samples, Standard penetration test, cone penetration test, in-situ vane shear test, seismic refraction method, and electrical resistivity methods.

	Soil exploration report. **Rock Mechanics:** Introduction, problems, defects in rock mass, joints, faults, Rock coring, RQD.
Total Lecture hours- 30 hours	
TEXTBOOKS &REFERENCES	
1.	Basic and Applied Soil Mechanics by Gopal Ranjan and ASR Rao, New Age International Publishers, Second Edition, 2007.
2.	Soil Mechanics and Foundation Engineering by V. N. S. Murthy, CBS Publishers & Distributors, New Delhi.
3.	Foundation Analysis and Design by J.E. Bowles, McGraw-Hill,1996.
4.	Geotechnical Engineering Principles and Practices by Donald P. Coduto, Man-Chu Ronald Yeung, and William A.Kitch, PHI Learning Pvt. Ltd., Second Edition.
5	Foundation Design by W. C. Teng, Prentice Hall.

CO-PO-PSO MAPPING

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	3	2	2	3	3	2	1	1	1	3	3	3
CO2	3	3	3	2	2	3	3	2	1	1	1	3	3	3
CO3	3	3	3	2	2	3	3	2	1	1	1	3	3	3
CO4	3	3	3	2	2	2	1	2	1	1	1	3	2	1

Correlation Level 1: Slight 2: Moderate 3: High

ESTIMATION AND CONSTRUCTION MANAGEMENT					
CREDIT	3	Subject Code: IP3202	L-3	T-0	P-0
PREREQUISITES: Engineering Drawing,Construction Technology					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Estimate quantities and prepare specifications for building and infrastructure works.				
CO2	Evaluate rate analysis, tenderingprocedures, contracts and billing practices.				
CO3	Integrate project management techniques like bar charts, CPM, and PERT for effective scheduling and control				
CO4	Manage allocation of various resources for a construction project.				
CONTENTS					
Module 1 (12 hours)	**Estimation:** Principles of estimation, methods and units, Estimation of materials in buildings, Principles of general and detailed specification for various types building works (long wall – short wall method, centre line method), Estimation of Road, Earth work calculation (Mean-section method, mid-section method and trapezoidal method), culverts and bridges.				
Module 2 (6 hours)	**Specifications- Types**, requirements and importance, detailed specifications for buildings **Rate analysis**- Purpose, importance and necessity, factors affecting Analysis of rates, Prime cost, Schedule rates (OPWD), Analysis of rates for various types of works. **Tender-** Types of Tenders, Preparation of tender documents, inviting tenders, contract types (Lump-sum, item rate, percentage rate etc.), EPC (Engineering procurement and construction) termination of contracts, penalty and liquidated charges, general and special conditions, , R.A. Bill & Final Bill, Payment of advance, insurance, Extention of time and deviation of contract, claims,Settlement of disputes, Arbitration, Introduction to e-tendering and GEM				
Module 3 (8 hours)	Objectives and functions of management in construction. **Project Management**: Project Planning, Scheduling and Controlling, Bar charts: Development of Bar charts and its shortcomings. Network techniques: Event, activity, Dummy activity. Network rules, Numbering of events, Critical Path Method, Critical activities, Slack, Project Evaluation and Review Techniques (PERT): Time estimates, Different types of Float in a activity, Probability of meeting schedule date for the project.				
Module 4 (4 hours)	**Cost Model:** Project cost, indirect and direct cost, slope of direct cost curve, optimum project duration, contracting the network for cost optimization. Introduction to updating, resources smoothing, and resources leveling **Quality Control:** Quality Control, Sampling Plan, Control Charts, X Chart, R Chart, C chart, and P Chart.				
Total Lecture hours- 30 hours					
Test Books:					
1.	Dutta, B.N., Estimating and Costing in Civil Engineering (Theory & Practice),				

	UBSPublishers, 2016
2.	M. Chakraboti, Estimation, Costing, Specification and Valuation in Civil Engineering, Chakraborti; Twentyninth revised & Enlarged Edition (1 January 2006)
3.	Construction Management and Planning, B Sengupta & H Guha, Tata McGrawHill
Reference Books:	
1	PERT & CPM, L. S. Sreenath. East - WestPress
2	Relevant IS Code: National BuildingCode-2016
3	Schedule of Rates (OPWD)

CO-PO-PSO MAPPING

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	**3**	**3**		**1**					**2**				**3**	2
CO2	**3**	**3**		**1**					**2**				**3**	2
CO3	**2**	**3**	**3**	**1**	**2**								2	2
CO4	**2**	**2**	**3**		**2**	**2**	**3**		**2**			**1**	**2**	1

Correlation Level 1: Slight 2: Moderate 3: High

CONSTRUCTION EQUIPMENT AND PROJECT MANAGEMENT					
CREDIT	3	Subject Code: IP3204	L-3	T-0	P-0
PREREQUISITES: Mathematics, Basics of Civil Engineering					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Explain different construction equipments efficiently, focusing on planning, cost control, maintenance, and safety.				
CO2	Summarize the fundamentals of earthwork operations and the effective use of various earthmoving equipments.				
CO3	Interpret various construction equipments used in dredging, trenching, tunneling, compaction, demolition, and other specialized operations.				
CO4	Integrate project management techniques like bar charts, CPM, and PERT for effective scheduling and control				
CONTENTS					
Module 1 (8 hours)	**Construction Equipment Management**: Identification – Planning - Equipment Management in Projects - Maintenance Management – Replacement - Cost Control of Equipment - Depreciation Analysis – Safety management **Equipment for Earthwork**: Fundamentals of Earth Work Operations - Earth Moving Operations - Types of Earth. Work Equipment - Tractors, Motor Graders, Scrapers, Front end Waders, Earth Movers.				
Module 2 (7 hours)	**Other Construction Equipment**: Equipment for Dredging, Trenching, Tunneling, Drilling, Blasting - Equipment for Compaction - Erection Equipment - Types of pumps used in Construction - Equipment for Dewatering and Grouting – Foundation and Pile Driving Equipment –Equipment for Demolition.				
Module 3 (7 hours)	**Materials Handling Equipment**: Forklifts and related equipment - Portable Material Bins – Conveyors - Hauling Equipment **Equipment for Production of Aggregate and Concreting**: Crushers – Feeders - Screening Equipment - Handling Equipment - Batching and Mixing Equipment - Hauling, Pouring and Pumping Equipment – Transporters.				
Module 4 (8 hours)	**Project Management**: Project Planning, Scheduling and Controlling, Bar charts: Development of Bar charts and its shortcomings. Network techniques: Event, activity, Dummy activity. Network rules, Numbering of events, Critical Path Method, Critical activities, Slack, Project Evaluation and Review Techniques (PERT): Time estimates, Different types of Floats of activity, Probability of meeting schedule date for the project. **Cost Model:** Project cost, indirect and direct cost, slope of direct cost curve, optimum project duration, contracting the network for cost optimization. Introduction to updating, resources smoothing and resources leveling				

Total Lecture hours- 30 hours	
Test Books:	
1.	Peurifoy, R.L., Ledbetter, W.B. and Schexnayder, C., Construction Planning, Equipment and Methods, McGraw Hill, Singapore, 2006.
2.	Sharma S.C. Construction Equipment and Management, Khanna Publishers, New Delhi, 1988.
3.	Deodhar, S.V. Construction Equipment and Job Planning, Khanna Publishers, New Delhi, 1988.
4.	PERT & CPM, L. S. Sreenath. East – West Press. 5. Relevant IS Code: National BuildingCode-2016 58 6. Schedule of Rates
Reference Books:	
1	Dr. Mahesh Varma, Construction Equipment and its planning and Application, Metropolitan Book Company, New Delhi. 1983
2	Project Planning and Control by Dr. B.C Punmia and K.K Khandelwal.

CO-PO-PSO MAPPING

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	3	3	3	3	2				3		1		1	1
CO2	2	2	2	2	2								1	1
CO3	2	3	2	2	2				1		1		1	1
CO4	2	3	3	3	2						1		2	1

Correlation Level 1: Slight 2: Moderate 3: High

CONSTRUCTION ENGINEERING AND MANAGEMENT

CREDIT	3	Subject Code: IP3206	L-3	T-0	P-0

PREREQUISITES: Mathematics, Basics of Civil Engineering

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Describe the advanced concreting methods, including shuttering, RMC operation, Design mix, and underwater concreting.
CO2	Demonstrate safety practices including accident prevention, hazard control, legal frameworks, and safety management in construction projects.
CO3	Integrate project management techniques like bar charts, CPM, and PERT for effective scheduling and control.
CO4	Evaluate tendering procedures, contracts and billing practices

CONTENTS

Module 1 (7 hours)	**Construction using Concrete Technology**: Concrete: Various types and erection methods of shuttering, Operation and erection of Ready-Mix Concrete Plant, Pumped Concrete, Concrete mix design with various methods of concreting and also underwater concreting using tremie method, Concreting for under water Construction, Self-compacting concrete.
Module 2 (7 hours)	**Safety Engineering:** Causes of Accidents on various sites, safety measures and safety policies to be adopted, determination of safety parameters, personal protective equipment. Workmen Compensation Act, Minimum wages act. **Type of Industrial Hazards**-Nature, Causes and Control Measures, Hazard Identifications and Control Techniques - HAZOP, FMEA, FMECA. -Cost of Construction Injuries-Legal Implications **Safety Organization** –Safety Policy, Safety Record Keeping, Safety Culture, Safety and First Line Supervisors, Middle Managers, Top Management Practices, Sub contractual obligation, Project Coordination and Safety Procedure.
Module 3 (8 hours)	**Project Management:** Project Planning, Scheduling and Controlling, Bar charts: Development of Bar charts and its shortcomings. Network techniques: Event, activity, Dummy activity. Network rules, Numbering of events, Critical Path Method, Critical activities, Slack, Project Evaluation and Review Techniques (PERT): Time estimates, Different types of Float of activity, Probability of meeting schedule date for the project. **Cost Model:** Project cost, indirect and direct cost, slope of direct cost curve, optimum project duration, contracting the network for cost optimization. Introduction to updating, resources smoothing and resources leveling.

