DEPARTMENT OF ENVIRONMENTAL SCIENCE & ENGINEERING

B. Tech (Environmental Engineering)

Scheme & Syllabus

Delhi Technological University

B. Tech. Environmental Engineering

I Year: First Semester

Teaching Scheme					Contact Hours/Week			Exam Duration (h)		Relative Weights (%)				
S. No.	**Subject Code**	**Course Title**	**Subject Area**	**Credit**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	AM101	Mathematics - I	BSC	4	3	1	0	3	0	25	-	25	50	-
2	AP101	Physics	BSC	4	3	0	2	3	0	15	25	20	40	-
3	CE101	Basic Civil Engineering	ESC	4	3	1	0	3	0	25	-	25	50	-
4	AC101	Applied Chemistry	ESC	4	3	0	2	3	0	15	25	20	40	-
5	EN103	Water and Wastewater Analysis	SEC	2	1	0	2	0	3	-	50	-	-	50
6	AEC/VAC	AEC/VAC	AEC/VAC	2	2/1/0	0	0/2/4	3/3/0	0/2/3	25/15/0	0/25/50	25/20/0	50/40/0	0/0/50
Total				**20**										

I Year: Second Semester

1	AM102	Mathematics-II	BSC	4	3	1	0	3	0	25	-	25	50	-
2	CO102	Programming Fundamentals	ESC	4	3	0	2	3	0	15	25	20	40	-
3	EN102	Environmental Awareness	ESC	4	3	1	0	3	0	25	-	25	50	-
4	EN104	Basic Environmental Engineering	DCC	4	3	1	0	3	0	25	-	25	50	-
5	EN106	Air Pollution and Waste Management	SEC	2	1	0	2	0	3	-	50	-	-	50
6	AEC/VAC	AEC/VAC	AEC/VAC	2	2/1/0	0	0/2/4	3/3/0	0/2/3	25/15/0	0/25/50	25/20/0	50/40/0	0/0/50
Total				**20**										

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II Year: Third Semester

Teaching Scheme					Contact Hours/Week			Exam Duration (h)		Relative Weights (%)				
S. No.	**Subject Code**	**Course Title**	**Subject Area**	**Credit**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	EN201	Strength of Materials	ESC	4	3	0	2	3	0	25	-	25	50	-
2	EN203	Engineering & Environmental Surveying	DCC	4	3	0	2	3	0	15	25	20	40	-
3	EN205	Environmental Chemistry and Microbiology	DCC	4	3	0	2	3	0	15	25	20	40	-
4	EN207	Water Engineering: Design & Application	DCC	4	3	0	2	3	0	15	25	20	40	-
5	EN209	Environmental Monitoring	DCC	4	3	0	2	3	0	15	25	20	40	-
6	AEC/VAC	AEC/VAC	AEC/VAC	2	2/1/0	0	0/2/4	3/3/0	0/2/3	25/15/0	0/25/50	25/20/0	50/40/0	0/0/50
7	MS299	Community Engagement Course	Mandatory	2										
Total				**24**										

II Year: Fourth Semester

1	EN202	Fluid Mechanics & Hydraulics	ESC	4	3	0	2	3	0	15	25	20	40	-
2	EN204	Air Pollution & Control	DCC	4	3	0	2	3	0	15	25	20	40	-
3	EN206	GIS & Remote Sensing	DCC	4	3	0	2	3	0	15	25	20	40	-
4	EN208	Solid Waste Management	DCC	4	3	0	2	3	0	15	25	20	40	-
5	EN210	Wastewater Engineering: Design and Applications	DCC	4	3	0	2	3	0	15	25	20	40	-
6	AEC/VAC	AEC/VAC	AEC/VAC	2	2/1/0	0	0/2/4	3/3/0	0/2/3	25/15/0	0/25/50	25/20/0	50/40/0	0/0/50
Total				**22**										

Additional 02 credits are to be earned from mandatory community engagement course in second year to fulfil the requirement of award of the four year B.Tech Degree.

