Jharkhand University of Technology, Ranchi
NEP-2020 based Syllabus w.e.f – 2025-26 Batch
B.Tech in Civil Engineering

Semester-Vth

S.No.	Course Code	Course Title	L	T	P	J	Cr	FM	Overall Pass Marks	Internal	External	Categorization
			Contact Hours per week									
		PROGRAMME CORE COURSES (PCC)										
01	CIVC501	PCC-I (Design of Concrete Structures)	3	1	0		4	100	35	30	70	
02	CIVC502	PCC-II (Environmental Engineering)	3	1	0		4	100	35	30	70	
		***PROGRAMME ELECTIVES I & II**										
03	CIVPEI501, CIVPEI502, CIVPEI503, CIVPEI504, CIVPEI505, CIVPEI506, CIVPEI507, CIVPEI508, CIVPEI509, CIVPEI510	PE-I (Any One From The Given Basket Of PE-I)	3	0	0		3	100	35	30	70	
04	CIVPEII501, CIVPEII502, CIVPEII503, CIVPEII504, CIVPEII505, CIVPEII506, CIVPEII507, CIVPEII508, CIVPEII509, CIVPEII510	PE-II (Any One From The Given Basket Of PE-II)	3	0	0	6	3	100	35	30	70	
05	COM501	Entrepreneurship Management	2	1	0		3	100	35	30	70	
Total			**14**	**3**			**17**	**500**	**--**	**--**	**--**	
Practical			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
06	COMP501	Seminar & Report Writing –I (UN Sustainable Development Goals)	0	0	3		1	50	25	30	20	

07	COMP502	Business Communications	0	1	2		2	50	25	30	20	
08	CIVP501	**Lab-I** (Environmental Lab)	0	0	3		1	50	25	30	20	
09	CIVP502	**Lab-II** (Computation, Design & Detailing- R C Structures)	0	0	3		1	50	25	30	20	
Total			**0**	**1**	**11**		**5**	**200**	--	--	--	
Audit Course			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
10	AUC501, AUC502, AUC503, AUC504	**REGIONAL LANGUAGE (ANY ONE THROUGH NPTEL/SWAYAM)** 1. MARATHI 2. KANNAD 3. TAMIL 4. TELUGU					-	100	35	30	70	
							Students will complete this Audit Paper of 12 weeks duration from NPTEL/SWAYAM. It is mandatory to pass this paper in order to pass this semester. Students may register on NPTEL/SWAYAM at any time from 1st to 5th semester also but the passing marks and credits will be reflected only in the 5th semester. The passing marks and certificate shall be forwarded by the institute to Controller of Examination (CoE), JUT, Ranchi timely.				
11	AUC505	Sports/NCC/NSS/YOGA/Painting/Music/ Classical Dance	6				-	50	25	30	20	
							Students shall participate actively in one of the activities and for Passing of the semester "Participation Certificate" in activity will be mandatory student participation shall be monitored and participation record shall be maintained at institute level. The marks obtained shall be forwarded to controller of Examination (CoE), JUT, Ranchi timely.					
Total			**6**				**-**	**150**				
Grand Total			**14**	**4**	**11**		**22**	**850**				

Professional Elective-I

S. No.	Course Code	Subject
01	CIVPEI501	Surface Hydrology
02	CIVPEI502	Groundwater Engineering
03	CIVPEI503	Design Of Hydraulic Structures And Irrigation Engineering
04	CIVPEI504	Advance Hydraulic Engineering And Design

Professional Elective-II

S. No.	Course Code	Subject
01	CIVPEII501	Rock Engineering
02	CIVPEII502	Land and Water Management
03	CIVPEII503	Highway Safety
04	CIVPEII504	Design of Bridges

05	CIVPEI505	Earthquake Resistant Design		**05**	CIVPEII505	Low Carbon Materials and Green Buildings
06	CIVPEI506	Ground Improvement Techniques		**06**	CIVPEII506	Building Information Modelling
07	CIVPEI507	Pavement Forensics and Rehabilitation		**07**	CIVPEII507	Air Pollution
08	CIVPEI508	Conservation of Heritage Structures		**08**	CIVPEII508	Travel Demand Analysis
09	CIVPEI509	Ground Water Hydrology		**09**	CIVPEII509	Systems Analysis in Civil Engineering
10	CIVPEI510	Water Resources Systems Planning and Design		**10**	CIVPEII510	GIS for Civil Engineering Applications

Abbreviations: - AU-Audit Course; L: Lecture, T: Tutorial, P: Practice.
J-Self learning hours shall not be reflected in the Time table. Self-learning includes micro projects/assignments/other activities as mentioned in earlier semesters.
***Passing in the Audit Course shall be mandatory.**
Note:- Students may choose their two Professional Electives (PE-1 & PE-II) from NPTEL/SWAYAM also on the approval of departmental academic council if that subject is not mentioned in the above basket.
Students will complete the Elective Papers (Professional) of 12 weeks duration from NPTEL/SWAYAM. Student may register on NPTEL/SWAYAM at any time from 1st to 5th semester also but the passing marks and credits will be reflected only in the 5th semester.
The secured percentage of marks and passing certificate of the subject shall be forwarded by the institute to Controller of Examination (CoE), JUT, Ranchi timely.
The institute will inform University Examination Session about selection of PE-1 and PE-2 subjects by the students also before 1" mid-semester examination of that semester.

Semester- VIth

S.No.	Course Code	Course Title	L	T	P	J	Cr	FM	Overall Pass Marks	Internal	External	Categorization
			Contact Hours per week									
		PROGRAMME CORE COURSES (PCC)										
01	CIVC601	PCC-I (Design of Steel Structural Elements)	3	1	0		4	100	35	30	70	
02	CIVC602	PCC-II (Construction Technology & Project Management)	3	1	0		4	100	35	30	70	
		PROGRAMME ELECTIVES III & IV										
03	CIVPEIII601, CIVPEIII602, CIVPEIII603, CIVPEIII604, CIVPEIII605, CIVPEIII606, CIVPEIII607, CIVPEIII608, CIVPEIII609, CIVPEIII610	PE-III (Any One From The Given Basket of PE-III)	3	0	0		3	100	35	30	70	
04	CIVPEIV601, CIVPEIV602, CIVPEIV603, CIVPEIV604, CIVPEIV605, CIVPEIV606, CIVPEIV607, CIVPEIV608, CIVPEIV609, CIVPEIV610	PE-IV (Any One From The Given Basket of PE-IV)	3	0	0		3	100	35	30	70	
		OPEN ELECTIVE-I										
05	CIVOEI601, CIVOEI602, CIVOEI603, CIVOEI604, CIVOEI605, CIVOEI606, CIVOEI607, CIVOEI608, CIVOEI609, CIVOEI610,	OE-I (Any one From The Given Basket of OE-I)	3	0	0	6	3	100	35	30	70	

	CIVOEI611, CIVOEI612, CIVOEI613, CIVOEI614, CIVOEI615, CIVOEI616, CIVOEI617, CIVOEI618, CIVOEI619, CIVOEI620											
Total			**15**	**2**	**0**		**17**	**500**	--	--	--	
Practical			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
06	CIVP601	**Lab-I** (Civil Engineering Software Lab)	0	0	3		1	50	25	30	20	
07	CIVP602	**Lab-II** (Computation, Design & Detailing- Steel Structures)	0	0	3		1	50	25	30	20	
08	CIVP603	**Lab-III** (Practices, Estimation & Costing)	0	0	3		1	50	25	30	20	
Total			**0**	**0**	**9**		**3**	**150**	--	--	--	
Audit Course			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
09	AUC601, AUC602, AUC603, AUC604, AUC605, AUC606, AUC607	**FOREIGN LANGUAGE (ANY ONE THROUGH NPTEL / SWAYAM)** 1. GERMAN 2. JAPANESE 3. CHINESE 4. KOREAN 5. SPAINISH 6. RUSSIAN 7. FRENCH					-	100	35	30	70	
							Student will complete this Audit Paper of 12 weeks duration from NPTEL/SWAYAM. It is mandatory to pass this paper in order to pass this semester. Students may register on NPTEL/SWAYAM at any time from 1st to 6th semester also but the passing marks and credits will be reflected only in the 6th semester. The passing marks and certificate shall be forwarded by the institute to Controller of Examination (CoE), JUT, Ranchi timely.				
10	AUC608	Sports/NCC/NSS/YOGA/Painting/Music/ Classical Dance					--	50	25	30	20	
							Students shall participate actively in one of the activities and for Passing of the semester "Participation Certificate" in activity will be mandatory student participation shall be monitored and participation record shall be maintained at institute level. The marks obtained shall be forwarded to controller of Examination (CoE), JUT, Ranchi timely.					
Internship			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
11	INT601	Industrial Internship	**08 weeks**				**2**	**50**	**25**	**30**	**20**	
Minor Project (For Exit Option)			**12 weeks**				**4**	**100**	**50**	**60**	**40**	

Total	**--**	**--**	**--**		**2**	**200**	**--**	**--**	**--**	
Grand Total	**15**	**2**	**9**		**22**	**850**	**--**	**--**	**--**	

Professional Elective- III

S. No.	Course Code	Subject
01	CIVPEIII601	Groundwater Hydrology
02	CIVPEIII602	Applied Hydraulics Engineering
03	CIVPEIII603	Simulation Modelling for Water Resources Engineering
04	CIVPEIII604	Coastal Engineering
05	CIVPEIII605	AI /ML for water Resources Engineering
06	CIVPEIII606	Hydro-climatology
07	CIVPEIII607	River Engineering
08	CIVPEIII608	Watershed Management
09	CIVPEIII609	Water Resources Systems Planning
10	CIVPEIII610	Life Cycle Analysis

Professional Elective- IV

S. No.	Course Code	Subject
01	CIVPEIV601	Concrete Technology
02	CIVPEIV602	Repair and Rehabilitation of Structures
03	CIVPEIV603	Introduction to Architectural Science
04	CIVPEIV604	Sustainable Design of Buildings
05	CIVPEIV605	Construction Economics and Finance
06	CIVPEIV606	Safety for Professionals
07	CIVPEIV607	Building Information Modelling
08	CIVPEIV608	Construction Equipment and Techniques
09	CIVPEIV609	Water Resources Systems Planning and Design
10	CIVPEIV610	Traffic Engineering and Management

Open Elective I

S. No.	Course Code	Subject	S. No.	Course Code	Subject
01	CIVOEI601	Remote Sensing and GIS	**11**	CIVOEI611	Disaster Resistant Structures
02	CIVOEI602	Ocean Energy	**12**	CIVOEI612	Smart City and Infrastructure
03	CIVOEI603	Urban and Regional Planning	**13**	CIVOEI613	Real Estate Management
04	CIVOEI604	Experimental Stress Analysis	**14**	CIVOEI614	Project Management
05	CIVOEI605	Sustainable Infrastructure	**15**	CIVOEI615	Environmental Impact Assessment
06	CIVOEI606	Disaster Modelling and Management	**16**	CIVOEI616	Municipal Solid Waste Management

07	CIVOEI607	Standardization and Conformity Assessment	**17**	CIVOEI617	Disaster Mitigation and Management
08	CIVOEI608	Computational Fluid dynamics	**18**	CIVOEI618	Water Pollution and its Management
09	CIVOEI609	Hydroinformatics	**19**	CIVOEI619	Global Warming and Climate Change
10	CIVOEI610	Uncertainty Modeling, Analysis And Quantification	**20**	CIVOEI620	Indoor and Ambient Air Quality Management

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***Passing in the Audit Course shall be mandatory.**
Note:- Students may choose their two Professional Electives (PE-II1 & PE-IV) & Open Elective-I from NPTEL/SWAYAM also on the approval of departmental academic council if that subject is not mentioned in the above basket.
Students will complete the Elective Papers (Professional or Open) of 12 weeks duration from NPTEL/SWAYAM. Student may register on NPTEL/SWAYAM at any time between 1st to 6th semester but the passing marks and credits will be reflected only in the 6th semester.
The secured percentage of marks and passing certificate of the subject shall be forwarded by the institute to Controller of Examination (CoE), JUT, Ranchi timely.
The institute will inform University Examination Session about selection of PE and OE subjects by the students also before 1" mid-semester examination of that semester.

Jharkhand University of Technology, Ranchi

B.Tech.

Civil Engineering

NEP-2020 based Syllabus w.e.f – 2025-26 Batch

Semester- Vth

PCC I (Design of Concrete Structures)

Course Code **L:T:P-3:0:0**

Rationale-

Course Outcomes

CO1 Design Reinforced Concrete beams using limit state and working stress methods

CO2 Design Reinforced Concrete slabs

CO3 Design Reinforced Concrete columns and footings

CO4 Design structures for serviceability

CO5 Design stair cases, canopy, retaining wall and water tanks

Course Content:

Unit: 1

Introduction: Review of Concrete making materials- Structural concrete- Grades- properties of Concrete- Modulus of elasticity-flexural strength-Characteristic and Design values-Partial safety factor. Methods of design: Aims of design- RCC- Limit State method- Assumptions- Stress-Strain behavior of Steel and Concrete- Stress block parameters- Working stress method-comparison of design process.Analysis and Design of Singly Reinforced Beams: Analysis of Singly Reinforced RC Section- Neutral axis-Balanced-Under Reinforced-Over Reinforced Sections- Moment of Resistance- Design parameters- Design examples.

Unit: 2

Analysis and Design of Doubly Reinforced Beams: Necessity of Doubly Reinforced sections-Analysis of Doubly Reinforced RC Section-Moment of Resistance- Design parameters-Design.Shear and Bond design of RCC: Shear forces in RC-Shear Resistance of RC- Truss analogy- design of Vertical stirrups-Bent-up bars- Limitation- Bond failure in RC- Check for bond resistance Development length-Design for shear and bond. Analysis and Design of Flanged Beams: Analysis of flanged RC section- Singly and Doubly reinforced-Effective flange width-Moment of Resistance- design examples.

Design of RCC Slabs: Concept of yield line theory - Design of One and Two way slabs- Effect of edge conditions- Moment of resistance-Torsion reinforcement at corners- Design examples.

Unit: 3

Design of Continuous Slab and Beams: Effect of continuity- analysis of continuous beam/slab- Moment and shear coefficients for continuous beam/slab- Critical sections. Design of RC Columns: Design principles of RC columns- Assumptions- Rectangular and Circular columns- Helical reinforcement- Minimum eccentricity-Use of Interaction diagrams for Axial load and Moment. Design of RC Footings: RC footings-Minimum depth of footing- Safe bearing capacity- Design for Bending-Shear in One way and Shear in Two way- Transfer of load at base of column.

Unit 4

Design for Serviceability: Concept of Serviceability- Deflection- Span to depth ratio- Short term-Long term deflection due to Shrinkage, Creep- Cracking-Crack width calculation. Design of Miscellaneous RC Structures: Design of Stair case – Design of Canopy Slab and Beam –Design of cantilever Retaining walls- Design of RC Circular Water tank- Design of single story RC Building.

Learning Resources:

Text Books:

1. B. C. Punmia, Ashok. K. Jain and Arun. K. Jain, Limit State Design of Reinforced Concrete Structures, Laxmi Pub. Pvt Ltd, 2016.
2. N. Krishnaraju, Design Of Reinforced Concrete Structures, IS:456-2000, CBS Publications, 2019, 4th Edition.

Reference Books:

1. Devdas Menon and S. Pillai, Reinforced Concrete Design, Tata McGraw Hill Pub., 2017, 3rd Edition.
2. R. Park and T. Paulay, Reinforced Cement Concrete Structures, MISL-WILEY Series, Wiley India Pvt. Ltd, 2009.

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105105/

PCC (Environmental Engineering)

Course Code **L:T:P-3:0:0**

Rationale-

Course Outcomes

CO-1 Plan and design water treatment units

CO-2 Design components of water distribution systems

CO-3 Design conveyance elements of wastewater collection systems

CO-4 Plan and design components of wastewater treatment systems

CO-5 Design sludge treatment and disposal systems

Course Content:

Unit: 1

Water Pollution: Sources, types of pollutants and their effects, water quality issues, contaminant transport, self-purification capacity of streams and water bodies, water quality standards, principles of water and wastewater treatment. Surface sources, subsurface sources, physical, chemical and biological characteristics, Estimation of water demand, water consumption rate, fluctuations in rate of demand, design period. Physical, chemical and biological characteristics of wastewater, analysis of wastewater, Importance of BOD and COD, Effluent standards, impacts of disposal Collection and Conveyance of Water: Intakes, types of Intakes, factors governing location of intakes, pumps, types of conduits, types of pipes, pipe appurtenances.

Unit:2

Water Treatment: Working principles and design of water treatment units, screening, plain sedimentation, sedimentation aided with coagulation, filtration, disinfection, water softening, miscellaneous treatments. Distribution System: Requirements of a good distribution system, methods of distribution, systems of supply of water, Distribution reservoirs, layout of distribution system, design of distribution system, analysis of pipe networks, appurtenances in distribution system, detection and prevention of wastage of water in distribution system.

Unit: 3

Sewers and sewer appurtenances: Wastewater Collection, Estimation of dry weather flow and storm water flow, Hydraulic design of sewers, Limiting velocities, effect of variation in flow of sewage on velocity of flow in sewers, types of sewers, design of storm water drains. Construction of sewers: factors affecting the selection of material for sewer construction, materials for sewers, joints in sewers, shapes of sewers, maintenance, cleaning & ventilation of sewers. Sewer appurtenances.

Unit: 4

Primary Treatment of wastewater: Preliminary & primary treatment of wastewater: screening, grit removal basins, removal of oil and grease, sedimentation, sedimentation aided with coagulation.Secondary Treatment of wastewater: Secondary treatment of Wastewater: Principles and classification of secondary treatment, activated sludge process, trickling filters, miscellaneous methods such as oxidation ditch, oxidation ponds, aerated lagoons, rotating biological contractors. Disposal of wastewater, selfpurification of streams, sewage irrigation, Treatment and disposal of sludge, On-site disposal methods

Unit: 5

Tertiary Treatment of wastewater: Tertiary wastewater treatment, necessity and principles, Industrial wastewaters and effluent treatment plants including institutional and industrial waste management.

Learning Resources:

Text Books:

1. Peavy H.S, Rowe, D.R., and Tchobanoglous, G., Environmental Engineering, McGraw Hill Education, 2017 1st Indian Edition.

2. Mackenzie L. Davis, Water and Wastewater Engineering: Design Principles and Practice, McGraw Hill Education, 2017,1st Edition.

Reference Books:

1. S.K. Garg, Environmental Engineering (Vol. I): Water supply Engineering, Khanna Publishers, 2017, 34th Edition.

2. John C. Crittenden, R. Rhodes Trussell, David W. Hand, Kerry J. Howe, George Tchobanoglous, MWH's Water Treatment: Principles and Design, John Wiley & Sons, Inc., 2012, 3rd Edition

3. Mackenzie L. Davis, Water and Wastewater Engineering: Design Principles and Practice, McGraw Hill Education, 2017, 1st Edition.

4. Terence Mcghee, Water Supply and Sewerage, McGraw-Hill Education, 1991, 6th edition.

5. Masters, G.M., Ela W. P., Introduction to Environmental Engineering and Science, Prentice Hall of India, 1994, 3rd Edition.

Other Suggested Readings:

1. http://cpheeo.gov.in/cms/manual-on-water-supply-and-treatment.php
2. https://nptel.ac.in/courses/105/104/105104102/
3. http://cpheeo.gov.in/cms/manual-on-operation--and-maintenance-of-water-supply-system 2005.php
4. http://cpheeo.gov.in/cms/manual-on-storm-water-drainage-systems---2019.php
5. https://nptel.ac.in/courses/105/105/105105201/
6. https://nptel.ac.in/courses/105/106/105106119/

PE-1 (SURFACE HYDROLOGY)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-3: Create insights into analysis and interpretation of precipitation data.

CLR-2: Address concepts related to water losses.

CLR-3: Explore the concepts of runoff and hydrograph analysis.

CLR-4: Comprehend flood estimation and to explore reservoir routing and stream flow routing.

CLR-5: Know various types of models and their processes.

Course Outcomes

CO-1: Analyze and interpret precipitation data

Co-2: Analyze various water losses

Co-3: Solve runoff estimation and hydrograph analysis

Co-4: Illustrate Flood Estimation and Analyze Reservoir And Stream Flow Routing

Co-5: Distinguish various models and their processes

Course Content:

Unit: 1

Precipitation: Hydrologic cycle – Global distribution of water – Water resources of India – Weather & Climate - Seasons in India – Distribution of rainfall in India – Precipitation – Radar measurement of rainfall – Analysis of rainfall data - Test for consistency – Mass curve – Hyetograph – DAD curve – IDF curves – Frequency analysis - Hydrologic equation – Water budget**.**

Unit:2

Water Losses: Evaporation – Dalton's law – Evaporation pans – Transpiration – Evapotranspiration – Blane Criddlemethod – Infiltration – Horton's equation – Infiltrometer – Phi index and W-index

Unit:3:

Runoff :Components of stream flow – Catchment characteristics – Classification of streams – Factors affecting runoff – Runoff estimation – Hydrograph components – Baseflow separation

– Unit hydrograph – S-curve – Synthetic unit hydrograph – Snyder's method

Unit:4:

Floods & Flood Routing : Floods – Types – Rational method – Empirical formulae – Flood frequency studies - California method and Weibull method - Encounter probability: Probability of exceedance and Probability of non-exceedance – Flood routing – Reservoir routing – ISD method & Modified Pul's method – Stream flow routing – Prism storage & Wedge storage - Muskingum method – Flood forecasting and warning.

Unit:5 :

Systems & Models: System concept in hydrology – Types of models – Watershed – System concept – Types of watershed models – Artificial Neural Network - Network training algorithm – Back propagation- Advantages and limitations of ANN - Fuzzy sets and fuzzy logic - Fuzzification, evaluation of rules, defuzzification - Fuzzy rule based reservoir operation model.