Module 4 (8 hours)	**Contracts**: Essentials of Contract, Various types of Contracts, General conditions and principles, Methods of tendering, Earnest Money, Security Money, Arbitration, Termination of Contract. **Quality Control**: Quality Control, Sampling Plan, Control Charts, X Chart, R Chart, C chart and P Chart.
Total Lecture hours- 30 hours	
Test Books:	
1.	Peurifoy Robert L and Oberiender Garold D., Formwork for Concrete Structures, McGraw-Hill,1996,
2.	Civil Engineering Contracts and Estimating", by B. S. Patil & Orient Logman Ltd New Delhi
3.	"Construction Planning &Managemen", by B.C. Punmia, laxmi Publications
4.	PERT & CPM, L. S. Sreenath. East – West Press. 5. Relevant IS Code: National BuildingCode-2016 58 6. Schedule of Rates
Reference Books:	
1	Dr. Mahesh Varma, Construction Equipment and its planning and Application, Metropolitan Book Company, New Delhi. 1983
2	Project Planning and Control by Dr. B.C Punmia and K.K Khandelwal.
3	Hurd M.K, Formwork for Concrete, Special Publication No-4, (Fifth Edition) American Concrete Institute, Detroit,1980,
4	Detroit, Guide for Concrete Formwork. American Concrete Institute. Box No 19150, Michigan-48219.
5	"Construction Planning & Management", by U. K. Shrivastava, Galgotia Publications Pvt. Ltd, May 2010
6	"Construction Project Management" by Kumar Neeraj Jha, Pearson Education Reference Book 6. "Basics of Construction Management" by Ajay Kumar Singhal, Skill Enhancement Academy

CO-PO-PSO MAPPING													
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	3	3	3	3	2				3		1		2	1
CO2	2	2	2	1	2								2	1
CO3	2	3	2	1	2				1		1		2	1
CO4	2	3	3	1	2						1		2	1
Correlation Level 1: Slight 2: Moderate 3: High														

WATER AND WASTEWATER ENGINEERING					
CREDIT	3	Subject Code: IP3208	L-3	T-0	P-0
PREREQUISITES: Environmental Engineering					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Apply the knowledge to check sources, characteristics, and impacts of wastewater and the need for its treatment.				
CO2	Design water intake, storage, distribution, and sewerage network for water and wastewater				
CO3	Plan treatment units and processes for water and wastewater				
CO4	Propose the best possible technology for treatment				
CONTENT					
Module 1 (7 hours)	**Introduction to Water Supply:** General outline and scope of water supply systems, Water availability and uses, Key issues and challenges in water supply systems. **Water Demand and Forecasting:** Concepts and types of water demand, Factors affecting water demand, Demand fluctuations and forecasting methods, Population forecasting techniques for design. **Storage structures:** balancing and service reservoirs, Design of storage capacity using mass curves, Regulation for hourly, daily, and seasonal demands, Basic philosophy of treatment and selection of unit operations.				
Module 2 (8 hours)	**Water Treatment Processes:** Water quality parameters and standards, Unit operations: aeration, coagulation, flocculation, sedimentation, Filtration: slow sand, rapid sand, multimedia filters. Disinfection: chlorination and alternatives; **Advanced treatment methods:** Removal of iron, manganese, hardness, fluorides, and taste/odor. Distribution System: Distribution network layouts and components, Hydraulics of pipe networks; Pipe network analysis (Hardy Cross method), Smart water supply systems for Indian cities.				
Module 3 (8 hours)	**Wastewater Generation:** Introduction to wastewater and its management, Sources and types of wastewaters, Importance of wastewater treatment and recycling, Estimation of wastewater quantity and flow variations. Wastewater Characteristics: Physical, chemical, and biological characteristics (BOD, COD, DO, solids, nutrients, metals, emerging contaminants). **Treatment:** Objectives of treatment, Preliminary processes: screening, grit removal, equalization. Primary treatment: sedimentation theory, design of rectangular and circular tanks. Secondary Treatment Processes: Microbial ecology and kinetics of biological treatment, Aerobic and anaerobic treatment systems, Suspended growth (activated sludge), attached growth (trickling filters, RBCs), Anaerobic processes: UASB, fluidized beds, biogas production.				
Module4	**Advanced treatment:** nutrient (N & P) removal, chemical processes,				

(7 hours)	Advanced oxidation, ion exchange, membrane processes (SBR, MBR, MBBR). **Sludge Treatment:** Characteristics and quantities of sludge, Sludge thickening, dewatering, stabilization (aerobic and anaerobic), composting. **Recycling, Decision Making, and Technology Trends:** Scope, stages, and criteria for wastewater recycling and reuse, Centralized vs decentralized systems; Designated reuse applications, Technology selection: risks, cost, socio-economic and environmental considerations, Case studies from India and abroad.
Total Lecture hours- 30 hours	
TEXTBOOKS	
1.	Water Supply Engineering-Environmental Engineering by S.K.Garg, Khanna Publishers
2.	Sewage Disposal and Air Pollution Engineering - Environmental Engineering by S.K.Garg, Khanna Publishers
3.	Water Supply and Sanitary Engineering by B.S. Birdi Dhanpat Rai Publishing Company
REFERENCES	
1.	Water Supply Engineering by B. C. Punmia and A.K.Jain, Laxmi Publications
2.	Water and Wastewater Technology by M.J.Hammer, PHI

CO-PO-PSO MAPPING

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

Correlation Level 1: Slight 2: Moderate 3: High

AIR POLLUTION AND CONTROL					
CREDIT	3	Subject Code: IP3210	L-3	T-0	P-0
PREREQUISITES: Environmental Engineering					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Understand the scope of atmospheric chemistry and atmospheric pollution.				
CO2	Monitor the meteorological factors and pollutant dispersion level.				
CO3	Design air pollution control equipment and its design principles and limitations				
CO4	Analyze the modelling and control techniques				
CONTENT					
Module 1 (7 hours)	**Introduction to Air pollution and its impacts:**Introduction,Sources of air pollution, Air pollutants, Criteria and non-criteria pollutants, Formation of smog, photochemical smog, acid rain and ozone layer depletion, Effect on animal health, vegetation, materials and atmosphere,Global warming and its implications, Greenhouse gases, global warming potential, Global climate change and its impact, Heat island effects. Sources of indoor Air pollution.				
Module 2 (8 hours)	**Meteorology and air pollution**: Air pollution meteorology, Atmospheric dispersion, lapse rates, Atmospheric stability conditions, Plume characteristics,Dispersion of air pollutants**,** Effective stack height, Maximum mixing depth,Models for point and line sources based on Gaussian plume dispersion, Diffusion equation, ground level emission, plume rise, limitations of Gaussian plume model, Box model for area sources. Holland's and Briggs equations.				
Module 3 (8 hours)	**Air pollutants Emission controls:**The natural self-cleansing properties of Environment,Air pollution control at source, Air pollution control by absorption, adsorption, condensation, concept of bio-scrubbers, bio-filters, etc., Air Pollution control from stationary sources by installing Engineering devices, concepts and the design of gravitational settlers, Cyclone collector, wet scrubber, Venturi-scruber, electrostatic precipitators, fabric filters, Flue gas esulphurization, NOX removal from flue gas.				
Module 4 (7 hours)	**Air pollution control Strategies:**Air pollution inventories, Air quality Index and Standards Introduction to cleaner production, Carbon foot print, Carbon sequestration techniques,Air pollution legislation in India, Global strategies for air emission control.				
Total Lecture hours- 30 hours					
TEXTBOOKS					

1.	Environmental Engineering (Vol-II), Sewage Disposal and Air Pollution Engineering, S.K.Garg, KP publication,2000.
2.	C. S. Rao, Environmental Pollution Control Engineering, New age International (P) Limited, Publishers, India
REFERENCES	
1.	Peavy, Rowe and Techobanoglous, Environmental Engineering, McGraw Hill Co., 1985, 4th Edition
2.	George Tchobanoglous, Hilary Theisen, S. A. Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw-Hill Companies.

CO-PO-PSO MAPPING

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

Correlation Level 1: Slight 2: Moderate 3: High

SOLID AND HAZARDOUS WASTE MANAGEMENT					
CREDIT	3	Subject Code: IP3212	L-3	T-0	P-0
PREREQUISITES: Environmental Engineering					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Identify solid and hazardous waste collection, transportation, and understand their characteristics and treatment methods				
CO2	Apply principles of physicochemical and biological waste treatment				
CO3	Design landfill systems and understand thermal treatment techniques				
CO4	Apply the knowledge onthe management of solid and hazardous waste				
CONTENT					
Module 1 (7 hours)	**Solid and Hazardous Waste: Sources, Classification & Collection Systems** Solid waste Management – sources and engineering, classification, characterization, generation and quantification. Transport – collection systems, collection equipment, transfer stations, collection route optimization Hazardous Waste Management – Fundamentals Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects				
Module 2 (8 hours)	**Physicochemical and BiologicalTreatment Technologies:** Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation. Biological Treatment of Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation				
Module 3 (8 hours)	**Disposal Techniques: Landfilling, Thermal Treatment & Site Remediation** Landfill design Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers. Thermal treatment –Incineration and pyrolysis. Soil contamination and site remediation – bioremediation processes, monitoring of disposal sites.				
Module 4 (7 hours)	**Specialized Waste Management: Radioactive, Biomedical & Integrated Approaches** Radioactive waste: sources, health effects, nuclear plant waste, disposal methods. Biomedical Waste management – sources, treatment, and disposal. Economics of on-site vs. off-site waste treatment and disposal (individual vs. common disposal) Waste minimization and concept of industrial ecology and industrial symbiosis Integrated waste management practices				

Total Lecture hours- 30 hours	
TEXTBOOKS	
1.	Vesilind, P.A., Worrell, W.A., and Reinhart, D.R., Solid Waste Engineering, Cengage Learning India Private Limited, 2004
2.	George Tchobanoglous, Frank Kreith, Handbook of Solid Waste Management, McGraw-Hill: New York 2002, 2nd Edition
REFERENCES	
1.	Peavy, Rowe and Techobanoglous, Environmental Engineering, McGraw Hill Co., 1985, 4th Edition
2.	George Tchobanoglous, Hilary Theisen, S. A. Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw-Hill Companies.

CO-PO-PSO MAPPING

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

Correlation Level 1: Slight 2: Moderate 3: High

NOISE POLLUTION AND CONTROL					
CREDIT	3	Subject Code: IP3214	L-3	T-0	P-0
PREREQUISITES: Environmental Engineering					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Identify sources of noise pollution				
CO2	Understand the effects of noise pollution				
CO3	Evaluate the noise control measures				
CO4	Applying analytical techniques to noise levels, evaluate the effectiveness of noise control measures, and design noise control strategies.				
CONTENT					
Module 1 (7 hours)	Definitions: Vibration, Waves, Vibration versus Waves, Wave Propagation, Wave Propagation in Time and Space, Types of Waves (Longitudinal, Transverse), Rayleigh waves. Nature of Sound: Nature of Sound Waves, Reflection, Rarefaction, Interference (Beats), Diffraction, Dispersion, Absorption, Transmission Sound Measurement: Decibel scale, pressure level, sound intensity level, sound power level, Octaves, decades bandwidth wave number tone: tones and octaves, Bandwidth, wave number,				
Module 2 (8 hours)	Decibel Scale: RMSE, Adding Decibels (Correlated and Uncorrelated), Complex Number, Complex Time Function, Linear Systems, Transfer Functions. Introduction to 1-D wave equation, The momentum equation, The Continuity Equation and Gas Law, Solution for 1-D wave equation, 3-D wave equation, Transmission Line Equations, 1-D Example Problems Impedance, Pressure Wave Travels in a Closed Tube, Standing Wave Formation in a Closed Tube with Rigid Termination, Pressure Wave Travels in an Open Tube, 1-D Sound Wave Propagation: Kundt's Tube-I, 1-D Sound Wave Propagation: Kundt's Tube-II, Radially propagating sound waves in spherical coordinate systems, Complex impedance for radially propagating sound waves in spherical coordinate system, Volume velocity, Interference of 1-D spherically propagating sound waves-I				
Module 3 (8 hours)	Noise sources and introduction to microphones, Classification of microphones, Microphone Parameters, Understanding microphone specifications, Noise Source: Terminology, Noise Source: Sound Attenuation, Noise Source: Sound Pressure Level due to a noise source located outdoors, Noise Source: Role of reflecting surfaces, Sound Pressure Level due to a Noise Source Located Indoors, Measuring Sound Power Level – Understanding Standard Octave Bands, Measuring Sound Power Level – Understanding Standard Octave Bands				

	Measuring Sound Power Level - Fan Noise, Weighting. Noise coming from Motors, Noise coming from Motors and Pumps, Noise comingfrom Pump and Motor Working Simultaneously, Noise coming from Compressors, Example problems regarding Noise coming from Compressor
Module 4 (7 hours)	Noise Spread Mechanisms, Reverberation time, Reverberation time example problem, Noise from Adjacent Room, Acoustic Enclosures, Acoustic Enclosures- Example Problems, Large acoustical enclosures, Acoustic barriers, Helmholtz resonator I, Silencers, Side branched mufflers, Expansion chamber muffler, Single expansion chamber muffler
Total Lecture hours- 30 hours	
TEXTBOOKS	
1.	Textbook of Noise Pollution and Its Control by S.C. Bhatia, Atlantic Publishers and Distributors (P) Ltd; Edition (1 January 2023); Atlantic Publishers and Distributors (P) Ltd
2.	Noise Pollution and its Control, Polak, KJ, 1st Edition, CBS Publishers & Distributors

CO-PO-PSO MAPPING														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	2	3	2	3	3	2	2	2	2	2	1
CO2	3	3	2	2	3	2	3	2	1	1	2	2	3	2
CO3	3	3	3	2	3	3	3	3	2	2	2	3	3	2
CO4	3	3	3	3	3	3	3	3	1	1	1	3	3	3
Correlation Level 1: Slight 2: Moderate 3: High														

ENVIRONMENTAL ENGINEERING

CREDIT	2	Subject Code: IP3401	L-3	T-0	P-0

PREREQUISITES: Basic Physics, Basic Chemistry

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Understand the multidisciplinary nature of environmental science and ecosystem structure and functions
CO2	Analyze various forms of environmental pollution and assess their impact using scientific parameters
CO3	Demonstrate knowledge of water and wastewater treatment processes and air pollution control technologies
CO4	Evaluate the role of environmental policies, EIA, and sustainable practices in pollution control and resource conservation

CONTENT

Module 1 (10 hours)	**Fundamentals of Environment and Ecosystem:** Multidisciplinary nature of environmental Engineering. **Study of Ecosystem:** Definition, Properties, Structure and Function of an ecosystem. Food chains, food webs, Flow of Energy, Ecological Pyramids, Biogeochemical cycles, Types of ecosystems, Bioaccumulation, Bio magnification, ecosystem value, Degradation of Ecosystem. **Concept of Environment and pollution:** Atmospheric chemistry, soil chemistry, water quality characteristics, DO, BOD and COD, water pollution, Marine Pollution, soil pollution, thermal pollution, nuclear hazard, Air Pollution: Air Quality, cause and effects of air pollution, Water and air quality standards, and Index, Noisepollution: Introduction, Noise standards, measurement, Ln Concept and control
Module 2 (8 hours)	**Water treatment process**: Pre-treatment of water, conventional process, advanced water treatment process. **Waste water treatment process**: Natural Treatment, Engineering Treatment -Pre-treatment, primary and secondary waste water treatment process **Air Pollution Control**: The natural self-cleansing properties of Environment, Air pollution meteorology, Atmospheric dispersion, Diffusion equation, ground level emission, plume rise, Effective stack height, Air Pollution control from stationarysources by installing Engineering devices, Flue gas desulphurisation, NOX removal.
Module 3 (8 hours)	**Solid waste management:** Source, classification, separation, storage and transportation of solid wastes, Waste minimization techniques, Benefits of waste minimization, reuse, recycle, thermal and biological treatment, secure land fill technique. **Impact of Environmental pollution and related issues:** Global climate change, global warming and greenhouse gases, Acid rain, ozone layer depletion, healthissues.
Module4 (4 hours)	**Environmental Impact Assessment:** EIA procedure, Preparation of an EIS From unsustainable to sustainable development, circular economy, Environmental Protection Act, Air (Prevention and Control of Pollution) Act, Water (Preventionand Control of

	Pollution) Act, Wildlife Protection Act.
Total Lecture hours- 30 hours	
TEXTBOOKS	
1.	Fundamentals of Ecology, M.C.Dash, Tata McGraw Hill, 2006.
2.	Environmental Pollution Control Engineering, C.S. Rao, New Age International Publishers, 2018
3.	Environmental Engineering, G. Kiely, TMH, 2007
REFERENCES	
1.	Environmental Engineering, H.S. Peavy, D.R. Rowe and G. Tchobanoglous, McGraw Hill.
2.	Introduction to Environmental Engineering and Science, G.M. Masters, Pearson, 2015
3.	Integrated Solid Waste Management, G. Tchobanoglous, McGraw Hill, 2014
4.	Water Supply Engineering, S.K. Garg; Khanna Publishers, 37th Edition

CO-PO-PSO MAPPING

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	2	1	1	1	2	3	1	1	2	1	2	2	2
CO2	3	3	2	2	2	2	3	1	1	2	1	2	2	2
CO3	3	3	3	2	2	2	3	1	2	2	2	3	3	3
CO4	2	2	2	2	1	3	3	2	2	2	2	3	3	3

Correlation Level 1: Slight 2: Moderate 3: High

BUSINESS MANGEMENT

CREDIT	2	Subject Code: BH3401	L-3	T-0	P-0

PREREQUISITES: Basic Physics, Basic Chemistry

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Comparing and contrasting efficient functional models of business management by integrating the three core areas such as Finance, Human Resource and Marketing Management.
CO2	Executing the Management principles in all the functional areas of business.
CO3	Correlating the interrelations and interdependence of the areas of Management in a business organization.
CO4	Assessing the functional and managerial practices in business organizations.