Learning Resources

1. Raghunath, H.M., Hydrology, New Age International Publishers, New Delhi, 2007.
2. Subramanya, K., Engineering Hydrology, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014
3. Chow, V.T., and Maidment, Hydrology for Engineers, McGraw Hill Inc., Ltd., 2000
4. Jaya Rami Reddy, A textbook of Hydrology, University Science Press, 2013
5. Vedula, S., and Mujamdar, P.P., Water Resources Systems, McGraw Hill Inc., 2005
6. NPTEL Course – Advanced Hydrology: https://nptel.ac.in/courses/105101002/.
7. NPTEL course – Watershed Management: https://nptel.ac.in/courses/105101010/16

PE-1 (Groundwater Engineering)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1: create insights into the occurrence and properties of groundwater

CLR-2: address concepts related to movement of groundwater

CLR-3: know well hydraulics

CLR-4: comprehend concepts related to exploration and investigation of groundwater

CLR-5: explore groundwater quality, management and modelling

Course Outcomes

CO-2: Identify the various properties of groundwater

CO-2: Apply and analyze the governing equations of groundwater movement

CO-3: Recognize yield of the well and its hydraulics

CO-4: Illustrate the various methods of investigation and exploration of groundwater

CO-5: Understand the concept of groundwater quality, management and modelling

Course Content:

Unit-1:

Introduction to Groundwater Ground water resources – Ground water recharge – Ground water development in India – Various water bearing formations – Types of Aquifers – Aquifer properties – Groundwater fluctuation – Groundwater balance and budgeting – GEC norms - Groundwater potential in India.

Unit-2:

Groundwater Movement: Groundwater Movement- Governing Equation - Darcy's Law - Heterogeneity and anisotropy - Estimation of aquifer parameters - 1D & 2D governing equation of flow through porous medium - Equation for flow into leaky aquifer - Flow through unconfined aquifer- Boundary conditions - Groundwater flow rates and direction - Aquifer with recharge - Flow into confined aquifer with constant and variable thickness.

Unit-3:

Well Hydraulics: Flow into well – Steady radial flow: Dupuit's and Theim's equations – Unsteady radial flow: Theis & Jacob equations – Wells in leaky aquifer – Partially penetrating wells –

Image well theory – Multiple wells – Well capacity & Well development – Construction and types of open & tube wells – Pumping test & Recuperation test.

Unit-4:

Subsurface Exploration**:** Objective and Need for exploration - Geophysical investigations - Surface geophysical techniques - Electrical resistivity method - Seismic refraction method - Remote sensing in groundwater exploration - Other surveying methods - Borehole geophysical techniques, Electric logging, radioactive logging, Induction, fluid and sonic logging - Geochemical method of exploration - Application of GIS in groundwater exploration Seawater intrusion theory - Causes and effects of seawater intrusion - Various methods of reducing seawater intrusion .

Unit-5:

Groundwater Management and Modeling**:** Groundwater quality standards - Types and sources of groundwater contamination - Various quality parameters and its significance - Attenuation of groundwater quality- Potential evaluation of groundwater quality - Physical, chemical and biological method of analysis - Conjunctive use of groundwater and basin management - Groundwater development under various scales - Groundwater modeling, problems in groundwater - Types of models - Conceptual model, physical model, Mathematical model and analog model - Data, input, boundary conditions and output, prediction - Calibration and validation of a model - Groundwater models.

Learning Resources

1. Raghunath, H. M., “Ground Water”, New Age International (P) Ltd, 2014.
2. D.K. Todd and L. F. Mays, "Groundwater Hydrology", John Wiley and Sons.
3. K. R. Karanth, "Hydrogeology", Tata McGraw Hill Publishing Company.
4. NPTEL course - Ground Water Hydrology: http://nptel.ac.in/courses/105105042/
5. NPTEL course - Ground Water Hydrology: http://nptel.ac.in/courses/105103026/

PE-1 (Design Of Hydraulic Structures And Irrigation Engineering)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1: Understand diversion headworks and distribution systems

CLR-2: Explore cross drainage works and their design

CLR-3: Know different types of dams and their design particulars

CLR-4: Provide an understanding of canal structures

CLR-5: Address mechanics of sediment transport and explore the design of stable and lined canals.

Course Outcomes

CO-1: Illustrate different components of diversion headworks and distribution systems

CO-2: Distinguish different cross drainage works

CO-3: design gravity and earthern dam

CO-4: identify and design various canal structures

CO-5: illustrate sediment transport and design stable and lined canals

Course Content:

Unit-1

Diversion Headworks and Distribution Systems, Diversion head works- Layout and functions - Weir and barrage- Causes of failure of weirs on permeable soils - Bligh's theory - Design of vertical drop weir - Khosla's theory of independent variables- Khosla's corrections -Use of Khosla's charts - Irrigation canals - Canal alignment - Cross section of unlined canals - Design of canals through alluvial soils - Kennedy's theory and Lacey's theory

Unit-2

Cross Drainage Works Cross drainage works - Types - Selection of suitable type - Design of Aqueduct (Type III) – Design of Syphon Aqueduct (Type III)

Unit-3

Dams: Dams -Types - Gravity dam – Selection of site - Stability analysis and modes of failure – Elementary profile – Design of gravity dam - Types of galleries – Earth dams – Types - Causes for failure and design criteria - Spillways – Types and design consideration

Unit-4

Canal Structures**,** Canal regulators – Head and cross regulator - Functions – Alignment of off-taking channel - Design of cross regulator - Design of distributary head regulator - Canal falls – Necessity and location of falls - Types of canal falls - Design of a trapezoidal notch fall - Design of simple vertical drop fall - Design of a Sarda fall – Canal Escape.

Unit-5

Conveyance: Mechanics of sediment transport – Design capacity of irrigation canal - Shield's entrainment method - Design of non-scouring stable channels with protected side slopes in alluvium soil - Design of most efficient channel section - Design of stable channels – Kennedy's theory - Design of stable channels – Lacey's theory - Balancing depth of canals - Economic justification of canal lining for unlined canals - Design of lined canals.

Learning Resources

1. Santhosh Kumar Garg, "Irrigation Engineering and Hydraulic Structures",Khanna Publishers, 2000.

2. Punmia B.C. et al., "Irrigation and Water Power Engineering", Laxmi Publications Pvt. Ltd., New Delhi, 2009

3. Asawa G. L., "Irrigation and Water Resources Engineering", New Age International Publishers, New Delhi, 2005

4. Sharma R.K., "Irrigation Engineering and Hydraulic Structures", Oxford and IBH Publishing Company, New Delhi, 2002

5. NPTEL – Irrigation and Drainage: https://nptel.ac.in/courses/126105010/ 6. NPTEL – Water Resources Engineering: https://nptel.ac.in/downloads/105105110/

PE-1 (ADVANCE HYDRAULIC ENGINEERING AND DESIGN)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1: study dimensional and model analysis

CLR-2: address concepts on boundary layer theory

CLR-3: explore measuring discharge and velocity in open channels

CLR-4: know the concepts related to uniform flow in open channel

CLR-5: understand the concepts related to non-uniform flow in open channel

Course Outcomes

CO-1: solve various fluid problems involving dimensional and model analysis

CO-2: appraise the concepts of boundary layer theory

CO-3: estimate discharge and velocity in open channels

CO-4: analyze uniform flow in open channels

CO-5: illustrate non-uniform flow in open channels

Course Content:

Unit-1

Dimensional and Model Analysis: Use of dimensional analysis - Fundamental and derived quantities - MLT system - Dimensional homogeneity - Rayleigh's method - Buckingham Pi method - Application of dimensional analysis - Model analysis - Similitude - Geometric similarity- Kinematic and dynamic similarity - Dimensionless numbers and their significance - Model laws - Model studies in fluid flow problems

Unit-2

Boundary Layer Theory: Boundary layer definitions and characteristics - Boundary layer thickness - Displacement thickness - Momentum and Energy thickness - Flow around submersible bodies - Forces exerted by flowing fluid on the body - Expression for Drag and Lift – Dimensional analysis of drag and Lift

Unit-3

Velocity and Flow Measurement: Non-Modular flume or Venturi flume - Modular flume or the Standing wave flume - Stream Flow measurements - Direct method of stream discharge - Indirect Method of stream discharge - Measurement of velocity - Current meter- Floats - Area -Velocity Method.

Unit-4

Uniform Flow Through Open Channel: Comparison between open channel and pipe flows - Types of channels and types of flow in channels - Chezy's formula - Manning's formula - Design of most economical section - Rectangular and trapezoidal channel.

Unit-5

Non-Uniform Flow Through Open Channels: Specific energy and specific energy curve, Critical depth, critical velocity, Minimum specific energy, critical flow; Subcritical flow and supercritical flow, gradually varied flow, Characteristics of surface profiles, curve and afflux, Length of back water curve and afflux, rapidly varied flow, hydraulic jump and its types, Expression for loss of energy due to jump, length of hydraulic jump, height of jump, Energy dissipaters and Length of back water stilling basins.

Learning Source

1. Modi, P.N., Seth S.M., Hydraulics and Fluid Machines, Standard book house, 2005
2. Subramanya, K., Theory and application of fluid mechanics, Tata McGraw Hill, 2002
3. Rajput R.K., Fluid Mechanics and Hydraulic Machines, S.Chand, 2014
4. Bansal R.K., Fluid Mechanics and Hydraulic Machines, Laxmi Publication, 2017
5. K. Subramanya; Engineering hydrology; McGraw Hill, fourth edition
6. Chandramouli P.N., Applied Hydraulic Engineering, Yesdee, 2017
7. NPTEL Course-Hydraulics. https://nptel.ac.in/courses/105106114/#
8. NPTEL Course-Fluid Machinery. https://nptel.ac.in/courses/112104117/

PE-1 (Earthquake Resistant Design)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:
CLR-2:
CLR-3:
CLR-4:
CLR-5:

Course Outcomes

CO-1: Apply seismic coefficient and response spectrum methods for analysis of multi storied buildings

CO-2: Apply concepts of ductility in the design of multi- storeyed structures

CO-3: Analyze multi- storeyed building frames based on latest earthquake code

CO-4: Apply the concepts of base isolation

Course Content:

Unit:1

Elements of Earthquake Engineering: Earthquake magnitude and intensity, Focus and Epicentre, Causes and Effects of Earthquakes, Characteristics of Earthquake, Seismic zone mapping.

Unit:2

Structural Systems for Seismic Resistance: Structural systems – building configuration, frames, walls, dual systems – response in elevation – plan – influence of structural classification- Concepts of seismic design.

Unit: 3

Analysis for Earthquake Loads: IS: 1893-2016- Seismic Coefficient method- modal analysis- Applications to multi-storied building frames.

Unit: 4

Ductile Detailing: Ductility of R.C structures- Confinement- detailing as per IS-13920-2016- moment redistribution – principles of design of beams, columns – beam column joints – soft story concept

Unit: 5

Base Isolation: Isolation systems – Effectiveness of base isolation and applications.

Learning Resources:

Text Books:

1. A.K. Chopra, Dynamics of structures, Prentice Hall, 2020.

2. I.S. 1893 - 2002, Criteria for Earthquake Resistance design of Structures.

Reference Books:

1. Clough R.W, Dynamics of Structures, 2015, 2nd Edition.

2. Mario Paz and Young Hoon Kim Structural Dynamics: Theory and Computation, Springer Publisher, 2018, 6th Edition

3. https://nptel.ac.in/courses/105/107/105107204/

PE-1 (GROUND IMPROVEMENT TECHNIQUES)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:

CLR-2:

CLR-3:

CLR-4:

CLR-5:

Course Outcomes

CO-1: Apply seismic coefficient and response spectrum methods for analysis of multi storied buildings

CO-2: Apply concepts of ductility in the design of multi- storeyed structures

CO-3: Analyze multi- storeyed building frames based on latest earthquake code

CO-4: Apply the concepts of base isolation

Course Content:

Unit: 1

Introduction to Ground Improvement: Overview of ground improvement techniques, Importance of ground improvement in construction projects, Factors influencing the need for ground improvement, Historical development and evolution of ground improvement methods.

Unit: 2

Shallow Stabilization Techniques: Introduction to shallow stabilization techniques, Types of shallow stabilization methods: compaction, preloading, vibro compaction, soil reinforcement, and chemical stabilization, Principles and mechanisms of each technique, Influence on bearing capacity and settlements in cohesive and cohesionless soils, Design considerations and factors affecting the selection of shallow stabilization methods, Case studies and real-world applications of shallow stabilization techniques

Unit:3

Deep Stabilization Techniques: Introduction to deep stabilization techniques, Types of deep stabilization methods: deep compaction (dynamic compaction, vibro compaction), deep mixing (deep soil mixing, jet grouting), stone columns, and grouted ground, Principles and mechanisms of each technique, Influence on bearing capacity and settlements in cohesive and cohesionless soils Design considerations and factors affecting the selection of deep stabilization methods, Case studies and real-world applications of deep stabilization techniques

Unit: 4

Combined Methods and Hybrid Techniques: Overview of combined methods and hybrid techniques in ground improvement, Integration of shallow and deep stabilization techniques for complex ground conditions, Case studies demonstrating the effectiveness of combined methods, Challenges and considerations in implementing combined and hybrid techniques, Future trends and innovations in combined ground improvement methods

Unit:5

Quality Control and Monitoring in Ground Improvement: Importance of quality control and monitoring in ground improvement projects, Key parameters to monitor during ground improvement activities, Instrumentation and techniques for monitoring ground improvement processes, Precautions to avoid different type of errors, Data interpretation and analysis for assessing the effectiveness of ground improvement measures, Case studies highlighting the role of quality control and monitoring in successful ground improvement projects

Learning Resources:

Text Books:

1. Manfred R. Hausmann, Engineering Principles of Ground Modification, McGraw-Hill College, 2013, First Edition

2. Bujang B.K. Huat, Arun Prasad, Sina Kazemian, Vivi Anggraini, Ground Improvement Techniques, 2021, First Edition

Reference Books:

1. Klaus Kirsch and Fabian Kirsch, Ground Improvement by Deep Vibratory Methods, CRC Press, 2017, Second Edition

2. Buddhima Indraratna, Jian Chu and Cholachat Rujikiatkamjorn, Ground Improvement Case Histories, Elsevier, 2015, First Edition

Other Suggested Readings:

1. https://nptel.ac.in/courses/105108075

PE-1 (PAVEMENT FORENSICS AND REHABILITATION)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:

CLR-2:

CLR-3:

CLR-4:

CLR-5:

Course Outcomes

CO-1: Explain and identify the various types of pavement distress and failure mechanisms

CO-2: Conduct pavement forensic investigations using non-destructive testing

CO-3: Assess the performance of pavement and decide on different rehabilitation strategies.

CO-4: Design effective pavement rehabilitation solutions.

CO-5: Conduct economic & environmental implications of pavement rehabilitation techniques

Course Content:

Unit: 1

Introduction to Pavement Forensics: Pavement Infrastructure, Liabilities arising due to premature pavement failures, Introduction to Pavement Forensics, Preliminary Investigation-Assessment of whether forensic evaluation is justified; Overview of forensic investigation plan –team formulation, Pre-investigation site visits, Preliminary investigation, initial forensic testing plan, Final testing plan.

Unit: 2

Distress identification in pavement structures: Distress identification in the flexible pavement – Cracking, Surface deformation, Patching, and potholes, Surface Defects; Distress identification in concrete pavements – Cracking, Joint Deficiencies, Surface defect; miscellaneous defects in flexible and concrete pavements, Distresses in inverted pavements, Quantification of distresses in flexible and concrete pavements.

Unit: 3

Non-Destructive, Destructive and laboratory evaluation procedures: Introduction to Non-Destructive testing – Ground penetrating radar, Profilometer, Falling weight deflectometer, Density gauge, Field permeameter, Magnetic tomography technology; Destructive evaluation – Field coring, Test pits and trenches; Laboratory investigations – separation/detection of individual materials, physical and chemical properties, relevant strength assessment; Traffic studies – quantifying overloading.

Unit: 4

Forensics evaluation case studies: Failure investigation of rutting without shoving, with shoving, wheel path cracking, non-wheel path cracking, moisture damage in bituminous mixes, delamination failure, Cracking in concrete pavements, Durability failures in concrete pavements.

Unit: 5

Rehabilitation techniques: Rectification of distresses in flexible pavements, Recycling (hot and cold) techniques, Full depth reclamation, Rectification of distresses in concrete pavements, Reinstating load transfer efficiency across cracks, sublimation, strengthening of flexible pavements.

Learning Resources:

Text Books:

1. Kandhal, P.S., Bituminous Road Construction in India, PHI Learning Pvt. Ltd, 2016, First Edition.

2. Specifications for Road and Bridge Works, Ministry of Road Transport and Highways, Indian Roads Congress, New Delhi, India, 2013, Fifth Edition.

Reference Books:

1. IRC SP 82 Code of practice for the maintenance of flexible pavements 2. IRC SP 83 Guidelines for maintenance, repair and rehabilitation of cement concrete pavements

Other Suggested Readings:

1. https://pavementinteractive.org/reference-desk/construction/site-preparation/subgrade preparation-for-new-pavements/ 2. https://www.virginiadot.org/vtrc/main/online_reports/pdf/15-r6.pdf

PE-1 (CONSERVATION OF HERITAGE STRUCTURES)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:

CLR-2:

CLR-3:

CLR-4:

CLR-5:

Course Outcomes

CO-1: Explore the importance of conserving the heritage structures.

CO-2: CO-2: Identify different aspects of conservation of structures.

CO-3: Analyse the restoration and reconstruction procedures.

CO-4: Identify the structural materials in heritage constructions.

CO-5: Exposure to structural health monitoring of the heritage structures.

Course Content:

Unit: 1

Introduction: Historical Perspective of conservation, Classification of heritage based on different criteria, Policies and agencies of conservation across world, Conservation principles and practices, Conservation scenario – Global and Indian versions.

Unit: 2

Geotechnical and structural aspects of conservation Processes: Conservation approach, Diagnostic investigations, Masonry characterisation, Deterioration in heritage structures – causes of decay, Maintenance, preservation, Repairs, restoration and reconstruction, Structural strengthening and retrofitting module.

Unit: 3

Structural materials and systems in heritages constructions: Rock-cut architecture, Structural behaviour of heritage structures, Material behaviour – stones, clay bricks, mud & masonry mortars, Concrete & modern heritage buildings, new buildings in heritage settings.

Unit: 4

Structural health monitoring: Investigations and conservation of historic structures – case studies, Heritage conservation – challenges and opportunities; Heritage tourism, sustainability aspects.

Learning Resources:

Text Books:

1. Francesca Gherardi and Pagona Noni maravelaki, Conserving stone heritage: Traditional and Innovative materials and techniques, Springer, 2011.

2. GG Amorodo and V. Fassina, Stone Decay and conservation: atmospheric pollution, cleaning, consolidation and protection, Elsevier, 1983.

Reference Books:

1.National policy for conservation of the ancient monuments, Archaeological sites and remains, ASI, New Delhi.

PE-1 (Ground Water Hydrology)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:
CLR-2:
CLR-3:
CLR-4:
CLR-5:

Course Outcomes

CO1: Understand the basics of groundwater and analyse movement of groundwater in aquifer.

CO2: Estimate the aquifer parameters and groundwater resources for different hydro-geological boundary conditions

CO3: Comprehend the types, design principles and construction of wells.structures

Course Content:

Unit: 1

Occurrence of ground water: origin - rock properties affecting ground water vertical distribution - geologic formations as aquifers -types of aquifers - aquifer parameters-ground water basins - springs - Laplace equation - potential flow lines - flownet – flownet for anisotropic soils- seepage under a dam - groundwater contours-determination of flow direction- steady unidirectional flows in aquifers- confined and unconfined - aquifer with percolation- steady radial flow towards a well- well in uniform flow - steady flow with uniform discharge- partially penetrating wells- steady flow in leaky aquifer.

Unit 2

Unsteady flow-general equation- Cartesian and polar coordinate- unsteady radial flow in to a well - confined, unconfined and leaky aquifers -–multiple well system - pumping tests - non equilibrium equation for pumping tests - Thies' method - Jacob method - Chow's method - characteristics well losses –step draw down test- well near aquifer boundaries -determination of boundaries from pumping test. Image wells for various boundary conditions-Cavity well and open well- yield tests-pumping and recuperation test.

Unit 3

Tube wells: design - screened wells - gravel packed wells - well loss-selection of screen size - yield of a well - test holes - well logs - methods of construction - dug wells -shallow tube wells - deep wells - gravity wells – drilling in rocks - screen installation - well completion - well development - testing wells for yield - collector - or radial wells - infiltration galleries - well point system - failure of tube wells Ground water investigation methods.

Text book(s)

- Raghunath, H.M., "Ground Water", New Age International, 2007.
- Karanth, K. "Groundwater Assessment, Development and Management", Tata McGraw Hill, 2003.

Reference(s)

- Todd, D.K. and Mays.L.W., "Ground Water Hydrology", Wiley India, 2011.
- Garg S.P., "Ground Water and Tube wells", Oxford & IBH, 1993.
- Raghunath H. M., "Hydrology: Principles, Analysis and Design", New Age International Publishers, 2006.

PE-1 (Water Resources Systems Planning And Design)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:

CLR-2:

CLR-3:

CLR-4:

CLR-5:

Course Outcomes

CO1: Understand the water resources systems and express it using mathematical models.

CO2: Formulate and solve various optimization models of water resources planning and management problems.

CO3: Identify the advantages and limitations of various modeling methods and algorithms used in water resources planning and management.

CO4: Use the simulation and optimization models for planning and management decision making

Course Content:

Unit 1

Water systems engineering –scope and approach. Issues and the systems planning approach- water system dynamics- water resource development alternatives.

Unit:2

Water systems planning objectives- Constraints and Criteria – Economic and Econometric principles Hydrologic input analysis, Demand analysis, System elements & Subsystem planning - Stochastic planning and management - Design and management issues.

Unit 3

Optimization methods and their application in Water resources systems. Linear programming and Dynamic programming models. Problem formulation for water resources systems – Multi objective planning – Large scale system analysis- Case studies.

Unit:4

Ground water system planning – Conjunctive surface and groundwater development- Hierarchical approach.

Unit:5

Water quality management planning- Regional planning- Policy issues.