CONTENT

Module 1 (8 hours)	**Management Principles** Management Concepts, Nature and Functions, Management Process and Roles of Managers, Levels of Management and Managerial Skills, Theories of Management – Contributions of F.W.Taylor, Henry Fayol, Elton Mayo, Line and Staff Relationship, Centralisation and Decentralisation, Delegation of Authority , Management thoughts in Modern Trend –Systems Approach
Module 2 (8 hours)	**Financial Management** Concept, Financial function and Role of Financial Managers, Instruments of raising short-term and long-term funds, Capital Structure, Techniques of Project Appraisal, Components of Working Capital, Operating Cycle, Factors affecting requirement of Working Capital.
Module 3 (7 hours)	**Human Resource Management** Nature and Scope of Human Resource Management, Manpower Planning, Recruitment and Selection Methods, Performance Appraisal, Need, Objectives, Modern methods of Appraisals: 720 degree, MBO, Assessment Centre Method, Talent Acquisition, Training Need Analysis, Career Planning, Organisational Citizenship Behaviour.
Module4 (7 hours)	**Marketing Management** Concept, Nature, Scope and Importance, Marketing Mix and 7P's of Marketing, Segmentation, Targeting, Positioning, Factors influencing consumer decision-making, e-marketing and Green Marketing

Total Lecture hours- 30 hours

TEXTBOOKS

1.	Modern Business Organisation and Management, S.A. Sherlekar, Himalaya Publishing House, 2016.
2.	Essentials of Management, Stephen P. Robbins, 6th Edition, Pearson, 2010.
3.	Financial Management, Sheeba Kapil, 1st Edition,Pearson, 2013.
REFERENCES	
1.	Marketing Management, Rajan Saxena, 6th Edition, TMH publishing house, 2022.
2.	Principles of Management, Dipak Kumar Bhattacharyya, 1st Edition, Pearson, 2011
3.	Mgmt (Principles of Management), Willium& Tripathy, 1st Edition, Cengage Learning, 2016

CO-PO-PSO MAPPING

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	-	2	-	2	-	2	2	3	3	3	3	3	-	-
CO2	-	-	-	-	-	1	3	3	3	3	3	3	-	-
CO3	-	-	-	-	2	2	1	3	3	3	3	3	-	-
CO4	-	-	-	-	-	1	1	3	3	3	3	3	-	-

Correlation Level 1: Slight 2: Moderate 3: High

ENTREPRENEURSHIP DEVELOPMENT

CREDIT	2	Subject Code: BH3403	L-3	T-0	P-0

PREREQUISITES:

COURSE OUTCOMES
At the end of the course a student will be able to

CO1	Exemplifying the business opportunities, social responsibilities and the support system for setting up an enterprise.
CO2	Determining stages of Entrepreneurial Process starting from idea generation, developing a business plan and operational aspects of an Enterprise.
CO3	Appraising the different funding options and Financial Management of an enterprise.
CO4	Assessing the Start-up management practices like incubation, mentorship and Government initiatives.

CONTENT

Module 1 (8 hours)	**Introduction to Entrepreneurship** Concept, Functions of an Entrepreneur, Entrepreneurial Process, Entrepreneurial Motivation and Barriers, Traits to be a successful Entrepreneur, Creativity and scope of Entrepreneurship in India: Types of new age business (FinTech, EdTech, Healthcare, Agripreneurship, Defence, Drone, Space, IT, Robotics, Digital Transformation, Women-Entrepreneurship, Social Entrepreneurship, Corporate Social Responsibility, Business Ethics – Role of Values in Management
Module 2 (8 hours)	**Entrepreneurial Idea into Action** Developing a Business Idea; Opportunity, Methods and Creativity, Deciding to set up a start-up, Forms of business organisations (Sole tradership/propreitorship, Partnership, Joint-Stock Company) and MSMEs (Micro, Small and Medium enterprises), Size and Location of the enterprise, Feasibility Study: Market Survey, Techno-economic feasibility and preparing a Project Report.
Module 3 (7 hours)	**Entrepreneurial Finance and Funding** Sources of funding (Bootstrapping, Angel Investors, Venture Capital, Crowdfunding etc.) Project Investment Analysis, Break-Even Analysis, ROI Analysis, Basics of Income Statement and Balance Sheet.
Module4 (7 hours)	**Managing an Enterprise** The Start-up ecosystem, Business Incubators, Start-up Accelerators, Mentorship and Networking, Failure and Resilience, Risk Management, Ethical dilemmas and Exit Strategies, Start-up Policy and Initiatives of the Government

Total Lecture hours- 30 hours

TEXTBOOKS

1.	Entrepreneurship: Successfully Launching New Ventures, B.R. Barringer, 6th, Pearson, 2020

2.	Fundamentals of Entrepreneurship and Project planning, Madhurima Lall, 1st, Sultan Chand & Sons, 2021
3.	Entrepreneurial Development,S.S. Khanka, 1st Edition, S Chand and Company, 1999
4.	Entrepreneurship Development and Small business enterprises, P.M. Charantimath, 3rd Edition, Pearson, 2019
REFERENCES	
1.	Entrepreneurship: Theory, Process and Practice, Donald F Kuratco, 11th, Cengage, 2023
2.	Entrepreneurship, Robert. D. Hisrich & Sabyasachi Sinha, 11th Edition, TMH, 2020

CO-PO-PSO MAPPING

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	-	-	-	-	2	3	3	3	3	3	3	3	-	-
CO2	-	2	2	2	2	3	3	3	3	3	3	3	-	-
CO3	-	-	-	-	2	3	3	3	3	3	3	3	-	-
CO4	-	-	-	-	2	3	3	3	3	3	3	3	-	-

Correlation Level 1: Slight 2: Moderate 3: High

INDUSTRIAL SAFETY ENGINEERING					
CREDIT	2	Subject Code: IP3403	L-3	T-0	P-0
PREREQUISITES: NA					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Apply safety principles in various work environments, especially in construction and machine operations.				
CO2	Identify safety hazards, implement safety measures,				
CO3	Analyse risks to prevent accidents and injuries.				
CO4	Understand of safety protocols, policies, and the responsibilities of individuals and organizations in ensuring a safe working environment.				
CONTENT					
Module 1 (6 hours)	**Safety Introduction:** Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization-objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.				
Module 2 (7 hours)	**Personal Protection in work environment:** Personal protection in the work environment, Types of PPEs, Personal protective equipment- respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.				
Module 3 (7 hours)	**Safety issues in Construction:** Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space – Temporary Structures. Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.				
Module4 (12 hours)	**Safety Hazards in Machines and Hazard identification and analysis:** Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices.Safetyinturning,and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding. Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material				

	Handling equipment-operation & maintenance. Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard and Operability study (HAZOP))–methodology, criticality analysis, corrective action and follow-up. Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets (MSDS).
Total Lecture hours- 30 hours	
TEXTBOOKS	
1.	R.K Jain (2000) Industrial Safety, Health and Environment management systems, Khanna Publications.
2.	Paul S V (2000), Safety management System and Documentation training Programme handbook, CBS Publication.
3.	Krishnan, N.V. (1997).Safety management in Industry. Jaico Publishing House, New Delhi.
REFERENCES	
1.	John V. Grimaldi and Rollin H.Simonds. (1989) Safety management. All India Traveller Book Seller, Delhi.
2.	Ronald P. Blake. (1973). Industrial safety. Prentice Hall, New Delhi.
3.	Alan Waring. (1996). Safety management system. Chapman & Hall, England.
4.	Vaid, K.N., (1988). Construction safety management. National Institute of Construction Management and Research, Mumbai

CO-PO-PSO MAPPING

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	3	2	2	2		3					3	2
CO2	3	3	3	2				3	2				3	2
CO3	3	3	3	2				3					3	2
CO4	2	2	1	2		3		3	2	2			2	2

Correlation Level 1: Slight 2: Moderate 3: High

DESIGN OF IRRIGATION STRUCTURE					
CREDIT	3	Subject Code: IP3502	L-3	T-0	P-0
PREREQUISITES : Theory of Irrigation Engineering and Basic Mathematics					
COURSE OUTCOMES					
CO1	Preparation of design and drawing for different irrigation structures.				
CO2	Analyzing the civil engineering tools for evaluating the performance of dams, spillways, canals etc.				
CO3	Apply specific energy concept in various hydraulic engineering applications.				
CO4	Compiling the stability analysis of Hydraulic and Irrigation structure, ensuring the adequate factor of safety under different site conditions				
CONTENTS					
Exp.1	Site requirement and Data preparation for different Hydraulic structures				
Exp.2	Hydraulic Particular for preparation of Longitudinal section of canals				
Exp.3	Canal Design: Preparation of cross section of canals both unlined and lined.				
Exp.4	Design and detailing of Glacis fall				
Exp.5	Design of any one type of Cross Drainage Works				
Exp.6	Gravity Dam Design: Profile of the dam, Forces on Dam, Shear stress, Principal Stress on Dam				
Exp.7	Stability analysis of Gravity Dam				
Exp.8	Profile determination of Ogee type spillway				
Exp.9	Earthen Dam: Seepage Line determination				
Exp.10	Stability analysis of Earth Dam				
Test Books:					
1.	Theory and Design of Irrigation Structures by R.S. Varshney, S.C. Gupta and R.L, Gupta, Nem Chand & Bros publication				
2.	Irrigation Engineering and Hydraulic Structures S.K. Garg, Standard Book House				

Reference Books:	
1	"Irrigation Engineering and Hydraulic Structures" by Santosh Kumar Garg
2	"Design of Hydraulic Structures" by P. Novak, A.I.B Moffat, and C. Nalluri

CO-PO MAPPING

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	3	3		3	1				2		2	3	
CO2	2	3	2		3		1						3	
CO3	1	3	2		1		1		2				2	
CO4	2	3	2		3								3	

Correlation Level 1: Slight 2: Moderate 3: High

**

L- Total lectures per week

T-Theory/Tutorial perweek

P-Practical/lab sessions per week

ENVIRONMENTAL ENGINEERING LABORATORY					
CREDIT	3	Subject Code: IP3504	L-0	T-0	P-3
PREREQUISITES: Environmental Engineering					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Assess practical experience of studying environmental parameters				
CO2	Assess the quality of water and wastewater				
CO3	Assess the air quality level				
CO4	Assess the noise quality level				
CONTENT					
Exp.1	Determination of pH and turbidity of the given water.				
Exp.2	Determination of alkalinity and acidity of water and wastewater and Total Hardness of the given water and wastewater				
Exp.3	Optimum dose of coagulants by jar test				
Exp.4	Identify and quantify various solids present in the water sample				
Exp.5	Quantify the residual chlorine present in the water sample and the available chloride present in the water sample.				
Exp.6	Determine the Biochemical Oxygen Demand of the water and wastewater sample				
Exp.7	Determine the Dissolved Oxygen level of the water sample using Winkler's method.				
Exp.8	(a)Identify the Respirable Particulate Matter (PM10) concentration of the present air quality, (b) Determine the Total suspended particulate matter (TSP) present in the air sample, and (c) Indoor and ambient noise level analysis				
Exp.9	(a) Determination of SO_X in indoor air and (b) Determination of NH_3 in indoor.				
Exp.10	(a) Microbiological culture analysis of bacterial samples and (b) Perform the MPN Test for the given water sample				
TEXTBOOKS					
1.	APHA, Standard Methods for the Examination of Water and Wastewater, APHA, USA, 2001				

CO-PO-PSO MAPPING

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	3	2	3	1	1	3	3	3	1	1	3	3	3
CO2	3	3	2	3	1	1	3	3	3	1	1	3	3	3
CO3	3	3	2	3	1	1	3	3	3	1	1	3	3	3
CO4	3	3	2	3	1	1	3	3	3	1	1	3	3	3

Correlation Level 1: Slight 2: Moderate 3: High

SEVENTH SEMESTER

ADVANCE CONCRETE DESIGN					
CREDIT	3	Subject Code: IP4201	L-3	T-0	P-0
PREREQUISITES: Design of concrete structures and Structural analysis-II.					
COURSE OUTCOMES: At the end of the Course, the student will be able to					
CO1	Evaluate the deflection and crack width of reinforced concrete beams and slabs.				
CO2	Implement of IS: 13920 (2016) for ductile design and detailing of RC frames.				
CO3	Design of deep beams, corbel, and concrete shear walls.				
CO4	Design of various types of water tanks as per IS specifications.				
CONTENTS					
Module 1 (8 hours)	Behavior of reinforced concrete beams and slabs, long term & short-term deflection, Estimation of crack width.				
Module 2 (8 hours)	Ductility of reinforced structures; material ductility-steel and concrete, section ductility, member ductility, structural ductility, ductile detailing of reinforced concrete frames for seismic forces. Analysis and design of building frames subjected to wind load and Earthquake forces.				
Module 3 (8 hours)	Design of deep beams & corbel, Design of concrete shear walls.				
Module 4 (8 hours)	Design of water tanks, design requirements, design of tanks on ground, under-ground and elevated water tanks.				
Total Lecture hours- 32 hours					
Test Books:					
5.	R Park and T Paulay," Reinforced Concrete Structures", John Wiley & Sons				
6.	S Pillai, D Menon, “Reinforced Concrete Design”				
7.	P.C. Varghese, "Advanced Reinforced Concrete Design", PHI, 2nd Edition, 2002				
8.	A.K. Jain, "Reinforced Concrete: Limit State Design", Nemchand and Bros, 1999				
5.	Ramakrishna &Arthur, "Ultimate strength design for structural concrete".				

CO-PO-PSO MAPPING														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	3	2		1						2	2	1
CO2	3	2	3	2		1						2	2	1
CO3	3	2	3	2		1						2	2	1
CO4	3	2	3	2		1						2	2	1
Correlation Level 1: Slight 2: Moderate 3: High														

BRIDGE ENGINEERING					
CREDIT	3	Subject Code: IP4203	L-3	T-0	P-0
PREREQUISITES: Design of concrete structures, Prestressed concrete, Structural Analysis-II					
COURSE OUTCOMES At the end of the Course, the student will be able to					
CO1	Identify different loads and support conditions pertaining to bridges.				
CO2	Design of reinforced concrete slab culvert, box culvert.				
CO3	Design of T beams bridges and prestressed concrete bridges.				
CO4	Design balanced cantilever bridge and continuous bridge.				
CONTENTS					
Module 1 (8 hours)	Introduction and selection of type of bridges, longitudinal arrangement and economical span, bridge components, Design preliminaries: Layout, types of loads including wind and seismic loads, standard specifications for road bridges, substructures, superstructures,				
Module 2 (7 hours)	IRC provisions on loads and stresses, specification for single/double multi lane railway and road bridges, Abutments, piers and their foundations. Design of reinforced concrete slab culvert, box culvert bridge by Limit State Method following latest IS/IRC codes.				
Module 3 (7 hours)	Deck slab bridge, Tee beam and slab bridge by Limit State Method. Design of prestressed concrete bridge by Limit State Method.				
Module 4 (8 hours)	Design of balanced cantilever bridge. Design of continuous bridge, Introduction to long span bridges and segmental bridges by Limit State Method.				
Total Lecture hours- 30 hours					
Test Books:					
1	N.K.Raju, " Design of bridges", Oxford & IBH Publishing Co. pvt. ltd.				
2	D.J.Victor," Essentials of bridge engineering", Oxford &IBH Publishing Co. pvt. ltd.				
3	Indian Road Congress Codes No.5,6,18,21,24, Jamnagar House, Shah Jahan Road, New Delhi.				

Reference Books:	
1	Ponnuswamy, S., Bridge Engineering, Tata McGraw-Hill Publishing Company Limited, 1986
2	Surana, C.S. and Agarwal, R., Grillage Analogy in Bridge Deck Analysis, Narosa Publishing House Pvt. Ltd., 1998.
3	Raina, V.K., Concrete Bridge Practice "Analysis, Design and Economics, 2nd Ed., Tata McGraw-Hill Pub., 1994.
4	Hambly, E.C., Bridge Deck Behaviour, 2nd Ed., E & FN Spon (Chapman & Hall), 1991.