Reference(s)

1. Vedula S. and Mujumdar P P, "Water Resources Systems: Modelling techniques and analysis", Tata – McGraw Hill, 2007.
2. S K Jain, V P Singh, "Water Resources Systems Planning and Management", Elsevier Science, 2003
3. Maass. A. et.al., "Design of Water Resources Systems", Harvard University Press 2013.
4. M. C. Chathurvedi , "Water Resources Systems: Planning & Management", Tata McGarw Hill Publications, 1987.
5. Louks D P et.al, "Water Resources System Planning and Management: An introduction to methods, models and applications", UNESCO, Paris, 2017.
6. Goodman. A.S. and Major. D.C.,"Principles of Water Resources Planning", Prentice Hall, 1984.

PE-II (Rock Engineering)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:

CLR-2:

CLR-3:

CLR-4:

CLR-5:

Course Outcomes

CO-1: Comprehend the significance of rock mechanics in engineering practice.

CO-2: Determine rock properties and classify the rock mass.

CO-3: Assess the stability of rock slopes and suggest slope protection methods.

CO-4: Evaluate the rock bearing capacity and calculate the load capacity for deep foundations in rock.

CO-5: Identify the suitable tunnel driving and support/stabilization methods.

Course Content:

Unit: 1

Introduction: Development of Rock Mechanics and its Engineering Importance. Laboratory and in-Situ Testing: Rock sampling, Determination of density, Porosity and Water absorption, Uniaxial Compressive strength, Determination of elastic parameters, Tensile strength, Shear Strength, Flexural strength, Swelling and slake durability, permeability, point load strength, Factors affecting strength of rocks.

Unit: 2

Engineering classification of Intact rock and rock mass: Classification by Rock Quality Designation (RQD), Rock structure Rating (RSR), Rock Mass Rating (RMR), Geomechanics and Norwegian Geotechnical Classification (Q-system). Strength and modulus from classifications, Classification based on strength & modulus and strength.

Unit: 3

Stability of Rock Slopes and Foundations on Rocks: Types, mode of slope failure, causes of slope failure, stability analysis, Hoek's stability charts, prevention and control of rock slope failures, stabilization methods, prevention methods and warning methods.

Unit: 4

Rock Foundations: Types of Foundations, Shallow foundation- failure mechanisms, different situations with shallow foundations, sliding instability, foundations over sinkholes, foundations on faults, foundations on swelling rocks, deep foundations.

Unit: 5

Tunneling in rocks: Applications of tunnels, investigation and planning, tunnel drilling methods, tunnel support systems and stabilization methods, construction control and tunnel maintenance

Learning Resources:

Text Books:

1. Ramamurthy T. Engineering in Rocks for slopes, foundations and tunnels, Prentice Hall of India. Learning Pvt. Ltd., (2015).
2. John A. Franklin and Maurice B. Dusseault, Rock Engineering Applications, McGraw Hill, 1991.

Reference Books:

1. Nagaratnam Sivakugan, Sanjay Kumar Shukla, Braja M. Das, Rock Mechanics an Introduction, CRC Press, 2019.
2. B.P. Verma, Rock Mechanics for Engineers, Khanna Publishers, 2015.

Other Suggested Readings:

1. https://onlinecourses.nptel.ac.in/noc21_ce34/preview

PE-II (Land and Water Management)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:

CLR-2:

CLR-3:

CLR-4:

CLR-5:

Course Outcomes

CO-1 Plan irrigation systems and command area development programs.

CO-2 Evaluate performance of an irrigation system.

CO-3 Plan measures for reclamation of waterlogged lands.

CO-4 Develop strategies for conflict management in irrigation projects.

Course Content:

Unit: 1

Introduction: Need for proper management of land and water resources.

Unit:2

Planning of irrigation projects: Inadequacies in present approaches in canal irrigation management command area development programs.Classification of irrigable soils: soils-plant-water relationships – soil management Irrigation management – Irrigation Management Matrix – Society and irrigation – perceptions of various stakeholders on irrigation system performance

Unit:3

Macro and precision irrigation: Diagnostic analysis of irrigation systems – performance indicators for performance evaluation of irrigation projects

Unit:4

Water logging and salinity: Water quality for irrigation, Participatory irrigation management: Farmer's management of irrigation system acts - conflict esolution Legal aspects in water sharing and management: PC-CP - case studies.

Learning Resources:

Text Books:

1. Majumdar D.K., Irrigation Water Management, Prentice Hall of India, New Delhi, 2013, 2nd Ed.

2. Michael A.M., Irrigation: Theory and Practice, Vikas Publishing House Pvt. Ltd. New Delhi, 2009.

Reference Books:

1. Murthy V.V.N., Land and Water Management Engineering, Kalyani Publishers, Ludhiana, 2011

2. Scwabe G.O., Fangmeir D.D., and Elliot W.J., Soil and Water Management Systems, John Wiley

and Sons, N York, 1996.

Other Suggested Readings:

1. https://www.iima.ac.in/c/document_library/4ParticipatoryIrrigation8f9a.pdf?uuid=a5eced82-3f75

4068-9aa1-57aef9de0876&groupId=62390

PE-II (HIGHWAY SAFETY)

Course Code **L:T:P-3:0:0**

Rationale-

Course Outcomes

CO-1 Analyze the effect of driver characteristics, roadway characteristics, and climatic factors on highway safety

CO-2 Interpret and analyse the road crash data using various methods

CO-3 Identify the hazardous location and predict the possibility of road crashes

CO-4 Analyse the intersection traffic safety using empirical and non-empirical methods

CO-5 Apply traffic management techniques to solve safety issues

Course Content:

Unit:1

Introduction of highway safety: Scenario and statistics, accident characteristics, crash types, causes, severity, factors affecting highway/road safety, safety aspects related to geometric design, road safety improvement strategies, elements of a road safety plan, examples for practice.

Unit:2

Analysis of accident data: accident/crash data and record, accident data analysis, crash rate and its estimation, accident exposure, cash frequency, relative safety, identification of hazardous location, black spot, statistical analysis using crash data, collision diagram, condition diagrams, crash reconstruction, understanding basic physics, calculation of speed for various skid, friction, worked examples.

Unit:3

Accident prediction: method for prediction of crash, variables influencing accidents, potential index for safety improvements, determination of expected crashes, safety performance functions, before-after methods in crash analysis, with control sites, crash modification factor, empirical bays models, crash reduction factors, working examples and case study.

Unit:4

Intersection safety analysis: Background, intersection features affecting safety, geometric design, traffic control and traffic characteristics, safe sight distance requirements, uncontrolled intersection safety, roundabout crash analysis, intersection level, approach level safety analysis, conflict categories, level of injury crash, worked examples and case study.

Unit: 5

Traffic management and road safety audit: Traffic improvements strategies for safety, Intelligent transportation system, crash avoidance system, incident management, road safety audit procedure, aims and objectives, roles and responsibility, design standards, tasks, various stages of safety audits; common identifiable problems, structuring of report, identifying common problems, case study.

Learning Resources:

Text Books:

1. L.R. Kadiyali, Traffic Engineering and Transportation Planning, Khanna Publisher, 2017, 9th Edition

2. Nicholas J. Graber and Lester A. Hoel, Traffic and Highway Engineering, Cengage Learning India Privet Limited, 2017, 5th IS Edition

Reference Books:

1. R Srinivasa Kumar, Introduction to Traffic Engineering, University Press (India), 2018, 1st Edition

2. C. Jotin Khisty and B. Kent Lal, Introduction to Transportation Engineering, Pearson Press, 2018,

3rd Edition

Other Suggested Readings:

1. https://onlinecourses.nptel.ac.in/noc22_ce41/preview

2. https://ocw.mit.edu/courses/16-63j-system-safety-spring-2016/

PE-II (Design of Bridges)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:
CLR-2:
CLR-3:
CLR-4:
CLR-5:

Course Outcomes

CO1: Apply the codal provisions for loading and design standards of bridges.

CO2: Design the substructure including pier and pier cap and well elements.

CO3: Design the superstructure of bridge using different methods.

CO4: Design girder bridges and cable stayed bridges.

CO5: Design and select materials suitable for bearings.

Course Content:

Unit: 1

Introduction: Bridge components - Classification – Investigation for bridges – Loads and Loading standards – IRC and Railway loads – Impact.

Unit: 2

Bridge substructure: Determination of maximum flood discharge - Determination of linear water way - Determination of maximum depth of scour - Loads acting on substructure - Design of abutment, pier and pier cap - Design of well elements - Sinking of wells.

Unit: 3

Bridge Superstructure: Effective dispersion width method and Pigeaud's curves method for design of slab - Analysis of beams– Courbon's Method – Hendry Jaeger Method – Guyon and Massonet Method - Box Girder Bridges - Grillage analogy.

Unit: 4

Cable Bridges: Advantages - Arrangement of stay cables - types of towers - Linear analysis of cables and towers Bridge

Unit: 5

Bearings and expansion joints: Functions, types and selection of bearings - Bearing materials - Design of elastomeric bearings and spherical pot bearings for different conditions - Expansion joints – types of expansion joints.

Learning Resources:

Text Books:

1. Analysis and Design of Substructures: Limit State Design, Swami Saran, Oxford & IBH Publishing Co., 2018, 2nd Edition.

2. Bearings in Structural Engineering, J.E. Long, Wiley, 2016.

Reference Books:

1. Concrete Bridge Design, R.E. Rowe, Elsevier Science and Technology, 1962, 1st Edition.

2. The Analysis of Grid Frameworks and Related Structures, L.G. Hendry and A.W. Jaeger, Chatto & Windus, 1958.

Other Suggested Readings:

1. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce23/

PE-II (Low Carbon Materials and Green Buildings)

Course Code **L:T:P-3:0:0**

Rationale-

Course Outcomes

CO-1: Exposure to clean and renewable energy systems & Technologies.

CO-2: Identify the sustainable materials and their usage in the constructions.

CO-3: Analyse optimizations for design of energy efficient buildings.

CO-4: Estimate the renewable energy of buildings.

CO-5: Hands on experience for the design of a sustainable building.

Course Content:

Unit: 1

Introduction: Embodied energy, Operational energy in Building and Life cycle energy. Ecological foot print, Bio-capacity and calculation of planet equivalent.

Unit: 2

Role of Materials used in constructions: 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 etc. concrete with alternative material for sustainability.

Unit: 3

Energy use in Buildings: Reduction in water consumption in concrete, Recycled aggregate, Energy for grinding crushing of cement aggregate etc. and reduction. Operational energy in

building role of materials and thermal conductivity; Comparative energy performance emission performance and financial performance, Indoor air quality, volatile organic content (VOC) emission issues and indoor air quality for sustainability and health hazard.

Unit: 4

Green Buildings: Operational energy reduction and net zero building, Optimization for design of building for energy efficiency and example of optimization through use of Evolutionary genetic algorithm; Radiation budget, urban heat island; Surface water balance, Effects of trees and microclimatic modification through greening.

Unit: 5

Renewable Energy: Use of Building Integrated Photo Voltaic (BIPV) and other renewable energy in buildings, basic concepts and efficiency; Energy codes ECBC requirement, Concepts of OTTV etc; Green Performance rating, requirements of LEED, GRIHA etc. Sustainable building: A small project on designing a sustainable building.

Learning Resources:

Text Books:

1. Newman, J. and Choo, Ban Sang, Advanced Concrete Technology-Processes, Elsevier, 2003, 1st Edition.

2. Newman, J. and Choo, Ban Sang, Advanced Concrete Technology-Constituent Materials, Elsevier, 2003, 1st Edition.

Reference Books:

1. Kubba, S, LEED Practices, Certification, and Accreditation Hand book, 1st ed. Elsevier, 2010.

2. Minsitry of Power, Energy Conservation Building Code 2018, Revised Version, Bureau of Energy Efficiency, 2018

Other Suggested Readings:

1. TERI-Griha's Green Design practices (www.teriin.org/bcsd/griha/griha.htm)

2. Leadership in Energy and Environmental Design (www.usgbc.org/LEED)

PE-II (Building Information Modelling)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:
CLR-2:
CLR-3:
CLR-4:
CLR-5:

Course Outcomes

CO-1: Create BIM model for effective coordination during planning, design and execution.

CO2: Identify clash and avoid it's occurrence.

CO3: Apply the concept of BIM 4D for project scheduling

CO4: Apply the concept of 5D BIM for quantity takeoff and estimation

Course Content:

Unit 1

Building Information Modeling – Introduction & Process, Evolution of BIM, BIM Model -of various buildings like Commercial & Residential, WTP, Transportation, Airports. Isometric View – Introduction, Examples and Problems. 3D Modeling

Unit 2

Design Authoring – Workflow, Discipline Based Modeling, Architectural, Engineering Analysis, Structural Analysis, HVAC, Electrical, Plumbing, Energy Analysis, Lighting Analysis, Design Review. Views in Model, Visualization Modes, Walkthrough & Fly through the Model, Layers & Properties, AR, VR & MR.

Unit 3

Clash Check, Types of Clashes, Federated Model - Clash avoidance process, Clash Detection Process Introduction, Clash Detection - Priority Matrix, Clash Detection – Rules, Clash Detection – Report, Clash Detection – Grouping, Clash Detection - Roles & Responsibilities, Clash Detection Process – Demo. CDE, Level of Development (LOD)- Level of Detail & Level of

Information, LOD - for all elements- Chart & Matrix

Unit :4

Project Schedule, 4D BIM Modeling, Construction Analysis, 3D Control & Planning, BIM for Safety, Disaster & Risk Analysis, Digital Fabrication, Phase Planning, As-built/Record Models. 5D BIM and Quantity Take off with UOM, Exercise & Demo, Quantity Take Off, 5D – Estimation and Analysis, Cost Control, Asset Information Model, COBie and Deliverables, Space Attributes, Asset Attributes and Asset requirement, Infrastructure System, Information Exchange with Facility Management.

Unit:5

Industrialization of Construction through BIM – DfMA, IoT in BIM, Data analytics using AI and ML, Smart Infrastructure, Digital Twin –Connected Infrastructure.

TEXT BOOKS / REFERENCES:

1. Karen Kensek and Douglas Noble, Building Information Modelling: BIM in Current and Future Practice Wiley; 1st edition (15 August 2014)

2. Andre Borrmann, Markus Konig, Christian Koch, JakobBeetz, Building Information Modelling, Springer 2015.

3. Rafael Sacks, Chuck Eastman, Ghang Lee, Paul Teicholz , BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, Wiley; 3rd edition (2 October 2018).

ISO 19650 – 2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM)

PE-II (Air Pollution)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:
CLR-2:
CLR-3:
CLR-4:
CLR-5:

Course Outcomes

CO-1 Identify sampling and analysis techniques for air quality assessment

CO-2 Describe the plume behaviour for atmospheric stability conditions

CO-3 Apply plume dispersion modelling and assess the concentrations

CO-4 Design air pollution controlling devices

Course Content:

Unit: 1

Introduction: Water Quality, Objectives and Standards, Water quality characteristics, sampling and analysis, Analytical methods, Automated analysis and remote monitoring.

Unit: 2

Air Pollution: Definition - Sources & Classification of Air Pollutants - Effects of air pollution on humans, plants and materials- Global effects - Air Quality and NAAQS - National Clean air Programme- Sampling of Pollutants in ambient air - Stack sampling

Unit: 3

Meteorology and Air Pollution: Factors influencing air pollution, Wind rose, Mixing Depths, Lapse rates and dispersion - Atmospheric stability, Plume rise and dispersion, Prediction of air quality, Box model - Gaussian model - Dispersion coefficient - Application of tall chimney for Pollutant dispersion.

Unit: 4

Control of Particulate Pollutants: Properties of particulate pollution - Particle size distribution - Control mechanism - Dust removal equipment - Design and operation of settling chambers,

cyclones, wet dust scrubbers, fabric filters & ESP.

Unit: 5

Control of Gaseous Pollutants: Process and equipment for the removal by chemical methods - Design and operation of absorption and adsorption equipment - Combustion and condensation equipment.

Learning Resources:

Text Books:

1. Khare M, Sharma P, Kota, S.H, Sumanth C, Air Pollution Science Engineering and Management Fundamentals, ISBN 9780367750527, CRC Press, 2024.

2. Noel, D. N., Air Pollution Control Engineering, ISBN 978-0070393677, Tata McGraw Hill Publishers, 1999.

Reference Books:

1. Colls, J., Abhishek T, Air Pollution: Measurement, Modeling and Mitigation, ISBN13: 9780-415-47932 CRC Press, 2009.

2. Boubel, R.W., Fox, D.L., Turner, D.B. and Stern, A.C., Fundamentals of air pollution, Third Edition, ISBN 978-0-08-050707-1, Academic Press, New York, 1994.

3. https://nptel.ac.in/courses/105102089

4. https://indair-neeri.res.in/

PE-II (Travel Demand Analysis)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:
CLR-2:
CLR-3:
CLR-4:
CLR-5:

Course Outcomes

CO-1 Develop a basic knowledge of urban transportation planning and urban transportation issues.

CO-2 Assess the data required for travel demand estimation.

CO-3 Analyse and estimate urban travel demand.

CO-4 Develop transportation network and apply traffic assignment.

CO-5 Analyse and estimate regional travel demand.

Course Content:

Unit: 1

Urban Transportation Planning and Issues: Urbanization, urban class groups, transportation problems and identification, impacts of transportation, urban transport system planning process; transportation problems and issues in urban areas; travel characteristics; issues related to regional transportation planning, methods of delineation regions; policies for urban and regional transportation; types of transit systems, public, private, para-transit transport, mass and rapid transit systems, BRTS and Metro rails, capacity, merits and comparison of systems; social equity; coordination, types of coordination.

Unit: 2

Travel Demand and Data Collection: Basic Concepts in Transportation Planning; accessibility and mobility; scale and context; demand function; travel attributes; assumptions in demand estimation; sequential, and simultaneous approaches; aggregate and disaggregate techniques; Collection of data – organization of surveys and analysis; study area, zoning, screen lines; types and sources of data - road side interviews; home interview surveys; stated and revealed data-collection; commercial vehicle surveys, sampling techniques, expansion factors; accuracy checks,

use of secondary sources; economic data: income, population, employment, vehicle owner ship; trends in passenger travel and goods in urban area.

Unit: 3

Trip Generation Analysis: Zonal models, category analysis, household models, trip attraction models, commercial trip rates. Trip Distribution: Growth factor methods, gravity models, opportunity models, time function iteration models.

Unit: 4

Mode Choice Analysis: Logit model derivation and application; random utility modeling; maximum likelihood estimation; selecting models and model fit; Mode choice behaviour, competing modes, mode split curves, models and probabilistic approaches. Traffic Assignment: Basic elements of transport networks, coding, route properties, path building criteria, skimming tree, network representation and analysis: minimum path finding and equilibrium assignment. All-or-Nothing assignment, capacity restraint techniques, reallocation of assigned volumes, Equilibrium Assignment.

Unit: 5

Regional Travel Demand Estimation: Factors affecting goods and passenger flows, use of aggregate direct demand model to estimate freight and passenger demand, IVF models.

Learning Resources:

Text Books:

1. Traffic Engineering And Transport Planning, Kadiyali, L.R., Khanna Publishers, 2018, Ninth Edition.

2. Transportation Engineering, Khisty, C.J., and Lall, B.K., Pearson, 2017, Third Edition.

Reference Books:

1. Transportation Planning: Principles, Practices and Policies, Sarkar, P.K., Maitri, V., Joshi, G.J., PHI Learning, 2017, Second Edition.

2. Urban Transport: Planning and Management, Jain A.K., APH Publishing Corporation, 2008.

Other Suggested Readings:

1.https://nptel.ac.in/courses/105/107/105107067/

2.https://dspace.mit.edu/bitstream/handle/1721.1/107706/11-540j-fall2006/contents/lecture notes/index.htm.

PE-II (Systems Analysis In Civil Engineering)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:
CLR-2:
CLR-3:
CLR-4:
CLR-5:

Course Outcomes

CO-1 Develop a basic knowledge of urban transportation planning and urban transportation issues.

CO-2 Assess the data required for travel demand estimation.

CO-3 Analyse and estimate urban travel demand.

CO-4 Develop transportation network and apply traffic assignment.

CO-5 Analyse and estimate regional travel demand.

Course Content:

Unit:1

Modeling Techniques: Concepts of Systems Engineering, Types of mathematical models, Formulation of a prescriptive model, Overview of optimization techniques.

Unit: 2

Linear Programming: Graphical method, Simplex method, Sensitivity analysis, Dual LP, Transportation problem, Assignment problem, Integer Linear Programming. Dynamic Programming: Concepts of dynamic programming, Formulation of recursive equation, Resource allocation using DP, Capacity expansion, Inventory control.

Unit: 3

Nonlinear Optimization: Classical optimization techniques, Lagrange methods, Kuhn-Tucker conditions, steepest gradient technique and other gradient based search techniques, Overview of genetic algorithm.

Unit: 4

Decision Theory: Decision analysis, Decision making under risk and uncertainty, Markovian decision process, stochastic inventory control.

Unit: 5

Simulation: Types of simulation models, Monte-Carlo simulation, Applications of simulation. Overview of Multi Objective Optimization Techniques.

Learning Resources:

Text Books:

1. Revelle C.S., Whitlatch E.E. and Wright J.R., Civil and Environmental Systems Engineering, Pearson Education Inc., New Jersey, 2004

2. Dahe P. D., Operations Research – A Systems Engineering Approach, CENGAGE India, 2019.

Reference Books:

1. Hillier F.S. and Lieberman G.J., Introduction to Operations Research, McGraw Hill Education, 2017

2. Taha H.A., Operations Research – An Introduction, Pearson Education, 2019

3. https://nptel.ac.in/courses/105/108/105108081/

PE-II (GIS for Civil Engineering Applications)

Course Code **L:T:P-3:0:0**

Rationale-

CLR-1:

Course Outcomes

CO-1 Formulate and solve deterministic optimization models

CO-2 Apply deterministic optimization techniques for resource allocation, scheduling, inventory, control, capacity expansion and transportation problems

CO-3 Apply decision theory and stochastic optimization techniques for decision making under uncertainty

CO-4 Formulate and solve optimization models for planning and design of civil engineering systems

Course Content:

Unit: 1

Introduction: GIS definition, development, application areas. Map Concept: Map-Definition, Elements of Maps, Types of maps, Advantages and disadvantages of analog/digital maps, Coordinate Systems- Geometric models of earth, Global/Local coordinate system,

Unit: 2

Projection Systems- Classification, Cylindrical projection, Conical projection, Selection of a particular projection.