CO-PO-PSO MAPPING

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

Correlation Level 1: Slight 2: Moderate 3: High

PRESTRESSED CONCRETE STRUCTURES					
CREDIT	3	Subject Code: IP4205	L-3	T-0	P-0
PREREQUISITES: Design of concrete structures					
COURSE OUTCOMES At the end of the Course, the student will be able to					
CO1	Discuss the terminology, concept and principles related to prestressing systems and post tensioning systems.				
CO2	Evaluate different losses in the prestress and analyze the sections for resultant stresses.				
CO3	Analyze and design of pretensioned as well as post-tensioned concrete beams using limit state method for bending and shear.				
CO4	Explain concept of concordance of cables, anchorage zone stresses, end block anchorage and its application to bridges.				
CONTENTS (30 hours)					
Module 1 (9 hours)	Prestressing system, materials and codes: Basic concept, Losses of prestress, analysis of prestress and bending stresses. Need for high strength steel and concrete. Advantages and applications. Pre-tensioning and post tensioning systems.				
Module 2 (9 hours)	Design of beams: Analysis and design of section for bending and shear, pressure line, concept of load balancing, cracking moment, bending of cables, limit state analysis and design, anchorage zone stresses, design of end block, Application to bridges.				
Module 3 (6 hours)	Selection of prestress concrete members, short term and long-term deflections of uncracked members.				
Module 4 (6 hours)	Flexural strength of prestressed concrete sections Continuous beams, Design concept concordance of cables, Secondary design consideration. Design pretensioned and post tensioned beam.				
Total Lecture hours- 30 hours					
Test/Reference Books:					
1	Prestressed Concrete, Raju, N.K., Tata McGraw Hill				
2	Prestressed Concrete, T. Y. Lin				
3	Prestressed Concrete, Ramamruthan				

CO-PO-PSO MAPPING														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	**3**	**3**	**3**	**2**	**2**	**1**				**1**	**1**	**1**	**3**	
CO2	**3**	**3**	**3**	**2**	**2**	**1**				**1**	**1**	**1**	**3**	
CO3	**3**	**3**	**3**	**2**	**2**	**1**				**1**	**1**	**1**	**3**	
CO4	**3**	**3**	**3**	**2**	**2**	**1**				**1**	**1**	**1**	**3**	
Correlation Level 1: Slight 2: Moderate 3: High														

FINITE ELEMENT METHODS					
CREDIT	3	Subject Code: IP4207	L-3	T-0	P-0
PREREQUISITES: Strength of Materials,Structural Analysis-I					
COURSE OUTCOMES At the end of the Course, the student will be able to					
CO1	Identify the information requirements and sources for analysis, design and evaluation of object.				
CO2	Derive element stiffness matrices of 1-D and 2-D body element.				
CO3	Apply mechanics of materials topics to provide preliminary results used for testing the reasonableness of finite element results.				
CO4	Analyze and build FEA models (i.e. displacements and stresses) of 1-D and 2-D body for various engineering problems, iso-parametric element and plate.				
CONTENTS (30 hours)					
Module 1 (9 hours)	Introduction: The Continuum, Equations of Equilibrium, Boundary Conditions, Strain displacement relations, Stress strain Relations, Plane stress and plane Strain problems, Basics of finite element method (FEM), different steps involved in FEM, Different approaches of FEM, Direct stiffness method, Energy approach, Weighted residual Method.				
Module 2 (9 hours)	One- and Two-Dimensional Problems: Detail formulation including shape functions. stress strain relations, strain displacement relations and derivation of stiffness matrices using energy approach, assembling of element matrices, boundary conditions, Numerical solution of one-dimensional problems using spring, bar, truss, beam elements and frames. Derivation of shape function using Lagrange's interpolation, Pascal's triangle, Convergence criteria.				
Module 3 (6 hours)	Finite Element modeling of two-dimensional problems using Constant strain Triangle (CST) elements, Stress strain relations for isotropic and orthotropic materials, four nodded rectangular elements, axisymmetric solids subjected to axisymmetric loading.				
Module 4 (6 hours)	Isoperimetric Elements: Natural coordinates, isoperimetric elements, four node, eight node elements. Numerical integration, order of integration.				
Total Lecture hours- 30 hours					
Test/Reference Books:					
1	C. S. Krishnamoorthy, Finite Element analysis-Theory and Programming, Tata Mc Hill.				

2	R. D. Cook., Concepts and Applications of Finite Element Analysis , Wiley.
3	O. C Zienkiewicz .and R. L. Taylor, Finite Element Method, Mc Graw Hill
4	C.S. Desai and J.F. Abel, Introduction to the Finite Element Method: CBS Publishers

CO-PO-PSO MAPPING

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

Correlation Level 1: Slight 2: Moderate 3: High

EARTHQUAKE ENGINERING

CREDIT	3	Subject Code: IP4207	L-3	T-0	P-0

PREREQUISITES : Structural Dynamics

COURSE OUTCOMES
At the end of the Course, the student will be able to

CO1	Summarize the fundamentals on earthquake engineering and seismicity conditions.
CO2	Analyze the earthquake characteristics and associated effects on structures.
CO3	Perform dynamic analysis on Structures.
CO4	Apply the basic principles of seismic design and construction of structures in accordance with the Indian standard code.

CONTENT

Module 1 (8 hours)	Introduction on Seismology, Internal structure of earth, Strong motion and estimation of Seismic Hazards, Continental drift and plate tectonics, elastic rebound theory, and Types of seismic Waves
Module 2 (9 hours)	Dynamic earthquake analysis, Earthquake load analysis of structure (Linear and Non-linear), Analysis of structure by linear static method (Seismic Co-efficient Method) and linear dynamic method (Response Spectrum Method), Equation of motion for SDOF system, Response analysis for Multi Support Earthquake excitation
Module 3 (6 hours)	Seismic Soil-Structure interaction, Terminology used in SSI, Damping in Soil, Basement topography.
Module 4 (7 hours)	Non-linear seismic response of structures, Base isolation for Earthquake resistant design, Conventional Seismic design approach.

Total Lecture hours- 30 hours

TEXTBOOKS

1.	Earthquake resistant design of structures by Pankaj Agarwal and Manish Shrikande. PHI India.
2.	Earthquake resistant design of structures by S.K. Duggal , Oxford University Press.

3.	Seismic analysis of structure by T.K. Datta, John Wiley & Sons Pvt. Ltd
REFERENCES	
1.	Structural Dynamics for structure by Hart G.C. & Wong K., John Wiley & Sons Pvt. Ltd
2.	Dynamic Soil –Structure Interaction by Wolf J.P. , Prentice Hall, Englandwood Cliffs, New jersy.

CO-PO-PSO MAPPING

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

Correlation Level 1: Slight 2: Moderate 3: High

STRUCTURAL DYNAMICS					
CREDIT	3	Subject Code: IP4211	L-3	T-0	P-0
PREREQUISITES: Engineering Mechanics					
COURSE OUTCOMES At the end of the Course, the student will be able to					
CO1	Summarize the basic of dynamic loading and response and formulate dynamic equations of equilibrium of structural systems.				
CO2	Familiarize with the free vibration analysis of SDOF and MDOF				
CO3	Differentiate free and forced vibration analysis of linear system.				
CO4	Analyze structural response on earthquake resistant structures.				
CONTENT					
Module 1 (8 hours)	Source of vibrations, types of excitations, Equation of motion, Spring action and damping, Degrees of freedom, Single degree of freedom systems, Free vibrations of undamped and viscosity damped systems, Coulomb damping, Response of viscously damped SDOF systems to harmonic excitation, Modal analysis				
Module 2 (8 hours)	Vibration isolation Principle of vibration measuring instrument, Equivalent viscous damping and structural damping Response of undamped system of rectangular, triangular and ramp loading, Duhamel integral method, response spectra.				
Module 3 (8 hours)	Multi degree of freedom system, Vibration undamped 2 DOF systems, Vibration absorber, Rayleigh-Ritz method. Introduction to free and forced vibration of continuous system				
Module 4 (6 hours)	Analysis of structural response to Earthquake, Seismology background, Deterministic analysis of earthquake, concept of random vibration.				
Total Lecture hours- 30 hours					
TEXTBOOKS					
1.	Dynamic of Structure by A.K. Chopra, Prentice Hall , 3rd Edition				
2.	Structural Dynamics by Mario Paz, CBS Publication, New Delh				
REFERENCES					
1.	Theory of vibrations with application by W.T. Thomson., CBS publication.				
2.	Structural dynamics by Craig, Jr R.R., Wiley publication.				
3	Dynamics of Structures by Clough R.W., McGraw Hill Publication				

4	Earthquake Engineering by V.K. Sood, Wiley Publication

CO-PO-PSO MAPPING

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

Correlation Level 1: Slight 2: Moderate 3: High

REMOTE SENSING AND GIS (ACC)					
CREDIT	3	Subject Code: IP4101	L-3	T-0	P-0
PREREQUISITES : Surveying and Geomatics					
COURSE OUTCOMES At the end of the Course, the student will be able to					
CO1	Understand the scope of Remote Sensing and GIS.				
CO2	Identify and explain the characteristics of satellite systems and data acquisition platforms.				
CO3	Apply image interpretation and digital image processing techniques including preprocessing, enhancement, and classification (supervised and unsupervised).				
CO4	Comprehend the architecture, components, and functions of GIS, including spatial data models, map projections, and data analysis processes.				
CONTENT					
Module 1 (6 hours)	Basic Concepts of Remote sensing: Definition, Principle of remote sensing, Electromagnetic spectrum, interaction of EMR, Spectral reflectance curve. Data: acquisition platforms, products, Data analysis: Visualization, interpretation, image classification.				
Module 2 (8 hours)	Satellite characteristics-Orbits, Swath, Nadir, Pixel size, Sensor resolutions-Spatial, Spectral, Radiometric and Temporal. Indian Satellites and other purpose driven satellites, Data products. Image interpretation, Image processing techniques, Optical and infra-red Remote sensing, Thermal remote sensing, Microwave remote sensing, Hyperspectral remote sensing.				
Module 3 (7 hours)	Basics of Radar, Digital image processing system, Pre-processing of raw data, Image enhancement, Transformation, Supervised and un-supervised Classification, Accuracy assessment, Data Integration, analysis and interpretation.				
Module 4 (9 hours)	Introduction to GIS: Definition and terminologies, GIS architecture, components of GIS, Advantages and disadvantages of GIS. Data acquisition- raster and vector data, Registration and relating different data, Spatial analysis, Data integration, Data modeling, Data models, Data structures, Measurement of length, perimeter and area, management, Database models, Geospatial analysis				

	Maps: types, scale, symbol, characteristic, use. Coordinate systems: definition, types. Map Projection: definition, types
Total Lecture hours- 30 hours	
TEXTBOOKS	
1.	Remote Sensing and GIS by Basudeb Bhatta, Oxford; Second edition
2.	Introduction to Geographic Information System by Kang-Tsung-Chang, McGraw-Hill Higher Education, 4th edition.
3.	Swain P.H., and S.M. Davis, "Remote Sensing – The Quantitative Approach", McGraw Hill Publishing Company, N York.
REFERENCES	
1.	Lillesand T.M. and Kiefer R.W., "Remote Sensing and Image Interpretation", John Wiley and Sons, N York.
2.	Meijerink A. M. J., H. A. M. de Brouwer, C. M. Mannaerts and C. R. Valenzuela, "Introduction to the use of Geographic Information Systems for Practical Hydrology", ITC Publication, Paris.

CO-PO-PSO MAPPING

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

Correlation Level 1: Slight 2: Moderate 3: High

List of Open Elective subjects offered by Department of Civil Engineering

GEO-ENVIRONMENTAL ENGINEERING					
CREDIT	3		L-3	T-0	P-0
PREREQUISITES: Geotechnical Engineering - I and Environmental Engineering					
COURSE OUTCOMES At the end of the Course, the student will be able to					
CO1	Analyze and be able to find various engineering properties of wastes				
CO2	Understand the soil-water interaction and design of geosynthetic for waste contamination				
CO3	Study the waste containment facilities and disposal practices				
CO4	Understandingand design of an engineering landfill				
CONTENT					
Module 1	**Scope of geo environmental engineering -:** Multiphase behavior of soil, role of soil in geo-environmental applications , importance of soil physics, soil chemistry, hydrogeology, biological process sources and type of ground contamination, impact of ground contamination on geo-environment, Soil mineralogy characterization and its significance in determining soil behavior.				
Module 2	**Soil-water interaction and concepts of double layer –** forces of interaction between soil particles. Concepts of unsaturated soil – importance of unsaturated soil in geo-environmental problems, measurement of soil suction, water retention curves. **Soil-water-contaminant interactions and its implications** – Factors effecting retention and transport of contaminants.				
Module 3	**Evolution of waste containment facilities and disposal practices** – Site selection based on environmental impact assessment, different role of soil in waste containment – different components of waste containment system and its stability issues. Site characterization, risk assessment of contaminated site, **Remediation methods**: objectives of site remediation, selection and planning of remediation methods, some examples of in-situ remediation.				
Module 4	**Landfills:** Types of landfill, site selection, waste containment liners, leachate collection system, cover system, gas collection system.				
Total Lecture hours- 30 hours					

TEXTBOOKS	
1.	Rowe R.K.,"Geotechnical and Geoenvironmental Engineering Handbook" Kluwer Academic Publications, London,2000
2.	Reddi L.N. and Inyang, H. I.,"Geoenvironmental Engineering, Principles and Applications" Marcel Dekker Inc. New York,2000.
3.	Sharma H.D. and Reddy K.R.,"Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies" John Wiley & Sons, Inc., USA, 2004
4	Mitchell, J.K.,"Fundamentals of Soil Behavior" Wiley,2005.
REFERENCES	
1.	Hillel D.,"Introduction to Soil Physics" Academic Press, New York,1982.
2.	Sparks, D.L.,"Environmental Soil Chemistry" Academic Press, New York,2002.

CO-PO-PSO MAPPING

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

Correlation Level 1: Slight 2: Moderate 3: High

INTEGRATED WASTE MANAGEMENT FOR A SMART CITY					
CREDIT	3		L-3	T-0	P-0
PREREQUISITES: Environmental Sciences, Introduction to Environmental Engineering					
COURSE OUTCOMES At the end of the Course, the student will be able to					
CO1	Classify urban solid wastes based on physical and chemical characteristics.				
CO2	Analyze MSW collection, processing, and disposal technologies.				
CO3	Interpret Indian regulations on MSW, C&D, and e-waste management.				
CO4	Evaluate integrated waste management solutions for smart cities.				
CONTENT					
Module 1 (07 hours)	**Fundamentals of Waste Management & Regulatory Framework** Introduction to Solid Waste Management: Types, sources, and challenges, Characteristics and quantification of MSW, MSW Rules 2016, Swachh Bharat Mission and Smart Cities Program.				
Module 2 (09 hours)	**Municipal Solid Waste Handling and Disposal** Collection, segregation, transportation, and processing of MSW, Landfilling: Design, operation, environmental concerns, Composting: Aerobic and anaerobic processes, Energy recovery techniques: RDF, incineration, WTE systems				
Module 3 (06 hours)	**Specialized Waste Streams – C&D and E-Waste** Overview of C&D waste: Composition and challenges, C&D Waste Management Rules, Beneficial reuse: Recycled aggregates, materials, E-Waste: Sources, global and Indian scenarios, E-Waste Management Rules 2016 and implementation barriers				
Module 4 (08 hours)	**Integrated Approaches and Smart City Case Studies** Current issues and challenges in SWM, Analysis of MSWM in 20 selected smart cities, Stakeholder engagement, policy gaps, and integrated solutions, Innovative practices and sustainable urban waste systems.				
Total Lecture hours- 30 hours					
TEXTBOOKS					
1.	George Tchobanoglous, Hilary Theisen and Samuel A Vigil, Integrated Solid Waste management, Tata McGraw Hill				
2.	William A Worrell and P. Aarne Veslind, Solid Waste Engineering, 2nd Edition (SI Edition) Cengage Learning, 2012 (ISBN-13: 978-1-4390-6217-3)				
REFERENCES					

1.	Manual on Solid Waste Management, prepared by The Central Public Health and Environmental Engineering Organization(CPHEEO), India
2.	MSW Management Rules 2016, Govt. of India, available online at CPCB website.
3.	Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website

CO-PO-PSO MAPPING

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

Correlation Level 1: Slight 2: Moderate 3: High

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ADVANCED NUMERICAL METHODS					
CREDIT	3		L-3	T-0	P-0
PREREQUISITES: Engineering Mathematics					
COURSE OUTCOMES At the end of the Course, the student will be able to					
CO1	Familiarize with finite precision computation, numerical solutions of nonlinear equations in a single variable.				
CO2	Develop and understanding of numerical interpolation and approximation of functions, numerical integration and differentiation.				
CO3	Understand numerical solution of ordinary differential equations.				
CO4	Familiarize with calculation and interpretation of errors in numerical methods.				
CONTENT					
Module 1 (12 hours)	**Introduction:** Introduction to numerical methods and analysis and computer programming; **Error Analysis:** Approximations; Round off and Truncation errors; Error Analysis. **Roots of Equations (single variable):** Method of Bisection, Regular Falsi, Secant Method, Fixed point Method, Newton Raphson method, Multiple roots. Analysis and order of convergence. **Polynomials:** Mueller's method, Bairstow's method. **Solution of Linear System of Equations:** Dense, Sparse and Banded systems, Direct Methods -Gauss Elimination, Gauss-Jordan, LU decomposition, Thomas Algorithm. Condition number of matrix, effect of round-off errors. Iterative improvement of solution by direct methods. **Iterative methods:** Jacobi and Gauss Seidel iteration, rate of convergence of iterative methods. Successive over Relaxation. **Solution of Nonlinear System of Equations:** Iterative methods, Fixed Point iteration, Newton-Raphson method.				

Module 2 (10 hours)	**Approximation Theory:** Approximation of Continuous functions -basis functions, norms and semi-norms, inner product, formulation of least square problem, derivation of normal equations, orthogonal basis functions. Tchebycheff and Legendre polynomials. **Interpolating polynomials:** Newton's divided difference polynomial, Lagrange polynomials. **Interpolation using spline functions:** linear, quadratic and cubic splines. Polynomial regression of discrete data. Transformation of nonlinear problems to linear approximation problems. **Eigenvalues and Eigenvectors:** Power method, inverse power method. Fadeev-Leverrier method for formulation of the Characteristic polynomials, QR decomposition.
Module 3 (12 hours)	**Numerical Differentiation:** Introduction to finite difference approximations, truncation error analysis. Finite difference approximations on irregular grid. Richardson's extrapolation. **Numerical Integration:** Rectangular rule, Trapezoidal Rule and Simpson's rule. Local and global error analysis. Romberg Integartion. Gauss Quardrature, Improper Integrals. ODE, **Initial Value Problems:** Euler's method, improvement of Euler's method, Runge -Kutta Methods, Multi Steps Methods. Predictor Corrector Methods. ODE, **Boundary Value Problems:** Decomposition into Linear System of ODEs, Shooting Method, Direct Method. **Partial Differential Equations:** Elliptic, Parabolic and Hyperbolic Equations, Explicit and Implicit Methods, Crank Nicholson Method.
Total Lecture hours- 30 hours	
TEXTBOOKS	
1.	Jain M.K, SRK Iyenge and RK Jain, "Numerical Methods for Scientific &Engg. Computation".
2.	Mathews J. H "Numerical Methods for Mathematics, Science and Engineering".
REFERENCES	
1.	Gerald C.F and PO Wheatley "Applied Numerical Analysis".
2.	Rajeshwaran S, "Numerical Methods in Science & Engineering (A Practical App Publication.
3.	Gupta S.C and V. K. Kapoor "Fundamentals of Applied Statistic", Sultan Chand