Unit: 3

Fundamental concepts of GIS**:** Modeling Real World Features- Raster data model, vector data model, Data Formats- Spatial and Non-Spatial data. Database preparation and editing: Data collection and Input, Data conversion, Hardware & software Requirements, Topology – Editing and Error Rectification, Types of topology, Topological Relationships.

Unit: 4

Spatial Analysis: Buffer Analysis-Variations in Buffering, Applications of buffering, Overlay

AnalysisFeature type and overlay, Vector Overlay methods, Network Analysis-Impedance, Shortest path analysis, closest facility, Concepts of Proximity analysis, Neighborhood operations, DEM and TIN.

Unit: 5

GIS Project Planning: Steps in GIS project, Problem Identification and Implementation of a GIS project. GIS Applications: Transportation, Water Resources, Environment, Geology, Emergency Management, Agriculture, Urban planning, climate change, Business. Advances in GIS: Concepts and application of open source Mobile and Web GIS.

Learning Resources:

Text Books:

1. C.P. Lo, Albert K. W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice Hall India Pvt. Ltd, New Delhi, 2016.

2. Kang-Tsung Chang, Introduction to Geographic Information Systems, Tata McGraw Hill Publishing

Company Ltd, New Delhi, 2015.

2. Peter A. Burrough and Rachael A. McDonnell, Principles of Geographical Information Systems, Oxford University Press, 2016.

Lab-I (Environmental Engineering Laboratory)

Course Code **L:T:P-3:0:0**

Rationale-

Course Outcomes

CO-1 Determine physical, chemical and biological characteristics of water and wastewater

CO-2 Determine optimum dosage of coagulant

CO-3 Determine break - point chlorination

CO-4 Assess the quality of water and wastewater

Course Content:

Syllabus:

1. Determination of pH.
2. Determination of Conductivity.
3. Determination of Acidity of water.
4. Determination of Alkalinity of Water.
5. Determination of Chlorides.
6. Determination of Hardness of water.
7. Determination of Fluorides.
8. Determination of Available Chlorine in bleaching powder.
9. Conducting Break Point Chlorination Test.
10. Determination of Residual Chlorine.
11. Determination of Dissolved Oxygen.
12. Determination of Chemical Oxygen Demand.
13. Determination of Biochemical Oxygen Demand.
14. Conducting Jar test for determining optimum dosage of coagulant.
15. Determination of Total Solids, Total Dissolved Solids & Settleable Solids

Learning Resources:

Text Books:

1. APHA, Standard methods for the examination of water and wastewater. (2012). 21st Edition, Washington:

2. CPCB, Guide Manual: Water and Wastewater Analysis

Reference Books:

1. Sawyer, C. N., McCarty, P. L., and Perkin, G.F., Chemistry for Environmental Engineering and Science, 5th edition McGraw-Hill Inc., 2002

2. Kotaiah, B., and Kumara Swamy, N., Environmental Engineering Laboratory Manual, Charotar Publishing House Pvt. Ltd., 1st Ed., 2007.

Other Suggested Readings:

1. https://www.vlab.co.in/

Lab-II (Computation, Design & Detailing- R C Structures)

Course Code **L:T:P-3:0:0**

Rationale-

Course Outcomes

CO1: Apply the knowledge of design to detail connections

CO2: Apply the knowledge of design to detail axial members, beams, andcolumns

CO3: Analyze, design and detail structural elements in a steel warehouse using a commercially available software

Course Content:

Unit:1

Preparation of Design basis report - recap of elevations, plan and section of buildings

Unit:2

Introduction to functions of detailing – Structural drawing for detailing – General detailing requirement – bar bending schedule - Transport, storage, fabrication, assembly and placing of steel reinforcement - Typical structural drawings - Welding

Unit:3

Detailing of (a) beams: singly, doubly, and T beams, (b) slabs: one-way, two-way, corners held down, and corners held up, (c) columns: axially loaded and bi-axially loaded, (d) beam-column joint: exterior, interior, corner, (e) footing: isolated and combined footing and (f) staircase.

Unit:4

Computer aided analysis, design, and detailing: Multi-Storey frame analyses.

Text Book(s)

- N. Krishna Raju, “Structural Design and Drawing – Reinforced Concrete and Steel”, Universities Press, 2005.
- M.L.Gambhir, “Design of Reinforced Concrete Structures”, PHI Learning, 2009.
- Pillai S.U. and Menon D, “Reinforced Concrete Design”, Tata McGraw Hill, 2009.

Reference(s)

- D.Krishnamoorthy, “Structural Design & Drawing- Vol-I&II”, CBS Publishers, 2012.
- Karve, Shah, “Illustrated Design of R. C. Buildings (G+3)”, Standard Publishers Distributors, 2008.
- Park and Paulay, “Reinforced Concrete Structures”, Wiley India (P) Ltd, 2010
- Varghese P.C., “Limit State Design of Reinforced Concrete”, PHI Learning, 2013
- P.Dayaratnam, “Design of Reinforced Concrete Structures”,Published by Medtech, New Delhi 2018
- Jain A.K., “Reinforced Concrete - Limit State Design- 7th Edition”, Nem Chand & Bros., 2012
- Sinha S.N., “Reinforced Concrete Design”, Tata McGraw Hill, 2014.
- BIS Codes (IS 456-2000, IS 875-1987Part (I&II), SP 16-1980, SP24-1983, SP34-1999)
- Arthur H Nilson, “Design of Concrete Structures”, Tata McGraw-Hill Publications, 2005

Semester- VIth

PCC (Design of Steel Structural Elements)

Course Code **L:T:P-3:0:0**

Rationale-

CLO1: To understand the provisions of IS800-2007 code of practice and apply this understanding to design axially loaded tension members.

CLO2: To study the behavior and design of compression using simple and built-up sections.

CLO3 To understand the behavior of flexural members and design the laterally restrained and unrestrained beams.

CLO4: To study the design of bolted connections and arranging field visit to industries.

CLO5: To study the design of welded connections and arranging field visit to industries.

Course Outcomes

CO1: Apply the IS code of practice for the design of steel structural elements.

CO2: Design compression using simple and built-up sections.

CO3: Understand the behavior of flexural members and design the laterally restrained and unrestrained beams.

CO4: Analyze the behavior of bolted connections and design them.

CO5: Design welded connections for both axial and eccentric forces.

Course Content:

Unit: 1

Introduction - elastic and plastic properties of steel sections – stress distribution under various internal forces. Design of axially loaded tension members - Types of tension members - modes of failures

Unit: 2

Design of axially loaded compression members – Plastic moment and shape factor -section classifications - effective length - slenderness ratio – simple sections – built- up sections - design of lacings and battens - single angle and double angle strut – continuous and discontinuous strut.

Unit: 3

Flexural members – types of steel beams – Lateral stability of beams –effective length - design of laterally restrained and unrestrained beams – rolled sections - built-up beams/compound beams – Design for strength and serviceability, web yielding, web crippling, bearing stiffeners.

Unit: 4

Bolted connections - types of bolts - resistance of bolted connections under various failure modes – shear moment resistant connections - design of beam and columns splice.

Unit: 5

Welded connections - types - strength of welds - design of fillet and butt welds - shear and moment resistant connections - design and detailing of connections. Note: Assignments include the design and drawings of various steel structural elements.

References

1 Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi 2008.

2 Shiyekar, M.R., Limit State Design in Structural Steel, PHI, 2013.

3 Bhavikatti, S.S., Design of Steel Structures, I.K. International Publishing House Pvt. Ltd., New Delhi, 2010

4 IS 800 - 2007, Code of practice for general construction in steel, Bureau of Indian Standards, New Delhi.

5 SP6 (1)-1964, IS hand book for structural Engineers. Bureau of Indian Standards, New Delhi.

6 Online Teaching Material – Institute for Steel Development and Growth (INSDAG)

PCC (Construction Technology and Project Management)

Course Code **L:T:P-3:0:0**

Rationale-

CLO1: To learn the principles of construction of building components

CLO2: To learn the various construction techniques and their application in real-world projects

CLO3: To learn the application of prefabricated construction and building services in real world projects

CLO4: To learn the different types of construction equipment and analyse the planning and operation of various equipment in project sites

CLO5: To comprehend the application of Industry 4.0 technologies in construction

Course Outcomes

CO-1 Describe the factors considered in planning and construction of building

CO-2 Estimate schedule of activities in a construction project

CO-3 Categorize the equipment used in construction

CO-4 Assess the safety practices in construction industry

CO-5 Outline tender and contract document for a construction project

Course Content:

Unit:1

Functional planning of Buildings: Types of Buildings, Aspects and Principles of Building Planning, Building By-laws and Regulations, Site Selection criteria, Orientation of Building and its relation to surrounding environment.

Unit:2

Sustainability and Green Buildings, Foundation and its requirements, Masonry construction and Materials used; Construction of Floors and Roofs; Functional requirements and planning of a staircase.

Unit: 3

Project Management: Role of Project manager, Stakeholders in construction project, Different types of projects, similarities & dissimilarities in projects., Time, Scope & Money, Knowledge areas & Processes involved in construction projects, WBS of a major work, Planning, monitoring & executing, Planning, sequencing, scheduling, Bar Charts, Networks, CPM, PERT, Cash flow diagram, resource levelling & resource allocation, Crashing of project, Earned Value Analysis, Construction finances- decision making.

Unit: 4

Safety in construction: Cost of Accidents - Safety norms - Safety aids, Damping causes, its effects, and Proofing techniques; Fire hazards, protection, and grading rules; Methods of thermal insulation and materials used.

Unit: 5

Equipment for construction: Earthwork - Concreting - Pavement – Hoisting etc. Estimation, Tenders & Contracts: EOI- Prequalification - Types of Contract - Terminology use. Advanced Construction Techniques: Construction of piles, tunnels, cofferdams, etc. Advanced formwork techniques-Slip form, Maivan, Doka, etc.

Learning Resources:

Text Books:

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

2. K. K. Chitkara, Construction Project Management, Tata McGraw Hill Publishing Company Limited, New Delhi, 2019, Fourth Edition

Reference Books:

1. R. L. Peurifoy, Construction Planning, Equipment and Methods, McGraw Hill Education, 2010

2. Punmia and Khandelwal K.K., Project Planning and Control with PERT and CPM, Laxmi Publications Delhi, 2016

3. Choudhary S, Project Management, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/106/105106149/

2. https://nptel.ac.in/courses/105/103/105103093/

Lab-I (Civil Engineering Software Laboratory)

Course Code **L:T:P-0:0:3**

Rationale-

CLO1: To understand and learn the managerial duties and responsibilities of a construction/project manager.

CLO2: To learn and estimate time and cost with regard to manpower, materials and equipment of a construction projects.

CLO3: To learn and apply concepts related to project planning and scheduling

CLO4: To learn the types of construction contracts and their drafting

CLO5: To learn the application of software in construction management

Course Outcomes

CO1: Identify software tools in analysis and design of Civil Engineering Systems

CO2: Apply the available open source software tools used for analyzing specific problems in Civil Engineering.

CO3: Develop Civil Engineering drawings using CAD software.

CO4: Apply latest software tools for Advanced Modelling and Design of Civil Engineering Systems.

Course Content:

1. MATLAB - Applications
2. Civil Drawing: CAD, AutoDESK,
3. SAP 2000/STAAD pro/ETABS, MSP, Primavera, REVIT
4. Geotechnical software: Plaxis/Geostudio/Rocscience,
5. Transportation software: MxRoad Suite/VISSIM & VISSUM
6. Water and Environmental Software: MIKE-SHE/HEC-HMS/SWMM/SWAT/EPANET/Open FOAM/EIA/LCA

Learning Resources:

1. Software Manuals

Lab-II (Computation, Design & Detailing- Steel Structures)

Course Code **L:T:P-0:0:3**

Rationale-

Course Outcomes

CO1: Apply the knowledge of design to detail beams and slabs

CO2: Apply the knowledge of design to detail columns, beam-column joints and footings

CO3: Analyze, design and detail structural elements in a multi-storey building using a commercially available software

Course Content:

Unit1

Draughting practice - Key Plan and General Arrangement – Basic Detailing Conventions - Shop drawings - Erection Drawings - Detailing Quality Control and Assurance.

Unit2

Detailing Bolts and bolted joints – Detailing Welds and Welded joints - Detailing of beams – columns – panel zones – braces- roof system - Steel buildings—case studies.

Unit3

Computer aided analysis, design and detailing: warehouse building with roof truss.

Text Book(s)

- N. Krishna Raju, "Structural Design and Drawing – Reinforced Concrete and Steel", Universities Press, 2005.
- D.Krishnamoorthy, "Structural Design & Drawing- Vol-III", CBS Publishers, 2015.
- MYH Bangash,"Structural detailing in steel - A comparative study of British, European and American codes and practices"
- Thomas Telford Publishing 2000
- _____, "Detailing for Steel Construction" ASIC 2009.

Reference(s)

- BIS Codes (IS 800-2007, IS 875-1987Part (I&II), SP 38-1987, SP40-1987, SP47-1988)
- _____, “Joints in Steel Construction: Moment Resisting Joints to Eurocode 3”, SCI Assessment
- _____, “Joints in Steel Construction: Simple Joints to Eurocode 3”, SCI Assessment.

Lab-II (Practice, Estimation & Costing)

Course Code **L:T:P-0:0:3**

Rationale-

Course Outcomes

CO1: Understand the ethics governing the profession and recognize the roles of stakeholders in professional practice.

CO2: Quantify the items of work and estimate material requirement for construction

CO3: Derive the cost rates and build up the overall cost of the structure.

CO4: Apply the technical specifications for various works to be performed for a project.

CO5: Understand and apply the basic principles for valuation of propertie.

Course Content:

Unit 1

Professional Practice – Respective roles of various stakeholders: Government; Standardization Bodies; professional bodies; Clients/ owners; Developers; Consultants; Contractors; Manufacturers/ Vendors/ Service agencies. Ethics – Definition, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Professional Responsibility, Conflict of Interest, Environmental breaches, Negligence.

Unit 2

Estimation - Measurements for various items- Introduction to the process of Estimation; Use of relevant Indian Standard Specifications for the same, taking out quantities from the given requirements of the work, comparison of different alternatives, Bar bending schedules, Mass haul Diagrams, Estimating Earthwork and Foundations, Estimating Concrete and Masonry, Finishes, Interiors, MEP works; Material survey-Thumb rules for computation of materials requirement for

different materials for buildings, Use of Computers in quantity surveying; BIM and quantity take-offs.

Unit 3

Specifications - Types, requirements and importance. Detailed specifications for common building materials and items of work as per I.S specifications - Preparation of conveyance statement - Calculation of quantities of materials for items of work - Analysis of rate for items of works required for civil engineering works. - Preparation of abstract of estimate of civil engineering works. Percentage breakup of the cost, cost sensitive index. Valuation - Purposes - Types of values – concept of time-value of money - sinking fund - years purchase - Depreciation - obsolescence – Methods of valuation - valuation of land and building – Marketable and nonmarketable properties.

Exercises / Term Work Assignments:

- Types of estimate - plinth area method - cubic rate method - unit rate method - bay method - approximate quantity from bill method - comparison method - cost from materials and labour - preparation of detailed estimate
- Preparation of detailed estimate using Centre line method
- Preparation of detailed estimate using Long wall - short wall method
- Preparation of detailed estimate for R.C.C Structures.
- Preparation of detailed estimate for Steel Structures.
- Preparation of detailed estimate for roads
- Preparation of detailed estimate for sanitary and water supply works
- Preparation of valuation report.
    - Assignments on:
        - market survey of basic materials
        - rate analysis
        - specifications
        - simple estimates.

Text Book(s)

- Chakraborti, M., “Estimation, Costing, Specification and Valuation in Civil Engg”, Chakraborti , 2008.
- B.N. Dutta “ Estimating& Costing in Civil Engineering Theory and Practice”, UBS Publishers & Distributors Limited, 2016.

Reference(s)

- Rangwala, Estimating, Costing and Valuation, Charotar Publishing House, 2017.
- B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.
- The National Building Code, BIS, 2016
- RERA Act, 2017
- Vee, Charles &Skitmore, Martin (2003) Professional Ethics in the Construction Industry, Engineering
- Construction and Architectural management, Vol.10, Iss2, pp 117-127, MCB UP Ltd
- American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application
- Ethics in Engineering- M.W.Martin & R.Schinzinger, McGraw-Hill
- Engineering Ethics, National Institute for Engineering Ethics, USA
- www.ieindia.org
- Engineering ethics: concepts and cases – C. E. Harris, M.S. Pritchard, M.J.Rabins
- Kohli, D.D and Kohli,R.C, "A text book of Estimating and Costing (Civil)", S.Chand& Company Ltd., 2004.
- IS : 1200 – 1974 – Parts 1 to 25, Methods of Measurement of Building and Civil Engineering Works, Bureau of Indian Standards, New Delhi.
- Standard Data Books of Central Public Works Departments and Public Work Department of States.

PE-III (Groundwater Hydrology)

Course Code **L:T:P-0:0:3**

Rationale-

Course Outcomes

CO-1 Assess groundwater flow and model regional groundwater flow

CO-2 Identify of groundwater source by groundwater prospecting

CO-3 Design water wells

CO-4 Manage groundwater resources

CO-5 Plan and design artificial recharge systems

Course Content:

Unit: 1

Groundwater occurrence – distribution – aquifer – types - Surface investigation - Geophysical - electrical resistivity - Seismic refraction - Gravity and magnetic - Geologic - Air photo interpretation - Dowsing.

Unit: 2

Subsurface investigation - test drilling - resistivity logging- potential logging - temperature and caliper logging. Steady unidirectional flow - well in a uniform flow - steady flow with uniform recharge - unsteady radial flow to a well - well flow near aquifer boundaries - Multiple well systems - partially penetrating wells - characteristic well losses.

Unit: 3

Secular and seasonal variations - Fluctuations due to evapo-transpiration, Meteorological phenomena, tides, external loads and earthquakes - control by drains and wells. Recharge through sewage pits, shafts and wells.

Unit:4

Occurrence of sea water intrusion - Ghypon-Heizberg relation between fresh and saline waters - shape length and structure of the fresh salt water interface – prevention and control of seawater

intrusion - role of sea water in ground water - coastal zoning. Sand models - Electrical models - Viscous fluid models - membrane models - numerical analysis methods.

References

- Raghunath H.M., Ground Water Hydrology, New-Age International, 2nd Edition, 1990.
- Todd, D.K, Ground Water Hydrology, Prentice hall, 2004

PE-III (APPLIED HYDRAULICS ENGINEERING)

Course Code **L:T:P-0:0:3**

Rationale-

Course Outcomes

CO1: To classify the types of flows in open channel and also to design open channel sections in a most economical manner.

CO2: To study about non uniform flows in open channel and longitudinal slopes in open channel and also to learn about the characteristics of hydraulic jump.

CO3: To develop an understanding of fluid flow patterns and learn to use boundary layer theory and Drag.

CO4: To Provide insights to the Open channel hydraulics and introduce dimensional analysis for fluid flow problems.

CO5: To understand the flow profiles and different methods of profile determination.

Course Content:

Unit: 1

Open channel flow and its classifications, and properties, energy and momentum principles, Critical flow computation and its applications, transitions with sub critical and super critical flows. Types and regimes of flow – Velocity distribution in open channel – Wide open channel

Unit: 2

Design of non- erodible channels for uniform flow, most efficient channel section, compound Sections. Velocity measurement – Manning's and Chezy's formula – Determination of roughness coefficients – Determination of normal depth and velocity. Gradually varied flow: Theory and analysis, gradually-varied flow computations in prismatic channels, gradually varied flow in non-prismatic channels. Characteristics of flow profiles –

Unit: 3

Draw down and back water curves – Profile determination – Graphical integration, direct step And standard step method – Flow through transitions

Unit: 4

Rapidly varied flow- Theory of hydraulic jump, evaluation of jump elements in rectangular and non-rectangular channel, location of jump on horizontal floor, channel controls and transition – surges

Unit: 5

Boundary Layer Theory: Introduction, Development of boundary layer over a flat plate, boundary layer thickness, displacement, momentum and energy thicknesses, Application of momentum equation to boundary layer flow, local and mean drag coefficients.

References

- Streeter, V.L. Fluid Mechanics, Tata McGraw Hill, 1998.
- Chow, V.T. Open Channel Hydraulics, Tata McGraw Hill, 1975.
- Nagaratnam, S. Fluid Mechanics, Khanna Publishers, 1989.
- Chaudhry, M and Hanif. Open Channel Flow. Englewood Cliffs, NJ: Prentice- Hall,1993.
- Chanson, H (2004b).The Hydraulics of Open Channel Flow-An Introduction,
- (Butterworth-Heinemann, Oxford, UK) 2ndEdition (ISBN 07506 59785).

PE-III (Simulation Modelling For Water Resources Engineering)

Course Code **L:T:P-3:0:0**

Rationale-

CLO1 To know different types of aquifers

CLO2 To understand the surface and subsurface investigation in detail

CLO3 To integrate the fundamental and basic knowledge of ground water movement

CLO4 To understand the process of sea water intrusion and recharge

CLO5 To introduce the different model studies

Course Outcomes

CO1 Incorporate skills in developing models for various systems.

CO2 Acquires knowledge on fundamentals of regression techniques.

CO3 Develops and improves the knowledge of dynamic programming and stochastic programming.

CO4 Apply neural networks and genetic algorithms for solving complex problems using AI techniques.

CO5 Provides basic knowledge on fuzzy system and optimization tools.

Course Content:

Unit: 1

Introduction – Concepts of systems and systems Analysis; Systems Techniques in Water Resources: Optimization with methods using calculus.

Unit: 2

Regression – linear regression - multiple regression – non-linear regression – types – modelling concepts – Probabilistic functions in hydrology- Monte Carlo simulation - Linear Programming- simplex method – dual simplex method - graphical method.

Unit: 3

Dynamic programming – forward recursion – backward recursion – water allocation problem –

shortest path algorithm – water distribution network – stochastic dynamic programming.

Unit: 4

Artificial Intelligence – Neural networks – concepts – back propagation – bias, neuron, weights - radial basis function – case studies – Genetic algorithm – ANN- basics.

Unit: 5

Optimization tool- roulette wheel selection – mutation – crossover- case studies Reservoir optimization – Fuzzy inference system – Fuzzy linear programming.

References

1. Chintalacheruvu Madhusudana Rao, Advanced Modelling and Innovations in Water Resources Engineering, Volume 176 of Lecture Notes in Civil Engineering, Springer Nature, 2021
2. Richard H. McCuen, Hydrologic Analysis and Design, Pearson Education, 2016
3. Russell & Norvig, Artificial Intelligence: A Modern Approach, Global Edition, 4, Pearson Higher Ed, 2021
4. Dimitri Bertsekas, Dynamic Programming and Optimal Control: Volume II; Approximate Dynamic Programming, Athena Scientific, 2012
5. Terano, Asai & Sugeno Applied Fuzzy Systems, Academic Press, 2014

PE-III (COASTAL ENGINEERING)

Course Code **L:T:P-0:0:3**

Rationale-

CLO1: To provide basic knowledge on two dimensional wave equation

CLO2: To describe the various types of wave theories.

CLO3: To study the effect of wave loads on different coastal structures

Course Outcomes

CO1: Develop knowledge in basics of wave hydrodynamics.

CO2: Provides understanding various aspects of coastal engineering.

CO3: Describes wave forces, wave pressures and currents in the coastal areas.

CO4: Improves knowledge on sea defence structures.

CO5: Develop knowledge in basics of wave hydrodynamics.

Course Content:

Unit: 1

Basic Fluid Mechanics: Conservation of mass and momentum, Euler Equation, Bernoullis equation, potential flow, stream function. Waves: Classification of water waves - Two dimensional wave equation and wave characteristics.

Unit: 2

Indian Scenario – Classification of Harbours. Introduction - wind and waves – Sea and Swell - Introduction to small amplitude wave theory – use of wave tables- Mechanics of water waves – Linear (Airy) wave theory, Introduction to Tsunami

Unit: 3

Wave theories - Small amplitude waves – Finite amplitude waves - Stoke, Solitary and CnoidalWater particle kinematics - wave refraction; wave breaking; wave diffraction random and 3D waves- Short term wave analysis – wave spectra and its utilities - Long term wave analysis- Statistics analysis of grouped wave data – Currents: Classification - Behaviour - Design Criteria,

Scour and other effects of currents

Unit: 4

Dynamic beach profile; cross-shore transport; along shore transport (Littoral transport), sediment movement – Estuaries – Creek – Harbour – Littoral drift.

Unit: 5

Field measurement; models, groins, sea walls, offshore breakwaters, artificial beach nourishment - planning of coast protection works - Design of shore defense structures – Case studies.

References

1. Subratakumar Chakrabarti, Handbook of offshore engineering, Volume 1, Elsevier, 2005
2. Coastal, Estuaries and Harbour Engineer's reference book, Michael Abbott, W Alan Price, CRC Press, 1993
3. Coastal Engineering Manual, U. S. Army Corps of Engineers, Books Express Publishing, 2012
4. Mani J.S, Coastal Engineering, Second Edition, PHI Learning Pvt. Ltd., 2018
5. Leo H. Holthuijsen, Waves in Oceanic and Coastal Waters, Cambridge University Press, 2007

PE-III (Ai/Ml For Water Resources Engineering)

Course Code **L:T:P-0:0:3**

Rationale-

CLO1: To learn the basics of AI and its use in civil engineering.

CLO2: To study the structure and learning processes of artificial neural networks (ANN).

CLO3: To understand genetic algorithms and their applications in water management.

CLO4: To learn about fuzzy logic and its applications in civil engineering.

CLO5: To study machine learning and the Internet of Things (IoT) for water resource management.

Course Outcomes

CO1 Describe AI and its applications in civil engineering.

CO2 Implement ANN to solve water resource problems like rainfall prediction.

CO3 Apply genetic algorithms for optimizing water distribution and irrigation.

CO4 Use fuzzy logic for reservoir operations and flood predictions.

CO5 Use machine learning and IoT in smart irrigation and water supply systems.

Course Content:

Unit: 1

Artificial Neural network and Application of ANN in water Resource-Artificial Intelligence (AI)-Definition-Development of AI-Types of AI-Application of AI of Civil Engineering- Uncertainty and towards Learning Systems-Optimisation –AI techniques. Artificial Neural Networks-Basics of ANN–Topology-Learning Processes-Supervised and unsupervised learning. Least mean square algorithm-Structural Properties-Feed forward ANN-Back Propagation-Advantages of ANN, Rainfall-runoff and stream flow prediction problems in ANN-Optimisation-ANN in Water Conservation

Unit: 2

Genetic Algorithm (GA) - Introduction-Biological background-Genetic algorithm (GA) vs traditional algorithm-Basic Terminologies in GA Advantages and limitations of GA-Applications of GA-water distribution network- Scheduling-Irrigation planning.Fuzzy logic and applications - Introduction of Fuzzy logic-Fuzzy sets-Fuzzy relations-Fuzzy rule and decision making-hybrid soft computing–Neuro fuzzy-Application of Fuzzy-

Unit: 3

Durability of self-Compacting concrete-Reservoir operation-Neuro fuzzy application in Reservoir operations- Flood predictions.

Unit: 4

Machine learning and its application - Introduction–Machine learning (ML) approaches-understanding pattern recognition-Advanced machine learning algorithm-machine learning applications-ML for Rainfall- runoff modeling, Flood prediction- Irrigation and crop-water demand predication.

Unit:5

Internet of Things (IoT) – Introduction - IoT Enabling Technologies-Domain Specific IoT Smart agriculture -Water supply and pumping operation - Surveillance-Emergency response of dams-weather monitoring-Forest fire detection-River flood detection - Smart irrigation.

References

1 Gebrail Bekdaş, Sinan Melih Nigdeli and Melda Yücel, Artificial Intelligence and Machine Learning

2 Applications in Civil, Mechanical, and Industrial Engineering, 2019 IGI, global. Australia

3 Sivanandam S N and Deepa S N, Principles of Soft computing 2011, Second Edition, Wiley, USA

4 Arshdeep Bahga, Vijay Madisetti, Internet of Things: A hands on approach, 2015, University Press, UK

5 Stuart J. Russell and Peter Norvig Artificial Intelligence A Modern approach, 2015, Pearson, India

6 S M Yadav Application of soft computing techniques in Civil Engineering, 2018, MV, learning, India

PE-III (HYDROCLIMATOLOGY)

Course Code **L:T:P-3:0:0**

Rationale-

CLO1: To understand Learn atmospheric dynamics, global carbon cycle's history and dynamics, including non-CO2 greenhouse gases and the greenhouse effect.

CLO2: To analyze climate change scenarios, sensitivity, and human-climate change links using econometric models and GHG emissions estimates.

CLO3: To learn how climate change affects precipitation patterns, evaporation and transpiration, and surface and groundwater systems.

CLO4: To Use various models to project climate scenarios, calibrate, validate, and

develop adaptation strategies.

CLO5: To Conduct risk assessments for floods and droughts, analyze rainfall trends, and evaluate sediment impacts on water resources.

Course Outcomes

CO1: Describe the carbon cycles, greenhouse gases, and greenhouse effects.

CO2: Develop and assess climate models, understanding their simulations and regional impacts.

CO3: Analyse the effects of climate change on precipitation, runoff, groundwater, and sea levels.

CO4: Use various models to project climate scenarios, calibrate, validate, and develop adaptation strategies.

CO5: Conduct risk assessments for floods and droughts, analyse rainfall trends, and evaluate sediment impacts on water resources.

Course Content:

Unit: 1

Climate change – historical perspectives cyclone - the Global Carbon Cycle, the Ocean Carbon Cycle, the Terrestrial Carbon Cycle, Modeling the Carbon Cycle- Non-CO2 Greenhouse Gases

and Aerosols- Greenhouse Effect: Temperature, Radiation, & Energy,

Unit: 2

Climate Scenarios - Developing climate models–Climate system model–Climate simulation and drift–Evaluation of climate model simulation–Regional (RCM)–Global (GCM)–Global average response to warming–Climate change observed to date. - Impacts of Climate Change- Climate change & policy options - IPCC details and actions –Kyoto protocol–Kyoto mechanisms, clean development mechanisms, Carbon credits-International and Regional cooperation.

Unit: 3

Climate Change impacts on Hydrological Processes - Changes in precipitation patterns - Surface runoff, Extreme flow – Flash flood - Groundwater recharges and its Impacts - Temperature raise effects on evaporation and transpiration- Sea level raise and its impact – Drought.

Unit: 4

Climate & Hydrological Models - Types of models (conceptual, empirical, physical)- Model calibration and validation- Climate Change Scenarios – down scaling - Incorporating climate projections in models - Scenario analysis and uncertainty- Adaptation Strategies - Sustainable water management – Unit:5

Unit: 5

Infrastructure adaptation for climate resilience Applications of Climate change on Hydrology and Water resource Flood and drought risk assessment – Rainfall trend, extreme and future trend of rainfall and temperature analysis – Sediment and reservoir volume assessment for future period - Real-world applications of climate change impact on hydrology and water resource.

References

- Kevin E. Trenberth: Climate System Modeling, Cambridge University Press
- Neelin David J, Climate Change and Climate Modelling, 2011, First Edition,
- Cambridge University Press,UK.
- Thomas Stocker, Introduction to Climate Modelling, Advances in Geophysical and
- Environmental Mechanics and Mathematics. 2011, Springer, UK
- Stephen Peak and Joe Smith, Climate Change: From science to sustainability, Oxford University Press
- IPCC (1995) Climate Change 1995: The Science of Climate Change, Cambridge Niv Press, Cambridge, UK
- Robert T. Watson, Marufu C. Zinyowera, Impacts, Richard H. Moss, Adaptation and mitigation of climate change-Scientific Technical Analyses, 1996, Cambridge University Press,

Cambridge, USA

PE-III (River Engineering)

Course Code **L:T:P-3:0:0**

Rationale-

CLO1 To develop the student's knowledge on basics of River engineering.

CLO2 To provide some knowledge about behaviour of Rivers.

CLO3 To develop understanding of River morphology.

CLO4 To make the student understand about unsteady flow in Rivers.

CLO5 To provide knowledge about River training works.

Course Outcomes

CO1: Understand the basics of River engineering.

CO2: Understand the concepts of River behavior.

CO3: Computer river morphology.

CO4: Understand the unsteady flow process in River.

CO5: Understand about different types of River training works.

Course Content:

Unit: 1

Classification of Rivers, channel and flood plain features, sediment budgets, river morphology.

Unit: 2

River channel patterns, causes, characteristics and prevention of meanders, cutoff characteristics, bed forms, delta form and control.

Unit: 3

Bed level variation in alluvial streams, continuity equation for sediment, equilibrium depth of scour in long channel contractions, silting of reservoirs, local scour, secondary currents, flow in rigid boundary open channel bends, scour and deposition at alluvial bends.

Unit: 4

Governing equations for one dimensional flow, hydrograph routing, kinematic routing, diffusion routing, Muskingum–Cunge routing.

Unit: 5

Introduction to river training, types of river training works, working of different river training structures, protection bridge, guide bund, embankment and spurs.

References

1 H. H. Chang, “Fluvial Processes in River Engineering”, Krieger Publishing Company, 1stEdition, 2008.

2 W. Wu, “Computational River Dynamics”, Taylor & Francis, 1stEdition, 2007.

3 P Y Julien River Mechanics, Cambridge university press, 2nd edition, 2018

4 M. H. Chaudhry, “Open channel flow”, Springer, 2ndEdition, 2008.

5 M. B. N. Al-BaghdadiK, “Progress in River Engineering & Hydraulic Structures”, Create Space Independent Publishing Platform, 1stEdition, 2018.

6 M M Das Open channel flow, PHI, 3rd edition, 2011

PE-III (WATERSHED MANAGEMENT)

Course Code **L: T:P-3:0:0**

Rationale-

CLO1: To define watershed and explain its role in hydrology, ecology, and urban planning.

CLO2: To discuss methods for controlling water quality and quantity, and evaluate and apply best management practices (bmps) for flood control and drought management.

CLO3: To identify causes and consequences of soil erosion, propose erosion control measures, and describe and implement water conservation techniques, including rainwater harvesting.

CLO4: To summarize key watershed management policies and regulations, and understand the roles and coordination of federal, state, and local agencies.

CLO5: To explore new technologies in watershed management and assess the impact of climate change on these practices.

Course Outcomes

CO1 : To describe the hydrological cycle, watershed components, and their roles in hydrology and urban planning.

CO2: To apply BMPs for water management and create a watershed management plan with stakeholder involvement.

CO3: To implement erosion control and water conservation practices to improve land and water management.

CO4: To comprehend and apply key watershed management policies, regulations, and the roles of various agencies.

CO5: To use new technologies in watershed management and address climate change impacts with adaptive strategies.

Course Content:

Unit: 1

Watershed management: hydrological processes: basic hydrology: the hydrological cycle and its components. Hydrological data collection and analysis: definition and importance of watershed: significance of watershed management in civil engineering. The role of watersheds in hydrology, ecology, and urban planning. Components of a watershed: watershed boundaries and delineation. Types of watersheds. Characteristics of watershed.

Unit: 2

Watershed management strategies: water quality and quantity control. Flood control and drought management. Best management practices (BMPS): structural BMPS. Non- structural BMPS. Watershed planning and implementation: steps in developing a watershed management plan. Stakeholder involvement and public participation.

Unit: 3

Soil and water conservation: soil erosion: types of erosion, causes and consequences of soil erosion, soil loss models. Erosion control measures, sediment management. Water conservation techniques: methods for efficient water use and management. Rainwater harvesting and its applications.

Policy and regulatory framework: legal aspects: overview of watershed management policies and regulations. Key legislation related to water resources and environmental protection. Institutional framework: roles of various agencies and organizations in watershed management. Coordination among federal, state, and local authorities.

Unit: 4

Emerging trends and technologies: innovations in watershed management: new technologies and methods in watershed management. The impact of climate change on watershed management practices. Case studies and applications.

References

1 Chow, V.T. Handbook Of Applied Hydrology. Mc Graw-Hill, New York.

2 Dutta, S.K. Soil Conservation And Land Management, International Book Distributors.

3 Rattan, Lal. Soil Erosion In The Tropics: Principles And Management. Mcgraw-Hill.

4 Wurbs, R.A. And James, W.P. Water Resource Engineering. Prentice Hall India Learning Private Limited.

5 Brooks, K. N., Ffolliott, P. F., And Magner, J. A. Hydrology And The Management Of Watersheds. John Wiley & Sons.

PE-III (Water Resourcecs Systems Planning)

Course Code **L: T: P-3:0:0**

Rationale-

CLO1 To know the concept of system analysis

CLO2 To get knowledge on optimisation techniques, concepts and types

CLO3 To learn the classical optimisation techniques and simulation techniques

CLO4 To get introduced in to various optimisation algorithms and decision-making criteria

CLO5 To solve reservoir optimisation problems by using various optimisation techniques.

Course Outcomes

CO1: To describe the hydrological cycle, watershed components, and their roles in hydrology and urban planning.

CO2: To apply BMPs for water management and create a watershed management plan with stakeholder involvement.

CO3: To implement erosion control and water conservation practices to improve land and water management.

CO4: To comprehend and apply key watershed management policies, regulations, and the roles of various agencies.

CO5: To use new technologies in watershed management and address climate change impacts with adaptive strategies.

Course Content:

Unit: 1

Overview of the course, concepts of systems analysis, water resources planning, Modelling techniques, objectives and constraints, overview of optimization techniques.

Unit: 2

Linear programming, graphical method, simplex method, sensitivity analysis, duality. Dynamic

programming, concepts, formulation of recursive equation.

Unit:3

Classical optimization techniques, Lagrange methods, Kuhn-Tucker conditions, Search techniques, Stochastic optimization techniques, chance constrained LP, stochastic dynamic programming, decision making under uncertainty, fuzzy optimization. Overview of multi objective optimization, multi criteria decision making, Simulation- optimizations.Overview of Genetic Algorithm and other evolutionary algorithms Economic analysis, discounting techniques, benefit cost evaluation. River basin modelling, storage-yield relation, reservoir design and operation.

Unit:4

Overview of applications of optimization and simulation techniques in hydrologic and water resources systems – irrigation management, water quality management, groundwater management, water conveyance and distribution systems.

References

1. K. Deb, Multiobjective Optimization Using Evolutionary Algorithms, John Wiley And Sons, 2001.
2. K.M. Ravindran, G.V. Reklaitis, Engineering Optimization – Methods And Applications,John Wiley And Sons, 2006.
4. S.S. Rao, Engineering Optimization, New Age International (P) Ltd. Publishers, 2000.
5. Vedula S. And Mujumdar P.P., 'Water Resources Systems: Modelling Techniques And Analysis', Tata-Mcgraw Hill, 2005.
6. Jain S.K. And Singh V.P., 'Water Resources Systems Planning And Management', Elsevier, The Netherlands, 2003.

PE-IV (Concrete Technology)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1: Select the suitable ingredients for concrete and suggest suitable laboratory test to check its property.

CO2: Evaluate the properties of ordinary concrete and special concrete based on the destructive and non -destructive tests.

CO3: Evaluate durability related issues in concrete and suggest preventive measures.

CO4: Apply the modern methods in concrete manufacturing

CO5: Proportion the concrete mixtures to meet performance requirements.

Course Content:

Unit: 1

Materials: cement - different types - chemical composition and physical properties - tests on cement - I.S. specifications - aggregates - classification - mechanical properties and tests as per I.S. - alkali aggregate reaction grading requirements - heavy weight - light weight - normal weight - aggregate - sampling of aggregate – water-quality of water - admixtures - accelerators - retarders - water reducing agents – super plasticizers- use of silica fumes Properties of fresh concrete - workability - factors affecting workability - tests for workability - segregation and bleeding.

Unit: 2

Properties of hardened concrete - factors affecting strength of concrete - strength of concrete in compression, tension and flexure - stress- strain characteristics and elastic properties - shrinkage and creep - durability of concrete - permeability - chemical attack - sulphate attack - resistance to abrasion and cavitation - resistance to freezing and thawing - resistance to fire - marine atmosphere - quality control - frequency of sampling - test specimens - statistical analysis of test results - standard deviation - acceptance criteria

Unit: 3

Manufacture of concrete - measurement of materials - storage and handling - batching plant and equipment - mixing - types of mixers - transportation of concrete - pumping of concrete - placing of concrete - under water concreting - compaction of concrete - curing of concrete - ready mixed concrete

Unit: 4

Mix proportioning - nominal mixes - design mixes - factors influencing mix design - A.C.I method - I.S method design for high strength mixes. Special concretes - lightweight concrete - high density concrete - vacuum concrete - shotcrete - Fibre reinforced concrete-polymer concrete - ferrocement - high performance concrete - self compacting concrete. Introduction to Non-destructive test methods.

Text book(s)

- Neville.A.M. and Brooks.J.J., "Concrete Technology", Pearson Education, 2006.
- Santha Kumar, A. R., "Concrete Technology", Oxford University Press, 2018.

Reference(s)

- Mehta, P.K. and Monteiro, P.J.M., "Concrete - Microstructure, Properties and Materials", McGraw Hill Education, 2017.
- Shetty, M. S, "Concrete Technology-Theory and Practice", S. Chand & Co., New Delhi, 2018.
- A.M. Neville, "Properties of Concrete", Pearson Education, 2012.

PE-IV (REPAIR AND REHABILITATION OF STRUCTURES)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1: Apply the knowledge of construction materials and techniques to analyze building durability problems

CO2: Evaluate the common defects and distress in construction through diagnostic procedures

CO3: Select suitable materials and methods for protection and repair.

CO4: Apply maintenance and strengthening approaches to situations

CO5: Analyze and develop report for simple maintenance and repair problems.

Course Content:

Unit 1

Durability: Life expectancy of different types of buildings – influence of environmental elements such as heat, moisture, precipitation and frost on buildings- Effect of biological agents like fungus, moss, plants, trees, algae termite control and prevention - chemical attack and impact of pollution on building materials and components- Aspects of fire damage and assessment.

Unit 2

Building failures – causes and effects - cracks in buildings – types, classification. Investigation and condition assessment – Semi-destructive and Non -destructive testing methods.

Common defects in buildings and control measures - maintenance philosophy - phases of maintenance. Materials for repair - special mortar and concretes, concrete chemicals, admixtures, special cements and high grade concrete.

Unit 3

Techniques for repair - surface repair – material selection – surface preparation - rust eliminators and polymer coatings for rebars – repair methods of cracks in concrete and masonry - epoxy injection. Guniting and shotcreting. Waterproofing methods.

Unit: 4

Strengthening measures- flexural strengthening, beam shear capacity strengthening, column strengthening, shoring, under pinning and jacketing Conservation of historic buildings -materials and methods - examples.

Text book(s)

- Peter H. Emmons, "Concrete Repair and Maintenance", Galgotia Publications, 2010. Vidivelli.B., "Rehabilitation of Concrete Structures", Standard Publishers, 2009.

Reference(s)

- James Douglas, Bill Ransom, "Understanding Building Failures", Taylor & Francis Group, 2007. Philip.H.Perkins,"Repair, Protection and Water proofing of Concrete Structures", E & FN Spon, 1997.
- SP : 25 - 1984, "Causes and prevention of cracks in buildings", BIS Santhakumar.A.R., "Concrete Technology", Oxford University Press, 2018.
- Sidney M. Johnson, "Deterioration, Maintenance and Repair of Structures", Krieger Publishing Company, 1980.

PE-IV (Introduction To Architectural Science)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1: Apply knowledge of architectural design principles to critically evaluate building form and space

CO2: Apply knowledge of thermo-physical properties of materials in evaluating heat flow through buildings

CO3: Evaluate quality of indoor climate based on thermal comfort indices and suggest control methods

CO4: Evaluate the natural and artificial lighting of indoor spaces

CO5: Apply knowledge of behavior sound in free field and enclosures to analyze acoustical features.