CO-PO-PSO MAPPING														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2							2			2		
CO2	3	3	2	2	3						1			1
CO3	3	3	2	3				1		2			2	
CO4	2	3	3	1	3				2					
Correlation Level 1: Slight 2: Moderate 3: High														

DISASTER MANAGEMENT AND MITIGATION					
CREDIT	3		L-3	T-0	P-0
PREREQUISITES:					
COURSE OUTCOMES At the end of the Course, the student will be able to					
CO1	Affirm the usefulness of integrating management principles in disaster mitigation work.				
CO2	Distinguish between the different approaches needed to manage pre- during and post-disaster periods.				
CO3	Explain the process of risk management.				
CO4	Relate to risk transfer.				
CONTENT					
Module 1 (12 hours)	Introduction: Concepts and definitions: Disaster, hazard, vulnerability, resilience, risks, frequency and details, capacity, impact, prevention, mitigation. **Disasters classification;** natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility. **Disaster Impacts:** Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability, etc. Dos and Don'ts during various types of Disasters.				
Module 2 (10 hours)	**Disaster Risk Reduction (DRR):** Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment. Emerging approaches in Disaster Management - Three stages: Pre-disaster stage (preparedness), Emergency stage and Post Disaster stage – Rehabilitation. Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.				

Module 3 (12 hours)	**Environment and Development:** Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land use changes, urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods. **Disaster management:** Applications and case studies - Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.
Total Lecture hours- 30 hours	

TEXTBOOKS

1.	Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2017.
2.	Pradeep Sahni, "Disaster Mitigation: Experiences and Reflections", Prentice Hall, 2004.
3.	Singhal J.P. "Disaster Management", Laxmi Publications, 2010.
4	Govt. of India: Disaster Management Act, Government of India, New Delhi, 2007

REFERENCES

1.	Donald Hyndman & David Hyndman, "Natural Hazards; Disasters", Cengage Learning, 2010.
2.	Singh B.K., Handbook of Disaster Management: Techniques & Guidelines, Rajat Publi

CO-PO MAPPING

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	1	2	2	2	2	3	3	3	3	3	1	1	1	3
CO2	1	2	2	2	2	3	3	3	3	3	1	1	1	3
CO3	1	2	2	2	2	3	3	3	3	3	1	1	1	3
CO4	1	2	2	2	2	3	3	3	3	3	1	1	1	3

Correlation Level 1: Slight 2: Moderate 3: High

SUSTAINABLE MATERIALS AND GREEN BUILDINGS					
CREDIT	3		L-3	T-0	P-0
PREREQUISITES: Physics, Mathematics, Building Materials					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Explain fundamental concepts of sustainable engineering and the principles of sustainable material choices in civil engineering.				
CO2	Apply principles of sustainable engineering to assess impacts during the pre-building, building, and post-building phases, focusing on aspects like waste reduction, energy efficiency, and use of non-toxic materials.				
CO3	Analyze the impact of building design, construction, and maintenance on the environment and natural resources, and compare different approaches for achieving energy efficiency in buildings.				
CO4	Evaluate the sustainability performance of buildings using criteria like the LEED india rating system and assess the life cycle costing of building components, considering both economic and environmental impacts.				
CONTENT					
Module 1 (10 hours)	Introduction, Embodied energy, Operational energy in Building and Life cycle energy. Ecological foot print, Bio-capacity and calculation of planet equivalent. Principles of Sustainable Engineering.Role of Material: Carbon from Cement, alternative cements and cementitious material, Alternative fuel for cements for reduction in carbon emission. Sustainability issues for concrete. Role of quality, minimization of natural resource utilization, High volume fly ash concrete, geo-polymer concrete. Understanding water cycle, Water conservation and protection technologies, Water treatment systems and assessment of water management technologies.				
Module 2 (8 hours)	Pre-Building Phase, Impact on society regarding Waste Reduction, Pollution Prevention, Recycled Content, and Embodied Energy Reduction, Building Phase, Impact on Reduction in Construction Waste, Energy Efficiency, Water Treatment/Conservation, Use of Non-Toxic or Less-Toxic Materials, Renewable Energy Systems, and Longer Life, Post-Building Phase, Impact on Disposal-Reusability, Recyclability, and Biodegradability.				
Module 3 (6 hours)	Definition of Green Building. Impact of design, construction & maintenance of buildings on our environment and natural resources. Benefits of building green. Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency.				
Module 4 (8 hours)	Typical Energy Saving Approach in Buildings, LEED India Rating System and Energy Efficiency, Radiation budget, Surface water balance, Effects of trees and microclimatic modification through greening, Life cycle costing of the building and components including the economic & environmental impact and performance.				

Total Lecture hours- 30 hours	
TEXTBOOKS	
1.	David T. Allen, and David Shonnard, Sustainable Engineering: Concepts, Design and Case Studies, Pearson Education
2.	Bhavik R. Bakshi, Sustainable Engineering: Principles and Practice, Cambridge University Press
3.	HarharaIyer G, Green Building Fundamentals, Notion Press
REFERENCES	
1.	Dr. Adv. HarshulSavla, Green Building: Principles & Practices
2.	Joanne Kauffman and Kun-Mo Lee, Handbook of Sustainable Engineering, Springer
3.	Catherine Mulligan, Sustainable Engineering: Principles and Implementation, CRC Press

CO-PO MAPPING

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	2	3	1	1	1	2	3	2		2	1	2	2	1
CO2	3	3	2	3	2	3	3	3	1	2	2	2	3	2
CO3	3	3	2	3	2	3	3	3	1	2	3	2	3	2
CO4	3	3	3	3	3	3	3	3	2	3	3	2	3	3

Correlation Level 1: Slight 2: Moderate 3: High

PROJECT MANAGEMENT					
CREDIT	3		L-3	T-0	P-0
PREREQUISITES: Mathematics					
COURSE OUTCOMES At the end of the course a student will be able to					
CO1	Interpret the concepts of Project Management for planning of any projects.				
CO2	Identify the risk and propose techniques to reduce the risk of the project.				
CO3	Integrate project management techniques like bar charts, CPM, and PERT for effective scheduling and control				
CO4	Optimize the cost, time and resources of a project using management techniques.				
CONTENTS					
Module 1 (7 hours)	**Basics of Project Management:** Introduction, Need for Project Management, Project Management Knowledge Areas and Processes, The Project Life Cycle, The Project Manager (PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions, **Project Identification and Selection:** Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies. **Project Planning:** Introduction, Project Planning, Need of Project Planning, Roles and Responsibility project leader, Project Planning Process, Work Breakdown Structure (WBS), Concept of Organisational Structure (OBS), LOB.				
Module 2 (7 hours)	**PERT and CPM:** Introduction, Development of Project Network, Time Estimation, Determination of the Critical Path, Floats and types, Time- Cost trade off, Direct and Indirect cost, Cost slope, Crashing of project time, PERT Model, Time estimates, Slack and types, Critical path, Probability of Completion Time for a project. **Project Resource leveling:** Introduction, Resource Allocation, Resource Smoothening and Leveling, Project Cost Estimate and Budgets, Cost Forecasts				
Module 3 (8 hours)	**Project Performance Measurement and Evaluation:** Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation. **Project Execution and Control:** Introduction, Project Execution, Project Control Process, Purpose of Project Execution and Control, Project Close-out, Termination and Follow-up: Introduction, Project Close-out, Steps for Closing the Project.				
Module 4 (8 hours)	**Project Risk Management:**Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks **Project Management Software:** Introduction, Advantages of Using Project Management Software, Common Features Available In Most of the Project Management Software				
Total Lecture hours- 30 hours					

Test Books:	
5.	Jha Kumar Neeraj, Construction Project management Theory and Practice, Pearson- 2011
6.	Nagarajan K., Project Management, New Age International Publishers, Sixth Edition 2011
7.	Shrivastava U. K., Construction, Planning and Management, Galgotia Publication, -2012
8.	Sengupta&Guha, Construction, Planning and Management, Tata McGraw Hill, ND 1995
Reference Books:	
1	Chitkara K.K, Construction Project Management Planning, Scheduling and Control, Tata McGraw Hill Publishing Co New Delhi ,1998
2	Moder. J., Project Management with CPM, PERT and Precedence Diagramming,VanNorstrant Reinhold Co.
3	Peurifoy R.L., Construction, Planning, Equipments and Methods, McGraw Hill -2010
4	Gahlot&Dhir, Construction, Planning and Management, New Age Publisher- 2010

CO-PO-PSO MAPPING

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	3	3		1					1				2	1
CO2	3	3		1					1				2	1
CO3	2	3	3	1	2								2	1
CO4	2	2	3		2	2	3		2			1	2	1

Correlation Level 1: Slight 2: Moderate 3: High