Course Content:

Unit 1

Principles of architectural design: Factors influencing architectural development-examples. Primary elements – Form and Space. Organizing principles in architecture – symmetry – hierarchy – axis, linear, concentric, radial – asymmetric grouping- Primary and secondary masses. Principles of architectural composition – unity – balance- proportion – scale –rhythm – harmony – contrast. Role of colour, texture, shapes/forms in architecture. Forms related to materials and structural systems. Architecture as part of the environment.

Unit 2

The Thermal Environment: Climatic elements: classification of climates. Earth'sthermal balance. Thermal balance of human body – thermal comfort indices – comfort zone.Thermo-physical properties of building materials: resistance and transmittance - solar gainfactor. Heat flow through buildings – thermal transmittance of structural elements - periodic heat flow. Sun-building relationship. Design criteria for control of climate – passive and active approaches.

Unit 3

The Luminous Environment: Types of visual tasks – principles of day lighting – day light factor - evaluation of lighting by windows, skylights. Artificial lighting – illumination requirements –

lamps and luminaries. Design of artificial lighting – Lumen method – Point by point method. The Sonic Environment: Physics of sound – airborne and structure borne propagation –behavior of sound in free field and enclosures – design criteria for spaces – acoustical defects – sound reduction,sound insulation and reverberation control – acoustic materials – types and fixtures.

Potential case studies

1. Critical review based on architectural design principles - ancient/monumental/modern buildings
2. Case study on thermal or visual comfort audit for a commercial/office building
3. Exposure to Energy simulation tools

Text book(s)

- Francis D.K.Ching, "Architecture-Form, Space and Order", John Wiley NP, 2015
- Steven V. Szokolay., "Introduction to Architectural Science - The Basis of Sustainable Design", Routledge, 2014.

Reference(s)

- Muthu Shobha Mohan, "Principles of Architecture", Oxford University Press, 2006.
- Koenigseberger., "Manual of Tropical housing and Building – Climatic Design", Universities Press, 2010.
- Bureau of Indian standards, Handbook on Functional Requirement of Buildings – SP:41(S and T) – 1987 Krishnan, "Climate Responsive Architecture", McGraw Hill Education, 2017.

PE-IV (SUSTAINABLE DESIGN OF BUILDINGS)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1: Analyse the influence of climate on comfort levels in built environment.

CO2: Assess building energy issues and suggest design options.

CO3: Propose strategies for water conservation and waste recycling.

CO4: Apply green project management concepts in building construction.

Course Content:

Unit 1

Introduction to Sustainability: Overview of Sustainability and Green buildings, Selection of site –preservation and planning.Climatology: Basics of climatology, Influence of climate on buildings, Earth –Sun relationship. Heat transfer in buildings: Conduction/Convection/radiation heat transfer Comfort in Buildings: Thermal comfort - Strategies for Thermal comfort. Visual comfort – Enhancement strategies for Daylighting and Artificial lighting. Building Acoustics – defects and prevention of sound transmission. Indoor Air Quality - integrated approach for IAQ management. Sustainable building materials: Features of sustainable building materials and sustainable alternatives.

Unit 2

Resource and waste management in buildings: Energy efficiency –Energy efficiency in building envelope, energy simulation, Energy management system –lighting and renewable energy and Energy Audit. Water Efficiency –Planning and design of water management system,

Unit: 3

Rain water harvesting, Water efficient design and fixtures, Treatment and reuse, Water efficient landscape system.Waste management –Types of waste and its treatment methods, Construction and demolition waste management, Waste management in residential, commercial buildings, healthcare facilities.

Unit 4

Green project management and Life Cycle Assessment of Buildings:Green building evolution and Different phases of Green building project management. Life cycle assessment and its types –Modelling and Analysis, Greenhouse gas emission Sustainability rating systems: Green building rating systems-LEED, BREEAM and others, Indian Green building rating systems – IGBC & GRIHA, IGBC criteria for certification.

Potential case studies

1. Case study on thermal comfort audit for a commercial building
2. Energy audit for commercial building
3. Exposure to Energy simulation tools

Text Book

- Sustainable Building Design Manual- Volume II", Published by TERI, New Delhi, 2009.

Reference(s)

- Kibert, C.J., "Sustainable Construction: Green Building Design and Delivery", Wiley, 2022.
- Steven V. Szokolay., "Introduction to Architectural Science - The Basis of Sustainable Design", Routledge, 2014.
- Sandy Halliday, "Sustainable Construction", Routledge, (Taylor & Francis Group), 2013.
- Dejan Mumovic and Mat Santamouris (Ed), "A Handbook of Sustainable Building Design and Engineering", Routledge, 2021
- Francis D. K. Ching, Ian M. Shapiro, "Green Building Illustrated", Wiley, 2020.

PE-IV (Construction Economics and Finance)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1: Apply time-value of money concept to compare alternatives

CO2: Analyse equipment cost and replacement alternatives.

CO3: Prepare different types of cost estimates

CO4: Understand the financial management procedures and estimate the financial ratios

Course Content:

Unit 1

Engineering economics : Basic principles – Time value of money, Quantifying alternatives for decision making, Cash flow diagrams, Equivalence- Single payment in the future (P/F, F/P), Present payment compared to uniform series payments (P/A, A/P), Future payment compared to uniform series payments (F/A, A/F), Arithmetic gradient, Geometric gradient. Funds: cash flow, sources of funds; Histograms and S-Curves. Earned Value.

Unit: 2

Comparison of alternatives: Present, future and annual worth method of comparing alternatives, Rate of return, Incremental rate of return, Break-even comparisons, Capitalized cost analysis, Benefit-cost analysis.

Unit: 3

Depreciation, Inflation and Taxes Equipment economics: Equipment costs, Ownership and operating costs, Buy/Rent/Lease options, Replacement analysis.

Unit: 4

Cost estimating: Types of Estimates, Approximate estimates – Unit estimate, Factor estimate, Cost indexes, Parametric estimate, Life cycle cost. Financial management: Construction accounting, Chart of Accounts, Financial statements – Profit and loss, Balance sheets,

Financial ratios, Working capital management.

Text book(s)

- Bose, D. C., "Fundamentals of Financial management", 2nd ed., PHI, New Delhi, 2011.
- Prasanna Chandra, "Projects: Planning, Analysis, Selection, Financing, Implementation and Review", McGraw- Hill Education, 2019.

Reference(s)

- Gould, F. E., "Managing the Construction Process", 4th ed., Pearson Education, 2012.
- Harris, F., McCaffer, R. and Edum-Fotwe, F., "Modern Construction Management", 6th ed., Wiley India, New Delhi, 2012.
- Jha, K. N., "Construction Project Management, Theory and Practice", Pearson, New Delhi, 2015. Peurifoy, R. L. and Oberlender, G. D., "Estimating Construction Costs", 6th ed., McGraw-Hill, 2015.

PE-IV (Safety For Professionals)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1: Understand and interpret the significance of occupational health and safety. CO2: Assess safety metrics and safety performances.

CO2: Understand the need for safety regulations and legislation at the national level and infer their importance.

CO3: Evaluate workplace hazards and incidents using various analysis and investigation techniques.

CO4: Understand the Safety and health management system and identify its fundamental requirements

Course Content:

Unit 1

Significance of occupational safety and health at workplace.

Unit:2

Classification of incidents -Calculation of safety metrics- Safety legislation in India - Safety in design.

Unit 3

Workplace hazards and control - Role of the working environment in safety -Safe systems of work -Hazardous material handling - Hazard analysis techniques.

Unit 4

Process safety management -Occupational health and hygiene -Incident investigation procedures —Safety and health management systems.

Textbooks/Reference books:

- Reese. C.D and Eidson J.V, Handbook of OSHA Construction Safety and Health, Second Edition, CRC Press, Boca Raton, 2006.
- Reese, Charles D.. Occupational Safety and Health: Fundamental Principles and Philosophies. United States, CRC Press, 2017.

- Jimmie W. Hinze "Construction Safety", Prentice Hall of India, 1997.
- Harris .F, McCaffer .R and Edum-Fotwe .F, Modern Construction Management, Sixth Edition, Blackwell Publishing, Oxford, 2006.
- Holt S. J, Principles of Construction Safety, Blackwell Publishing, Oxford, 2008.

PE-IV (Building Information Modelling)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1: Create BIM model for effective coordination during planning, design and execution.

CO2: Identify clash and avoid it's occurrence.

CO3: Apply the concept of BIM 4D for project scheduling

CO4: Apply the concept of 5D BIM for quantity takeoff and estimation

Course Content:

Unit 1

Building Information Modeling – Introduction & Process, Evolution of BIM, BIM Model -of various buildings like Commercial & Residential, WTP, Transportation, Airports. Isometric View – Introduction, Examples and Problems. 3D Modeling Design Authoring – Workflow, Discipline Based Modeling, Architectural, Engineering Analysis, Structural Analysis, HVAC, Electrical, Plumbing, Energy Analysis, Lighting Analysis, Design Review. Views in Model, Visualization Modes, Walkthrough & Fly through the Model, Layers & Properties, AR, VR & MR.

Unit 2

Clash Check, Types of Clashes, Federated Model - Clash avoidance process, Clash Detection Process – Introduction, Clash Detection - Priority Matrix, Clash Detection – Rules, Clash Detection – Report, Clash Detection – Grouping, Clash Detection - Roles & Responsibilities, Clash Detection Process – Demo. CDE, Level of Development (LOD)- Level of Detail & Level of Information, LOD - for all elements- Chart & Matrix

Unit 3

Project Schedule, 4D BIM Modeling, Construction Analysis, 3D Control & Planning, BIM for Safety, Disaster & Risk Analysis, Digital Fabrication, Phase Planning, As-built/Record Models.

Unit 4

5D BIM and Quantity Take off with UOM, Exercise & Demo, Quantity Take Off, 5D – Estimation and Analysis, Cost Control, Asset Information Model, COBie and Deliverables, Space Attributes, Asset Attributes and Asset requirement, Infrastructure System, Information Exchange with Facility Management. Industrialization of Construction through BIM – DfMA, IoT in BIM, Data analytics using AI and ML, Smart Infrastructure, Digital Twin –Connected Infrastructure.

TEXT BOOKS / REFERENCES:

- Karen Kensek and Douglas Noble, Building Information Modelling: BIM in Current and Future Practice
- Wiley; 1st edition (15 August 2014)
- Andre Borrmann, Markus Konig, Christian Koch, JakobBeetz, Building Information Modelling, Springer 2015
- Rafael Sacks, Chuck Eastman, Ghang Lee, Paul Teicholz , BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, Wiley; 3rd edition (2 October 2018)
- ISO 19650 – 2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM)

PE-IV (Construction Equipment And Techniques)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1: Explain the working principles of construction equipment.

CO2: Ability to select appropriate equipment for earth moving, tunneling, concreting, mining and quarrying

CO3: Assess equipment performance and implement maintenance practices.

CO4: Apply safety norms during equipment utilization

Course Content

Unit 1

Basics and Hydraulics of Construction Equipment: Introduction to Construction Equipment- Functions, Operations of Construction Equipment- Introduction to Four & Two Stroke Engine and their components- Introduction and Components to Automobiles. Introduction to Principles of Hydraulic- Calculation of Pressure, Force & Flow- Components of a Hydraulic System- Basic layout of Hydraulic System- Applications of Hydraulics- Strand Jack Operation

Unit 2

Concreting, Earth Moving, Road Making and Quarry/Mining Equipment: Operations of a Batching Plant - Introduction and Components of Concrete Pump & Placer- Concrete Pipeline- Laying and Cleaning- Bulldozer- Classification and Components- Classification, Components and Attachments of Excavator- Backhoe Loader- Classification & components-

Unit: 3

Introduction and classification to Hot mix Plant- Process of Asphalt Paver-PQC Paver- Classification & Components- Motor Grader- Classification & Components- Horizontal Movement Vehicles- Quarry/Mining. Tunnelling Equipment / Piling Equipment: Introduction to Tunnel Boring Machines- Details and Operation of a Hard-Rock TBM- Details of Earth Pressure Balance (EPB) TBM- Details and operation of Slurry TBM & Components- Hydraulic Grabs-

Piling Rig.

Unit 4

Equipment Life Cycle Management:Life Cycle of an Equipment- Equipment Performance Parameters - Introduction to Maintenance- Types of Maintenance- Maintenance Practices Mechanization and Digitalisation in Construction and Safety in Construction Equipment: Importance of Digital Analytics- Digital Solution in Construction Projects- Importance of Mechanisation - Railway Track Construction- Rebar Processing Machine- Operation of Mechanised Equipment- Introduction to 3D Concrete Printer- Importance of Safety- Various PPE & Purpose- Safety of Men & Machines at Work- Safety During Construction Activities- Safety with Tools & Tackles.

TEXT BOOKS/ REFERENCES

- R.L.Peurifoy, C.J. Schexnayder, R.L.Schmitt. and A.Shapira, Construction Planning, Equipment, and Methods, McGraw Hill Education, 2018.
- F. Harris, Modern Construction and Ground Engineering Equipment and Methods, Second Edition, Longman, London, 1994.
- D.G. Gransberg, C.M. Popescu and R.C. Ryan, Construction Equipment Management for Engineers, Estimators, and Owners, CRC Press, 2006.
- D.A.Day and N.B.H. Benjamin, Construction Equipment Guide, Second Edition, Wiley, New Jersey, 1991.
- J.E.Schaufelberger andG.C.Migliaccio, Construction Equipment Management, Routledge, 2019

PE-IV (Water Resources Systems Planning and Design)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1: Understand the water resources systems and express it using mathematical models.

CO2: Formulate and solve various optimization models of water resources planning and management problems.

CO3: Identify the advantages and limitations of various modeling methods and algorithms used in water resources planning and management.

CO4: Use the simulation and optimization models for planning and management decision making

Course Content

Unit: 1

Water systems engineering –scope and approach. Issues and the systems planning approach- water system dynamics- water resource development alternatives Water systems planning objectives- Constraints and Criteria

Unit: 2

Economic and Econometric principles Hydrologic input analysis, Demand analysis, System elements & Subsystem planning - Stochastic planning and management - Design and management issues.

Unit: 3

Optimization methods and their application in Water resources systems. Linear programming and Dynamic programming models. Problem formulation for water resources systems – Multi objective planning – Large scale system analysis- Case studies.

Unit: 4

Ground water system planning – Conjunctive surface and groundwater development- Hierarchical approach- Water quality management planning- Regional planning- Policy issues.

Reference(s)

- Vedula S. and Mujumdar P P, “Water Resources Systems: Modelling techniques and analysis”, Tata – McGraw Hill, 2007.
- S K Jain, V P Singh, “Water Resources Systems Planning and Management”, Elsevier Science, 2003
- Maass. A. et.al., “Design of Water Resources Systems”, Harvard University Press 2013.
- M. C. Chathurvedi , “Water Resources Systems: Planning & Management”, Tata McGarw Hill Publications, 1987.
- Louks D P et.al, “Water Resources System Planning and Management: An introduction to methods, models and applications”, UNESCO, Paris, 2017.
- Goodman. A.S. and Major. D.C.,“Principles of Water Resources Planning”, Prentice Hall, 1984.

PE-IV (Traffic Engineering and Management)

Course Code **L: T: P-3:0:0**

Rationale-

CLO1: The components of a traffic stream

CLO2: Data collection through traffic surveys

CLO3: The fundamental relationships of traffic flow

CLO4: Capacity estimation of different types of intersections

CLO5: The contributory factors and analyses of accidents

CLO6: The traffic flow at a microscopic level

Course Outcomes

CO1: Understand the road traffic components and their characteristics in traffic engineering

CO2: Conduct different types of traffic engineering studies and perform basic statistical analysis of traffic data

CO3: Use speed-flow relationships and analyse the capacity of different kinds of intersections

CO4: Understand elements of road safety and approaches to accident studies

CO5: Use different distribution models and analyse traffic flow characteristics

Course Content

Unit: 1

Introduction - Objectives and scope of traffic engineering - Components of road traffic: vehicle, driver androad. Road user and vehicle characteristics and their effect on road traffic.

Unit: 2

Traffic manoeuvre. Traffic Surveys - Objectives, methods, equipment's used for data collection, analysis and interpretation. Traffic Forecast: General travel forecasting principles, different methods of traffic forecast, Softwares for statistical analysis

Unit:3

Concept of Design vehicle units and determination of PCU under mixed traffic conditions. Traffic Stream Characteristics - Relationship between Speed, Flow and Density. Determination of design

hourly volume. Highway Capacity: Factors affecting capacity, level of service; Capacity studies - Capacity of different highway facilities including unsignalised and signalised intersections

Unit: 4

Accident Analysis - Analysis of individual accidents and statistical data, Methods of representing accident rate. Factors in traffic accidents - influence of roadway and traffic conditions on traffic safety. Shock waves, Queuing theory and applications. Probabilistic Aspects of Traffic Flow - Vehicle arrivals, distribution models, gaps and headway distribution models; gap acceptance merging parameters, delay models

Text book(s)

- Elena S. Prassas, Roger P. Roess, William R. McShane, "Traffic Engineering", Pearson, 2010. Kadiyali, L. R., "Traffic Engineering and Transport Planning", Khanna Publishers, 2013.

Reference(s)

- O' Flaherty C. A., "Traffic Planning and Engineering", Elsevier India, 2006.
- Fred L. Mannering, Scott S. Washburn, and Walter P. Kilareski, "Principles of Highway Engineering and Traffic Analysis", Wiley, 2011.
- Pignataro, L., "Traffic Engineering - Theory and Practice", Prentice Hall, 1973.
- Institute of Transportation Engineers, "Transportation and Traffic Engg. Hand Book", 6th edition, 2009.
- Guidelines for the Design of At-Grade Intersections in Rural and Urban Areas, 1994.
- Leonard Evans, "Traffic Safety", Science Serving Society, 2004.
- Michael, A. P. Taylor, William Young, and Peter W. Bonsall, "Understanding Traffic Systems", Ashgate Publishing, 2000.
- Mike Slinn, Paul Matthews, Peter Guest, "Traffic Engineering Design - Principles and Practice", Butterworth- Heinemann, 2005.

OE-I (Remote Sensing And GIS)

Course Code **L: T: P-3:0:0**

Rationale-

CLO1: Explain the basic concepts of Remote Sensing and EM Spectra and the different types of satellite and sensors.

CLO2: Expose to the concepts of Photogrammetry and its applications

CLO3: Illustrate Energy interactions (with atmosphere and surface features) and Interpretation of satellite images

CLO4: Explain different components of GIS and its applications

CLO5: Develop knowledge on using GIS data and working with GIS software.

Course Outcomes

CO1: Understand principles and identify the components of remote sensing and EMR.

CO2: Schematize the process of data acquisition of satellite images and their characteristics

CO3: Understand the principles and identify the components of Photogrammetry and Thematic maps

CO4: Visualize the Remote sensing digitally with digital image processing techniques.

CO5: Apply Remote sensing and GIS in different engineering contexts

Course Content

Unit: 1

Remote Sensing – Principle - Electro-magnetic energy, spectrum - EMR interaction with atmosphere – Atmospheric Windows and its Significance – EMR interaction with Earth Surface Materials – Spectral Signature and Spectral Signature curves for water, soil and Earth Surface.

Unit: 2

Satellites - Classification – Satellite Sensors – satellite and sensor parameters -Resolution – Types of Remote Sensing - Visual Interpretation of Satellite Images – Digital Image processing – Characteristics of different platforms: Landsat, SPOT, IRS series, IKONOS, QUICKBIRD – Radar, LIDAR, SAR, MODIS, AMSRE, Sonar remote sensing systems introduction of GPS- data receiving mode- DTM generation- View shed analysis.

Unit: 3

GIS - History of Development - Components of GIS – Hardware, Software and Organizational Context – Data – Spatial and Non-Spatial – Data Input Sources— DBMS – Data Output - Data models - Raster and Vector data structures – Data compression – Raster vs. vector comparison.

Unit: 4

Analysis using Raster and Vector data – Operations – Overlaying - Buffering – Modelling in GIS - Digital Terrain Modelling, Analysis and application – Products of DEMs and their uses – Sources of errors in GIS and their elimination. Applications of Remote Sensing and GIS – Advanced applications of GIS – Disaster management, Water resource, Landuse – Land cover – Urban planning - Intelligent Transport Systems - Development of Resources Information Systems.

References:

1 Burrough P.A. and Rachel A. McDonell, Principles of Geographical Information Systems, Oxford Publication, 2004.

2 C.P. Lo and Albert K. W. Yeung, Concepts and Techniques of Geographical Information Systems, Prentice- Hall India, 2006.

3 Thomas. M. Lillesand and Ralph. W. Kiefer, Remote Sensing and Image Interpretation, John Wiley and Sons, 2003.

OE-I (OCEAN ENERGY)

Course Code **L: T: P-3:0:0**

Rationale-

CLO1 Learn the basics of ocean environment

CLO2 Understand the concept of wave measurement and linear wave theory

CLO3 Learn the ocean tidal current turbulence and wave energy systems

CLO4 Develop model testing techniques for marine current turbines

Course Outcomes

CO1 Understand the basics of ocean energy sources

CO2 Capable of understanding the concepts of measurements of current and tides by using measuring devices

CO3 Understand the different types of marine turbines

CO4 Improves knowledge on water turbines, Electrical operations and marine safety

CO5 Understand OTEC

Course Content

Unit: 1

Introduction to the ocean environment - Ocean circulation and stratification - Ocean habitat- Ocean economy - Ocean surface waves - Wave measurement - Linear wave theory - Wave spectrum - Wave energy resource

Unit: 2

Ocean tidal currents - Current measurement - Current turbulence o Current energy resource - Site selection and characterization for ocean energy system - Wave energy systems - Types of wave energy converters - Linear wave-structure interactions - Frequency domain analysis - Hydrodynamic coefficients and their computation - Time domain analysis - Phase control Arrays

Unit: 3

Model testing techniques - Marine current turbines - Types of marine current turbines Hydrodynamic models (BEM, Lifting line, IBEM) - Hydrofoil data and analysis Cavitation and strength - Design criteria - Multiple turbine interaction - Other types of energy systems o- Ocean Thermal Energy Conversion (OTEC) - Energy from salinity gradient

Unit: 4

Power take-off systems - Air turbines, Water turbines - High pressure hydraulic systems - Electrical generation - Energy storage - Mooring and anchoring systems. Operation and maintenance of ocean energy devices - Offshore operations - Maritime safety issues

References

- Sorensen, Bent, Renewable Energy, Its Physics, Engineering , environmental impacts, economics, and planning, 3rd Ed. Elisver Academic Press, London, 2004.
- Twidell, John and Weir, Tony, Renewable Energy Resources, Taylor and Francis, 2005

OE-I (Urban And Regional Planning)

Course Code **L: T: P-3:0:0**

Rationale-

CLO1 To develop an awareness about the trends in urbanization

CLO2 To understand the basic principles and concepts of urban planning

CLO3 To learn the laws and regulations related to the planning process existing in the country.

CLO4 To be acquainted with the various stages of the planning process

CLO5 To get introduces to the various agencies and organizations involved in the planning process

Course Outcomes

CO1: Demonstrate the various process involved in urban planning.

CO2: Apply the laws and governmental policies related to the planning process.

CO3: Implement the classical urban planning principles.

CO4: Apply the methods of financing of plans.

CO5: Demonstrate the regulations and by-laws.

Course Content

Unit:1

Definition and classification of urban areas - Trend of urbanization - Planning process - Various stages of the planning process - Surveys in planning.

Unit: 2

Plans - Delineation of planning areas -Regional plan, Master plan, Structure plan, detailed development plan and Transportation plan.

Unit: 3

Planning principles of Ebenezer Howard (Garden city movement), Patrick Geddes, Dr. C.A. Doxiades, Soria Y Mata (Linear city) and Clarence, A. Perry (The neighbourhood concept).

Unit: 4

Plan implementation - Urban Planning agencies and their functions – Financing - Public, private, Non-governmental organizations - Public participation in Planning.

Unit: 5

Development control regulations - Town and country planning act - Building bye- laws.

References

- Hutchinson, B.G., Principles of Urban Transport Systems Planning, Scripta, McGraw- Hill, New York, 1974
- Claire, Hand Book of Urban Planning, Van Nostrand Book Company, 1974.
- Gallian, B. Arthur and Simon Eisner, The Urban Pattern - City Planning and Design, Affiliated Press Pvt. Ltd., New Delhi, 1985.
- Margaret Roberts, An Introduction to Town Planning Techniques, Hutchinson, London, 1980.
- Hiraskar, G. K., Fundamentals of Town Planning, Dhanpat Rai Publications, 1992.

OE-I (Experimental Stress Analysis)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1: Understand the road traffic components and their characteristics in traffic engineering

CO2: Conduct different types of traffic engineering studies and perform basic statistical analysis of traffic data

CO3: Use speed-flow relationships and analyse the capacity of different kinds of intersections

CO4: Understand elements of road safety and approaches to accident studies

CO5: Use different distribution models and analyse traffic flow characteristics

Course Content

Unit: 1

Strain gauges – Mechanical, optical, acoustic, electrical inductance and capacitance pneumatic types – description and working principles

Unit: 2

Electrical resistance strain gauges, gauge characteristics and types – Equipment for recording static strain – reduction of strain gauge data. Load, pressure and displacement transducers.

Unit: 3

Model analysis – direct and indirect models – law of structural similitude – choice of scales – Model materials – limitations of model studies –Buckingham PI theorem – design of direct and indirect models – Beggs deformeter and its applications.

Unit: 4

Two dimensional photo – elasticity – optical principles stress optic law – Methods of producing isoclines and isochromatics using polariscopes – Methods of measuring fractional fringe orders – model materials – separation techniques

Unit:5

Fundamental of Photo elastic coatings, Moire fringe and brittle coating techniques – Introduction to stress freezing techniques – Introduction to non-destructive testings

References

- Daley and Riley, Experimental Stress Analysis, McGraw Hill Book Company, 1987.
- Srinath, L.S. et al., Experimental Stress Analysis, Tata McGraw Hill 1984.
- Hetenyi, M., Hand Book of Experimental Stress Analysis, John Wiley & Sons. Inc New
- York. 1980.

OE-I (Sustainable Infrastructure)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1 Understand the values and societal importance of the built environment for

CO2 Understand the influence on a sustainable development

CO3 Gain knowledge on how to use environmental impact assessments as a tool for design

CO4 Construction and management of a sustainable built environment

CO5 Comprehend the aspects of social sustainability in the construction industry

Course Content

Unit: 1

Extent and values of infrastructure (buildings, structures, plants and networks for communication and transport, water and wastewater treatment, production and distribution of energy).

Unit: 2

Relations between infrastructure and sustainable development; regulations and standards; indicators of sustainability.

Unit:3

Consequences of climate change; vulnerability and safety of infrastructure; materials and technology for construction and management;

Unit: 4

Applications for sustainable communities; service life and life cycle assessments (LCA, LCC, MFA, environmental assessment); an international perspective with case studies from around the world.

References

- Sarte S. B.,'Sustainable Infrastructure: The Guide to Green Engineering and Design, Wiley; 1st edition, 2010
- Horne R. E., Grant T., Verghese K., 'Life Cycle Assessment: Principles, Practice and Prospects', CSIRO, 2009.
- Karli Verghese, Helen Lewis, Leanne Fitzpatrick, 'Packaging for Sustainability',

Springer, 2012.

- FIB bulletin 88, ‘Sustainability of precast structures’, 2018.

Liv Haselbach, *The Engineering Guide to LEED-New Directions (Green Source):*

- *Sustainable construction*, McGraw-Hill Professional, 2008.

OE-I (Disaster Modelling And Management)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1 Understand different types of disaster and its triggering features

CO2 Understand and analyse hydrological disaster

CO3 Understand and develop models for geological disaster

CO4 Able to understand the coastal hazard and shore defence structures

CO5 Capable to preparing vulnerability mapping and risk assessment and developing Emergency Management System

Course Content

Unit: 1

Disasters: Definition- Hazard Risk, Mitigation, Natural and human induced disasters- types of hazards, disasters and catastrophes – Disaster Management.

Unit: 2

Hydrological Hazards: Flooding – PMP – PMF – Inundation mapping -flood prone area analysis and management. Dam breach analysis - Drought- types of drought - Factors influencing drought - delimiting drought prone areas - drought index, SPI and Palmer.

Unit: 3

Geological Hazards: Earthquakes; location, faults, causes, types, associated hazards and impacts, Richter scale and Modified Mercalli scale. Mass movements: Definition of landslide - types – causes - slope stability analysis.

Unit: 4

Coastal Hazards – storm surge - Tsunami and floods – cyclone – coastal vulnerability – shore line erosion – shore defence structures.

Unit: 5

Mitigation and Management: Hazard, Risk and Vulnerability mapping and modelling using GIS. Case studies for earth quake zonation. Risk Assessment - Preparedness- GIS case studies for earthquake, landslide–risk assessment–GIS case studies for earthquake, landslide and cyclones. Emergency Management Systems (EMS) in the Disaster Management Cycle.

References

- National Disaster Management Division (2004) Disaster Management in India – A Status Report, Ministry of Home Affairs, Government of India, New Delhi.
- UNDRO (1995) Guidelines for Hazard Evaluation Procedures,United Nations Disasters Relief Organization, Vienna.
- Nagarajan, R., (2004) Landslide Disaster Assessment and Monitoring, Anmol Publications, New Delhi.
- Ramkumar, Mu, (2009) Geological Hazards: Causes, Consequences and Methods of Containment, New India Publishing Agency, New Delhi.
- Arnold M et.al Ed. (2006) Natural Disaster Hotspots:Case Studies. The World Bank
- Hazard Management Unit Washington, D.C.204p

OE-I (Standardization And Conformity Assessment)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1 Understand the evolution and global activities of standardization, including the role of regulatory bodies.

CO2 Learn the system and procedures for developing standards, including their impact on innovation and policy.

CO3 Understand the functions, procedures, and importance of BIS in Indian standardization.

CO4 Gain knowledge of BIS certification schemes and regulatory updates.

CO5 Understand the fundamentals of conformity assessment and the role of IS codes in engineering.

Course Content

Unit: 1

Standardization: Standards - History of standards and standardization - standardization in Ancient world - standardization in Ancient India - standardization according to Arthshastra World war II and rise of standardization - standardization in modern world - standardization activity worldwide – standardization activity in India – WTO/TBT - role of regularity bodies in standardization – technical regulations

Unit: 2

Standard formulations: System of standardization – Indian – International – Regional – Types of standards – Procedure of standards development – standards and innovations – standardization as a base line for implementing innovation – strategic standards management – life cycle of standards – legal impact at policy issues associated with standardization

Unit: 3

Bureau of Indian Standard (BIS): Objects – Functions of BIS – BIS Act - Main Activities – Members of BIS – BIS Committees – Standard Procedure – Functions of the Standards Formulation Departments - purpose of standardization, marking and certification of articles and process-importance of standards to industry, policy makers, trade, sustainability and innovation.

Unit: 4

BIS Product Certification in India: Introduction to BIS Certification – Conformity Assessment Scheme for Products - Compulsory Registration Scheme (CRS) - Types of BIS Approvals - BIS Services and Supports - Regulatory Updates – International Cooperation - Global Certification an Overview. Brief Introduction to IS Codes in Circuit and Non-Circuit Branches of Engineering.

Unit: 5

Conformity Assessment: Fundamentals of conformity assessment -Definition and objectives; classification of assessment- merits and limitations; certification-importance and the process; accreditation-role, accreditation bodies (National & International), Process; types of certificates; role of accreditation; Practical applications and case studies.

References

- ISO Standards Handbook, International Organization for Standardization

- Alan Bryden and Dr. Samad El-Hout, Conformity Assessment: Fundamentals and Practice.
- Russell, J. P., The ISO 9001:2015 Handbook.
- Jacobson Kai, The Role of Standards in Today's society and in the future.
- John. G. Keogh, Hakan Anderson, International Conformity Assessment:
- Current Practices and Future Directions.
- BIS standards catalogue by Bureau of Indian Standards.
- ISO/IEC 17000: Conformity Assessment – Vocabulary and General Principles.

OE-I (Computational Fluid Dynamics)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1: Derive and analyze flow governing equations for various fluid dynamics.

CO2: Implement and evaluate turbulence and multiphase flow modeling techniques.

CO3: Discretize governing equations using finite volume methods for accurate solutions.

CO4: Solve discretized equations with direct, iterative, and advanced numerical methods.

CO5: Design structured and unstructured grids; perform benchmarking and calibration.

Course Content

Unit: 1

Derivation of flow governing equations; turbulence modeling; modeling approaches for multiphase flow; initial and boundary conditions; well-posedness.

Unit: 2

Discretization of the governing equations using finite difference/volume/element methods; concepts of consistency, stability and convergence; template for the discretization of a generic unsteady transport equation.

Unit: 3

Solution of discretized equations; direct methods; classical iterative methods; advanced methods for structured matrices; conjugate gradient techniques; multigrid methods.

Unit: 4

Solution of coupled equations: methods for compressible flows; evaluation of pressure in incompressible flows; pressure-velocity coupling algorithms.

Unit: 5

Structured and unstructured grids; structured grid generation; unstructured grid generation. Benchmarking; calibration.

References

- John Anderson, Computational Fluid Dynamics, McGraw-Hill Education, 1999.
- Pieter Wesseling, Principles of Computational Fluid Dynamics, Springer series, 2009.
- Anil W. Date, Introduction to Computational Fluid Dynamics, Cambridge, 2005.
- Charles Hisch, Numerical computation of internal and external flows, Elsevier, 2007

OE-I (Hydroinformatics)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1 Derive and analyze flow governing equations for various fluid dynamics.

CO2 Implement and evaluate turbulence and multiphase flow modeling techniques.

CO3 Discretize governing equations using finite volume methods for accurate solutions.

CO4 Solve discretized equations with direct, iterative, and advanced numerical methods.

CO5 Design structured and unstructured grids; perform benchmarking and calibration.

Course Content

Unit: 1

Satellite Products-Types and classification of sensors, imaging modes, characteristics of optical sensors, sensor resolution-spectral, radiometric and temporal, characteristics of detectors-Geospatial analysis using Raster and Vector data – File format, Data conversion between Raster and vector Projection and transformation - Reclassification - Neighbourhood and Regional Operations – Map Algebra – Vector Data Analysis - Proximity analysis - Attribute data Analysis-concepts of SQL. Tools for map Analysis: Weighted overlay, Boolean logic models – Index overlay models – Fuzzy logic method

Unit: 2

Introduction to hydroinformatics - data-driven modeling for water systems, Model classification, Models overview, Modeling accuracy, Introduction to machine learning and artificial intelligence, Introduction to Matlab and Python Programming

Unit: 3

Linear Models, Generalized linear models (GLMs) – Logistic Regression, Poisson Regression, Gamma and Exponential GLMs, k-Nearest Neighbors (kNN), Polynomial regression and Generalized additive models, Kernel-based methods, Decision trees - Classification and

Regression Trees (CART) - Bagging, Boosting and Random Forests, Support Vector Machines (SVM), Artificial Neural Networks (ANN), Resampling methods - Bootstrap, Regularization and Machine Learning System Design.

Unit: 4

Clustering: i) Hard (k-means) clustering and ii) Fuzzy clustering (fuzzy c-means) with introduction to fuzzy logic, Multivariate analysis - dimension reduction, singular value decomposition (SVD) analysis, principal component analysis (PCA), canonical correlation analysis (CCA).

Unit: 5

Hydroinformatics for Climate Change Impact Assessment and Regional Flood Frequency Analysis; Example of a Hydrologic Information System case studies.

References

- Lillesand, T. M. and R.W. Kiefer, remote Sensing and Image Interpretation, Fourth Edition, John Wiley.
- Von Storch and Zwiers, 1999, Statistical Analysis in Climate Research, Cambridge Univ. Press, U.K.
- Myers, R. H., Montgomery, D. C., Vining, G. G., & Robinson, T. J. (2012). Generalized linear models: with applications in engineering and the sciences (Vol. 791). John Wiley& Sons
- Abbott, 1991, Hydroinformatics- Information Technology and the Aquatic Environment, Avebury Technical, Aldershot, U.K.
- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning (Vol. 112). New York: Springer. (Alternatively, Hastie et al., 2008, The Elements of Statistical Learning - for advanced)

OE-I (Uncertainty Modeling, Analysis And Quantification)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO1 Represent mathematically the uncertainty in the parameters of physical models.

CO2 Propagate parametric uncertainty through physical models to quantify the induced uncertainty on quantities of interest.

CO3 Develop and implement models for representing random fields and their uncertainties.

CO4 Combine multiple sources of information to enhance the predictive capabilities of models

CO5 Apply methods to quantify the uncertainties in a system

Course Content

Unit: 1

Propagation of uncertainty. Deterministic vs nondeterministic perspectives. Sources of uncertainty. Epistemic vs. aleatoric uncertainty. Data driven vs. physics driven uncertainty modelling. Different approaches such as probabilistic, interval, fuzzy.

Unit: 2

Introductory probability and statistics, Uncertain Variable – Variables, Distribution, Operational Laws, Expected value, Variance, Moment, Entropy, Distance, Conditional Uncertainty Distribution, Uncertain Sequence, Uncertain Vector, Point estimation, hypothesis testing, time series.

Unit: 3

Uncertainty Modeling methods and Sampling Techniques – High dimensional model representation, Response Surface methods, Kriging model, Model reduction, Various Sampling and optimization techniques and solutions.

Unit: 4

Modelling: connecting data to the probabilistic models. Discretization of random fields. Karhunen-Loève expansion of random fields. Tools for uncertainty propagation. Computational aspects of uncertainty propagation. Uncertainty Quantification – Sensitivity analysis.

References

1. Haym Benaroya and Seon Mi Han, Probability models in engineering and science, Taylor and Francis, 2005.

2 Ghanem, Roger, David Higdon, and Houman Owhadi, eds. Handbook of uncertainty quantification. Vol. 6. New York: Springer, 2017.

3 De Cursi, Eduardo Souza, and Rubens Sampaio. Uncertainty quantification and stochastic modelling with MATLAB. Elsevier, 2015.

4 Smith, Ralph C. Uncertainty quantification: theory, implementation, and applications. Society for Industrial and Applied Mathematics, 2013.

5 Sullivan, Timothy John, Introduction to Uncertainty Quantification, Springer, 2015.

OE-I (Disaster Resistant Structures)

Course Code **L: T: P-3:0:0**

Rationale-

CLR:1 know the basic concepts and design philosophy for disaster resistant structures

CLR-2: learn the various materials used and design for disaster resistant structures

CLR-3: get an exposure about damage assessment and retrofitting

CLR-4: learn the design and detailing for lifeline structures

CLR-5: explore the modern techniques of damage assessment

Course Outcomes

CO1: Snderstand the design philosophy for loads, earthquake and wind

CO-2: Study the materials to be used, and design to be made for disaster resistant structures

CO-3: Study damage assessment and retrofitting

CO-4: Understand materials design and detailing for lifeline structures

CO-5: Know techniques of damage assessment

Course Content

Unit-1

Behaviour of Life Line Structures, Design philosophy to resist flood, cyclone, and earthquake and fire disasters National and International Codes of practice - By-laws of urban and semiurban areas – Past history and lessons from disasters - Approach to traditional and Modern Structures - Concept of life period based Design - case studies.

Unit: 2

Community Structures, Safety analysis and rating - Reliability assessment repairs and Retrofitting techniques of Community Structures - Protection of Nuclear Structures - Dams, bridges and buildings.

Unit: 3

Rehabilitation and Retrofitting, Testing and evaluation - Classification according to safety level - methods and materials for strengthening for different disasters - qualification test.

Unit: 4

Materials, Design and Detailing, Modern Materials for disasters reduction - Detailing aspects of structures subject to probable disasters - Construction techniques - Analysis methodology – Techniques for optimal performance - Provisions for artificial disasters - blast and impact.

Unit: 5

Techniques of Damage Assessment, Damage surveys - Maintenance and modification to improve hazard resistance - application GIS in disaster management - foundation improvement techniques.

Learning Resources

1.Raiker, R.N. "Learning from failures, Deficiencies in Design, Construction and Service", R&D Center, Raiker Bhavan, 1987

2. Allen.R.T., and Edwards.S.C., "Repairs of Concrete Structure", U.K.1987

3.Moskvin.V "Concrete and Reinforced Concrete" - Deterioration and protection - MIR Publishers - Moscow 1983 Lecture notes on the course "Disasters Management" - conducted by Anna University, 2000.

OE-I (Smart City And Infrastructure)

Course Code **L: T: P-3:0:0**

Rationale-

Course Outcomes

CO-1: Identify the core needs for a smart city

CO-2: Realize the difficulties encountered when moving to smart cities

CO-3: Realize the function of renewable energy in modern energy systems -

CO-4: Identify the various technologies employed to develop smart cities -

CO-5: learn about the various technologies used in intelligent transportation systems

Course Content

Unit-1

Fundamentals of Smart Cities, Introduction to Smart cities, Smart city indicators: Smart governance, Smart economy, Smart environment, Smart people, Smart living, Smart mobility, Smart City Mission, 2015, India "100 Smart Cities" Policy and Mission, Criteria for selection of 'Smart Cities', Case study on smart city projects in India

Unit-2 –

Transition Challenges, Legacy to smart infrastructure systems - Challenges faced in infrastructure layer, service layer and digital/data layer, Decision making constrains - Technological, Financial, Political, Social, environmental, Transition in Socio-Technical systems – role of feedback loop and data layer, Case study on Citizen's perspective on need for smart cities

Unit-3 –

Smart Energy System (SES), SES Conceptualization and its types, Applications of renewable energy in SES, Smart energy devices, SES in different sectors: buildings, water management, transport, waste management, Case study on SES used in various sectors.

Unit-4 –

Smart Buildings, Smart Services in buildings, IoT and Smart Building, Technologies involved in smart building, Energy conservation concepts in building, Green building concepts, GRIHA, LEED and IGBC rating system, Case study on a Platinum rated green building in India

Unit-5 –

Intelligent Transportation Systems (ITS), Technologies involved in ITS, Smart traffic monitoring systems, Sensors used in ITS, Floating car data, Methods to obtain Floating car data, Navigation systems, Applicatio ns of ITS

Learning Resources

- Smart City on Future Life - Scientific Planning and Construction by Xianyi Li Jo Beall (1997); “A city for all: valuing differences and working with diversity”; Zed books limited, London (ISBN: 1-85649-477-2)
- Smart city government of India. http://smartcities.gov.in
- Giffinger, Rudolf; Christian Fertner; Hans Kramar; Robert Kalasek; NatašaPichler-Milanovic; Evert Meijers (2007). "Smart cities – Ranking of European medium-sized cities". Smart Cities. Vienna: Centre of Regional Science

OE-I (Real Estate Management)

Course Code **L: T: P-3:0:0**

Rationale-

CLR-1: understand the scenario of different sectors of real estate

CLR-2: understand the relationship between economy and real estate

CLR-3: interpret the norms and regulation of real estate sector

CLR-4: develop the layout of the land for approval

CLR-5: know the housing situation and measures taken in India

Course Outcomes

CO-1: Understand the status of real estate sector in India

CO-2: Apply the real estate investment decision making concepts

CO-3: Understand the norms and regulation of real estate project appraisal -

CO-4: Create a layout of land for approval process

CO-5: Recognize the housing situation and reforms taken for housing in India

Course Content

Unit: 1

Introduction to Real Estate: Introduction to real estate, Real estate sector in India – land, Housing, office spaces, ware housing. Characteristics of land, Types of property, Ownership rights, Forms of ownership. Real estate contracts.

Unit: 2

Real Estate Economics and Investment: Real estate and economy - Relationship between Real estate and macroeconomy, Real estate investment cycle, Real estate project development considerations, Real estate financing, Real estate investment decision making, Tax implications, Risk management, and Property valuation.

Unit: 3

Real Estate Laws and Regulations: Survey of land, Recording, Land divisions and subdivisions, land documents and registration process, Power agent, Land use and development control

regulation – Master plan, zoning, Special economic zone, RERA 2016, Real estate investment trust, Transfer of property act 1882, Indian succession acts.

Unit: 4

Real Estate Development: Land development approval authorities, DTCP's approval procedure, NOC certificates, Criteria for layout development, building byelaws, Building permissions, FSI/FAR, TDR, OSR Calculation, Market price and guideline value, Case study of land layout approval process

Unit: 5

Real Estate Housing: Introduction to housing, Housing classification, Calculation of UDS, Housing situation in India – urban and rural, Housing policy schemes - Role of government in housing delivery, reforms to improve housing situation, Housing finance, PMAY 2015 – Types and features, Property tax calculation.

Learning Resources

1. Steve Berges (2015), The Complete Guide to Real Estate Finance for Investment Properties, John Wiley & Sons

2. Arlyne Geschwender (2010), Real Estate Principles and Practices, Real Estate Education Company (REECO)

3. Michael Weir (2001), Concepts of Property, Blackwell Publishers

4. Charles Jacobus (2010), Real Estate Principles, Dearborn Real Estate Education

5. N.G. Miller and D.M. Geltner (2010), Real Estate Principles for the New Economy, Cengage Learning

https://nptel.ac.in/courses/124/107/124107001/

OE-I (Project Management)

Course Code **L: T: P-3:0:0**

Rationale-

CLR-1: Appreciate the project objectives and prepare a project schedule for time, cost and resources.

CLR-2: Prepare an estimate of the project cost and managing projects.

CLR-3: Update Project Progress and prepare reports for review and to control the project.

CLR-4: Plan for the project organisation and directing

CLR-5: Prepare a final project closure report and international projects

Course Outcomes

CO-1: Comprehend and identify the elements of project management.

CO-2: Ability to select alternative courses of action to attain project objectives.

CO-3: Manage the phases of projects.

CO-4: Ability to Estimate, plan, calculate, and adjust project variable.

CO-5: Can manage project risk, including identifying, analyzing and responding to risk.

Course Content

Unit: 1

Project Perspectives: Project Life Cycle - Types of Projects- Selection of Professional Services - Stake-holders in Project - Structure of Project Organization - Role of Project Managers - Financing of Constructed Facilities – Project success Factors. Project Estimation and Management: Project scope- Work breakdown structure and its process - Multidisciplinary team and its role.

Unit: 2

Factors of Project estimates, types of costs, methods, refining estimates- Case study in WBS and project estimates. Value Engineering - Developing project network- CPM & PERT - Risk Management process – Contingency planning - Opportunity Management and Change control management - Resources allocation classifications methods - Case study in Risk management and resources allocation

Unit: 3

Construction Planning, Monitoring and ControlTypes of Project Plans - Work Breakdown Structure - Resource Levelling - Resource Allocation -Project Scheduling - Types of Project Scheduling - Project Progress Control - Measuring and Updating of Project Progress using Bar Chart, Progress Reports to aid Progress Review - Stage-wise Completion Cost - Earned Value Analysis.

Unit: 4

Project Organising and Directing: Introduction, Organizational Design, Hierarchical Systems, Organization Structure, Types of Organization Structure, Formal and Informal Organization, Factors Determining Span of Management, Centralization and Decentralization, Span of control, Understanding authority and responsibility.

Unit: 5

Project Closure and International Projects: Project Closure - Financial Closure - Contract Closure - Project Managers' Closure - Lessons Learnt from the Project - Profit/Loss at Completion - Disputes and Claims - Settlement of Disputes and Claims - Final Project Closure Reports - International projects – environmental factors and cross-culture - Agile Traditional Vs. agile methods - Case studies in project audits.

Learning Resources

- Clifford Gray, Erik Larson and Gautam V Desai, Project Management,Tata McGraw Hill Edition, 7th Edition, 2018.
- A Guide to the Project Management Body of knowledge PMBOK Guide PMBOK® Guide – Sixth Edition, 2017.
- Adrienne Watt, Project Management, BC Campus Victoria, 2nd edition, 2014.
- Choudhury, S, Project Management, Tata McGraw-Hill Publishing Company, New Delhi, 1988.
- George J. Ritz, Total Construction Project Management - McGraw-Hill Inc, 1994.
- Kumar Neeraj ha, Construction Project Management - Theory and Practice, Pearson Publications - Dorling Kindersley (India) Pvt. Ltd., 2012.

OE-I (Environmental Impact Assessment)

Course Code **L: T: P-3:0:0**

Rationale-

CLR-1: Understand Importance of EIA and its evolution

CLR-2: Learn principles and methods of environmental analysis

CLR-3: Know the interrelationship between various activities and their impact on environment

CLR-4: Understand the Application of EIA in various sectors

CLR-5: Explain the concept of environmental management.

Course Outcomes

CO-1: Understand the importance of various rules and regulation in EIA and role of stake holders in EIA

CO-2: Apply various techniques in Impact Assessment studies.

CO-3: Identify the Impact on Water, land and soil environments.

CO-4: Identify the Impact on Air, Noise, Biota and Socio-Economic environments.

CO-5: Evaluate the Impact using management plan and make suggestions.

Course Content

Unit: 1

Introduction: Basic concepts of EIA- Overview of Environmental Laws- EPA 1986, Water Act, Forest Act- Evolution: EIA Notification1994; 2006 and EIA Draft 2020- Types of EIA; Screening; Scoping- Role of Governmental and NGOs.

Unit: 2

EIA Methodologies: Baseline Description- Environmental Examination- Screening; Scoping- Methods: Checklist; Matrix; Network; Overlay; Cost Benefit Analysis- Public participation- Analysis of Alternatives- Expert systems

Unit: 3

Components of the Environment – Water, Land, Soil, Setting Baseline- Impact Prediction and Assessment of- Water: Surface Water, groundwater; Land; Soil- Case Studies.

Unit: 4

Components of the Environment – Air, Noise, Biota, Socio-Economic Setting Baseline- Impact Prediction and Assessment of- Noise, Air Environment; Biota; Socio-Economic; Cultural and Aesthetics- Case Studies.

Unit: 5

Environmental Management Plan, Environmental Management Strategies, Environmental Management Systems- ISO14001; Environmental Mitigation; Risk Analysis; Environmental Audit- TOR preparation- Documentation and Report Preparation.

Learning Resources

1. L. W. Canter, Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1997.

2. G. Burke, B. R. Singh and L. Theodore, Handbook of Environmental Management and Technology, 2ndEd., John Wiley & Sons, 2000.

3. R. Therivel, John Glasson, Andrew Chadwick, Introduction to Environmental Impact Assessment (Natural and Built Environment), Routledge, 2005.

4. K. Whitelaw and Butterworth, ISO 14001: Environmental System Handbook, 1997.

OE-I (Municipal Solid Waste Management)

Course Code **L: T: P-3:0:0**

Rationale-

CLR-1: Study the various sources and classification of solid and hazardous waste.

CLR-2: Know the concepts related to waste characteristics and source reduction.

CLR-3: Realize insights to the storage, collection and transport of waste.

CLR-4: Explore the concepts related to waste processing technologies.

CLR-5: Understand concepts related to waste disposal.

Course Outcomes

CO-1: Apply the acquired knowledge on building materials and products for construction.

CO-2: Identify various building finishing materials and ferro cement applications for the building construction.

CO-3: Apply the knowledge on the masonry, building transport and the termite treatment.

CO-4: Disseminate the knowledge on various eco-friendly building materials.

CO-5: Recognize the energy efficient buildings and cost-effective construction techniques.

Course Content

Unit:1

Sources and Types of Municipal Solid Waste: Introduction and Objective of Solid waste management, Sources of solid wastes, Classification of Solid Wastes-Sources & Types based, quantity – factors affecting generation of solid wastes, Salient features of Indian Legislations on management and handling of municipal solid wastes, Public health effect - Environmental effect, Case studies in hazards due to solid waste management

Unit: 2

Characteristics of Solid Waste and Source Reduction: Characteristics – Physical, chemical and biological methods of sampling and characterization, Waste Stream Assessment (WSA), Source reduction (Basics), Monitoring and Evaluation, Storage and collection of recyclables.

Unit: 3

Waste Collection, Storage and Transportation: Methods of Collection- Hauled container, Stationary container and other collection methods, types of vehicles, collection routes, Transfer station, types and requirements, selection of location, operation and maintenance.

Unit: 4

Waste Processing Techniques: Mechanical Volume and Size Reduction and Equipment's, Volume reduction or compaction, Size reduction or shredding, Processing techniques- Composting, Incineration, Pyrolysis, Gasification, Anaerobic degradation

Unit: 5

Disposal: Dumping of solid waste, Methods of dumping of solid waste, Landfill- types, essential components, monitoring of landfill, Leachate collection & treatment, Environmental monitoring system.

Learning Resources

1. George Tchobanoglous, Hilary Theisen, Samuel Vigil, Integrated Solid Waste Management, McGraw Hill,1993

2. Resources Management, Hazardous waste Management, Mc-Graw Hill International edition, New York, 2001. 3. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and Environmental

4. CPHEEO, "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.

5. NPTEL Course-Municipal solid waste management. https://nptel.ac.in/courses/120108005/

OE-I (Disaster Mitigation And Management)

Course Code **L: T: P-3:0:0**

Rationale-

CLR-1: Introduce various types of disasters and role of various stakeholders in disaster management.

CLR-2: Understand various hazards, and health issues on disaster management Life Long Learning.

CLR-3: Understand various phases of disaster management and risk reduction measures.

CLR-4: Acquire knowledge on hazard management systems.

CLR-5: Manage the pre and post disaster scenario.

Course Outcomes

CO-1: Understand the role of various stakeholders in risk reduction measures.

CO-2: Acquire knowledge on various modes of hazards and their occurrence.

CO-3: Illustrate key concepts of vulnerability and risk assessment techniques

CO-4: Evaluate various processes employed in pre-disaster scenarios for risk preparedness.

CO-5: Integrate the management principles in disaster management during post disaster scenario.

Course Content

Unit: 1

Introduction: Disaster Management- History; Global issues- Strategies- Phases- Global & Indian scenario- Major Disasters in India- Disaster Management in India- NDRF; Disaster Management Act (2005); Disaster Management Policy (2009)

Unit: 2

Hazards: Natural- Geological; Hydrological; Meteorological; Biological- Man Made- Industrial; Health related; Infrastructural; Intentional

Unit: 3

Vulnerability and Risk Assessment: Risk Evaluation- Quantitative & Qualitative; Risk Perception; Vulnerability- Mitigation Measures- Need; Agencies involved; Types; Obstacles involved- Role of Insurance

Unit: 4

Pre-Disaster Management: Integrated Developmental Planning for Disaster Management; Role of Government agencies and NGO's in Mitigation & Management- Vulnerable Groups in Disasters Management; Essential Supplies; Site Management- Role of Technology in Disaster Management; Emergency Management Systems; Role of Remote sensing, GIS and GPS in Disaster Management

Unit: 5

Post Disaster Management: Medical Trauma and Stress Management- Physical and Socio-economic Impacts of Disasters; Emotional Impacts of Disasters- Rehabilitation and Reconstruction; Education and Public awareness; Capacity building.

Learning Resources

1. D. Alexander, Natural Disasters, ULC Press, 1999
2. W.N. Carter, Disaster Management: A Disaster Management Handbook, Asian Development Bank, 2008
3. Damon P. Coppola, Introduction to International Disaster Management, 3rd edition, Elsevier, 2015
4. C.J. Barrow, Developing the Environment: Problems and Management, Harlow: Longman, 1995
5. Disaster Management Act "2005", Ministry of Home Affairs, Govt. of India, 2005

OE-I (Water Pollution And Its Management)

Course Code **L: T: P-3:0:0**

Rationale-

CLR-1: Create insights to the source and type of water pollution.

CLR-2: Analyze the characteristics of domestic and industrial water pollution.

CLR-3: Utilize resource recovered from the waste water.

CLR-4: Identify the various methods to control the water pollution and regulatory bodies.

CLR-5: Sustainable practice for effective water management.

Course Outcomes

CO1: Understand the various sources of water pollution

CO-2: knowledge of various characteristics presented in polluted water

CO-3: apply the concept of resource recovered from the polluted water

CO-4: knowledge of Water Act 1974 and regulatory bodies to control of Water Pollution

CO-5: analyze the environmental impact of water pollution

Course Content

Unit-1

Introduction to Water Pollution: Sources and types of water pollution - Point source pollution and Non-point source pollution - Types of pollutants - Adverse effects of pollutants - Principles of pollution assessment - Terms and definitions in wastewater - Transport of pollutants - Causes of Water pollution - Hydraulic flow of water pollution - Sampling procedure - Methods of sampling and storage - Effects of water pollution - Eutrophication and their process - Public awareness and practices in water pollution.

Unit-2

Characteristics and Effects of Polluted Water: Physical characteristics-Colour, odour, Turbidity, Temperature, Specific conductivity - Chemical characteristics- Organic and Inorganic - Biological characteristics and its significance - Analysis of water pollution and their testing procedures - Water Quality standards-BIS - Discharge of Effluent and their standards - Water

borne diseases - Impact of water related issues on animals - Ground water quality - Impact on Effluent in ground water quality - Effects of ground water pollution - Sampling methods of ground water pollution - Legal regulatory aspects of groundwater contamination - Industrial Participation with regulatory boards - Water used in different industries.

Unit-3

Mitigation and Control Measures: Mitigation Measures for Water pollution Contamination due to industries - Treatment of Industrial wastewater guidelines and protocol for treating Industrial wastewater - Pollution characteristics of certain typical industries - Thermal pollution and its adverse effects - Role of regulatory bodies in Protection of Water bodies-Control Measures - Discharge Standards for Rivers and Streams - Self-purification of streams - Role of stakeholders - Water quality monitoring and its purpose - Monitoring activities and its strategy - Types of monitoring - Steps involved in water quality monitoring - Parameters and frequency of monitoring – Graphical representation of water quality.

Unit-4

Rules and Regulations: Administrative regulation under recent legislations in water pollution control - Water (Prevention & control of pollution) Act 1974 - Water (Prevention & control of pollution) Rules 1975 - Water (Prevention &control of pollution) Cess Act 1977 - Role of pollution control board - Powers given to boards - Irrigational approach in waste conservation - Legal action against defaulters - Management strategy used for water conservation

- Industrial approach in water conservation - Awareness of domestic usage for conservation of water - Groundwater management - Public participation in water management - Environmental indices and its types - Water quality index and its types - Assessment of water quality index.

Unit-5 –

Effective Water Management : Rain water Harvesting - Classification of rainwater harvesting - Micro level harvesting, macro level harvesting and other methods - Roof top harvesting and their benefits - Role of Regulatory bodies - Role of local bodies- TWAD Board – CMWSSB - Case Studies related to Effective Water Management - Water crisis and their effects - Water crisis and their effects - Problems faced in water crisis - Zero water day – Awareness programme for water management and its sustainable development - Importance of World water day and World Environment day - Vulnerability of improper water management - Case study on adverse effects of water crisis - Sustainable development.

Learning Resources

1. Fair.G.M, “Water and Waste water engineering Vol. I& II”. John Wiley and sons, Newyork. 2010.

2. Metcalf & Eddy, “Wastewater engineering, Treatment and Reuse”, Tata McGraw hill publications, 2008.

3. CPHEEO, ““Manual on Sewerage & Sewage Treatment”, Ministry of Housing and Urban Affairs, Government of India, New Delhi, 2009. 4. P. K. Goel, Water Pollution: Causes, effects and Control. New Age International, 2006.

5. NPTEL Course: Water, Societyand Sustainability. - https://onlinecourses- archive.nptel.ac.in/noc18_hs36

6. NPTEL Course: Wastewater Treatment & Recycling. https://onlinecourses- archive.nptel.ac.in/noc18_ce26

OE-I (Global Warming And Climate Change)

Course Code **L: T: P-3:0:0**

Rationale-

CLR-1: Gain knowledge about the earth system

CLR-2: Study the basics of climate parameters and climate change causing elements

CLR-3: Understand importance of global warming

CLR-4: Understand different mitigation measures against global warming and their protocol

CLR-5: Explore renewable resource usage to reduce global warming

Course Outcomes

CO-1: Apply the acquired knowledge on earth system

CO-2: Identify the climate parameters and their impact due to human activates

CO-3: Identify the climate change impact in various sector

CO-4: Interpret different protocols related to climate change

CO-5: Implement and analyze reason behind global warming, mitigation measures of climate change

Course Content

Unit: 1

Earth's Climate System: Introduction to earth system-hydrosphere, lithosphere, cryosphere, atmosphere and biosphere. Hydrological cycle and Carbon cycle. Atmosphere and its composition, Atmospheric stability and lapse rate, Ozone layer and its functions, Ozone depletion and ozone hole, Global warming and its impacts, Greenhouse gases and greenhouse effect, El Nino and La Nina

Unit: 2

Climate Indices and Extreme Events: Climatology, Paleoclimatology, Indian climate system and their classification, Role of land and ocean to regulate climate, Role of ice and wind to regulate climate, causes of climate change Milankovitch theory, (natural cause), Human induced climate

variations, Climate Extremes-Cyclones, thunderstorms, Tornadoes, Heat waves, Sea level rising-Ice melting, temperature rising, Floods and droughts. Energy balance of the earth

Unit: 3

Physical Evidences of Climate Change: Climate change impact in different sectors- Agriculture, Forestry, Fishery, Socio economic impact – tourism, Evidences of warming and change in atmosphere/ ocean circulations. Sea level changes and Shore line changes. Polar ice, Isotopes, Ice melting and Ice core analysis, glaciers loss. Energy supply: Role of energy in development of human civilization, Emissions from energy generation. Role of energy in current climate change.

Unit: 4

International Responses to Climate Change : Climate change organization and programs, History of IPCC and UNFCCC, IPCC- Assessment report highlights, UNEP, Need for international protocols of climate change, Kyoto protocol, Montreal protocol, UNDP-United nations development program, Carbon credit and Clean development mechanism.

Unit: 5

Climate Change Adaptation and Mitigation Measures: Renewable and alternative energy technologies- Biomass, Solar, Hydro, Geothermal and Wind. Clean technology, biodiesel, compost, biodegradable plastics. Concept of sustainable development, Concept of carbon sequestration. Adaptation measures- Green building technology. Public awareness - Methods and ecology, economics and ethics: the missing links. Life cycle analysis, Role environmentalist.

Learning Resources

1. Dash Sushil Kumar, “Climate Change –An Indian Perspective”, Cambridge University Press India Private limited 2007.

2. Adaptation and mitigation of climate change-Scientific Technical Analysis. Cambridge University Press, Cambridge, 2006.

3. Atmospheric Science, J.M. Wallace and P.V. Hobbs, Elsevier / Academic Press, 2006.

4. Jan C. van Dam, Impacts of “Climate Change and Climate Variability on hydrological Regimes”, Cambridge university press, 2003.

OE-I (Indoor And Ambient Air Quality Management)

Course Code **L: T: P-3:0:0**

Rationale-

CLR-1: Take up the basic concepts of air pollution.

CLR-2: Introduce the knowledge of health related to air pollution

CLR-3: Acquire knowledge on various causes, effects and control measures of environmental air pollution.

CLR-4: Acquire knowledge about design criteria related to IAQ

CLR-5: Identify better ventilation system to improve good IAQ

Course Outcomes

CO-1: Analyze the sources, effects and control measures of environmental air pollution.

CO-2: Analyze air quality parameters and its impact.

CO-3: Recognize air pollution measurement methodology.

CO-4: Apply the concept of Exhaust system for better IAQ.

CO-5: Identify the Control devices related to air pollution.

Course Content

Unit: 1

Introduction: Hazard vs. risk; Concentrations of air pollutants; Fundamentals of contaminant mixture the respiratory system: Anatomy of the lungs, modeling gas exchange, diseases; Body burden;1st order system

Unit: 2

Design Criteria: Contaminant concentration limits; Fire and explosion; Hearing and sound; Heat stress; Odor Pollutant emission rates: Physical measurements, flux chambers, mass balances, emission factors. Diffusion Evaporation: Evaporation from liquid surfaces, evaporation in confined spaces, thermodynamics of evaporation

Unit: 3

Ventilation: General ventilation: Dilution vs. displacement ventilation; The well-mixed model: sources, wall losses, recirculation, air cleaners, infiltration and exfiltration, various room configurations; Clean rooms; Effectiveness of ventilation systems; Heating and cooling costs; Ventilation in tunnels Local ventilation: Hood design, bulk materials, proper selection and design of hoods, buoyant plumes, canopy hoods, air curtains. Air cleaners in series and parallel

Unit: 4

Exhaust Duct System Design: Energy equation, major and minor losses, fan performance curves, fan selection (matching fan to duct system requirements) 13 Particulate air pollution: Particle sizes/classifications/terminology; Aerodynamic drag and drag coefficient, particles settling in quiescent air (gravimetric settling - terminal settling speed); Equations of particle motion and particle trajectory calculations in an air flow, using Runge-Kutta to predict 2-D particle trajectories; Non-spherical particles - equivalent diameters; Gravimetric settling in rooms and ducts; Inertial separation in curved ducts

Unit-5

Air Pollution Control Devices: (APCSs): Lapple cyclones and other APCSs; Performance and efficiency of APCSs; Series and parallel APCSs for particle removal; Filters Control of particulates. Cyclones. Scrubbers. Electrostatic precipitators. Baghouse filters. Control of gases. Absorption. Wet scrubbers and packed scrubbers. Flue gas desulfurization. Adsorption. Incineration. Carbon sequestration.

Learning Resources:

1. Mukherjee, “Environmental Pollution and Health Hazards”, causes and effects, 1986.
2. Kenneth wark, Cecil F.Warner, “Air Pollution its Origin and Control”, Harper and Row Publishers.
3. Noel De Nevers, “Air pollution control Engineering”, McGraw Hill International Edition.
4. M. N. Rao, H. V. N. Rao, Air pollution, Tata McGraw Hill Pvt Ltd, New Delhi, 1993.