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III Year: Fifth Semester

Teaching Scheme					Contact Hours/Week			Exam Duration (h)		Relative Weights (%)				
S. No.	**Subject Code**	**Course Title**	**Subject Area**	**Credit**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	EN301	Hydrology and Groundwater Engineering	DCC	4	3	1	0	3	0	25	-	25	50	-
2	EN303	Environmental Management and Sustainable Development	DCC	4	3	1	0	3	0	25	-	25	50	-
3	EN305	Global Warming and Climate Change	DCC	4	3	1	0	3	0	25	-	25	50	-
4	MGMT	Engineering Economics / Fundamentals of Management	SEC	3	3	0	0	3	0	25	-	25	50	-
5	EN 3XX	Departmental Elective Course -1	DEC	4	3/3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
6	GEC	General Elective Course -1	GEC	4	3/3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
Total				**23**										

III Year: Sixth Semester

1	EN302	Environmental Impact Assessment	DCC	4*	3	0	2	3	0	15	25	20	40	-
2	EN304	Environmental Law and Policy	DCC	4	4	0	0	3	0	25	-	25	50	-
3	MGMT	Fundamentals of Management / Engineering Economics	SEC	3	3	0	0	3	0	25	-	25	50	-
4	EN3XX	Departmental Elective Course -2	DEC	4	3/3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
5	EN3XX	Departmental Elective Course -3	DEC	4	3/3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
6	GEC	General Elective Course -2	GEC	4	3/3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
Total				**23**										

*: Practical to be organized in field as Survey Camp.

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IV Year: Seventh Semester															
Teaching Scheme					**Contact Hours/Week**			**Exam Duration (h)**		**Relative Weights (%)**					
S. No.	**Subject Code**	**Course Title**	**Subject Area**	**Credit**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	EN401	B. Tech Project-I	DCC	4	-	-	-	-	-	-	40	-	-	60
2	EN403	Internship	DCC	2	-	-	-	-	-	-	40	-	-	60
3	EN4XX	Departmental Elective Course -4	DEC	4	3/3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
4	EN4XX	Departmental Elective Course -5	DEC	4	3/3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
5	GEC	General Elective Course -3	GEC	4	3/3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
6	AEC/VAC	Indian Knowledge System	VAC	Non Credit										
Total				**18**										
IV Year: Eight Semester															
1	EN402	B. Tech Project-II	DCC	8	-	-	-	-	-	-	40	-	-	60
2	EN4XX	Departmental Elective Course -6	DEC	4	3/3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
3	GEC	General Elective Course -4	GEC	4	3/3	0/1	2/0	3	0	15/25	25/0	20/25	40/50	-
Total				**16**										

Cumulative Total	**166**	

B. Tech. Environmental Engineering

Departmental Elective Course

Departmental Elective Course -1 (Semester - 5)	
EN307	Soil Pollution & Remediation
EN309	Environmental Toxicology
EN311	Environmental Pollution & e-waste Management
EN313	Advance Surveying
EN315	Automobile Emission & Control

Departmental Elective Course -2 & 3 (Semester - 6)	
EN306	Planning and Design of Environmental Engg. Works
EN308	Hazardous & Biomedical Waste Management
EN310	Transportation and Traffic Engineering
EN312	Surface & Ground Water Pollution
EN314	Water and Soil Conservation
EN316	Ecology and Bio-monitoring Techniques
EN318	Environmental Risk Assessment
EN320	Design of water distribution network
EN322	Green Technology

Departmental Elective Course -4 & 5 (Semester - 7)	
EN405	Occupational Hazards, Health & Safety
EN407	System Simulation & Modeling
EN409	Advanced Open Channel Hydraulics
EN411	Risk and Reliability Analysis of Environmental System
EN413	Environmental Economics
EN415	Noise Pollution & Control
EN417	Irrigation and Drainage Engineering
EN419	Non-Conventional Energy Systems
EN421	Disaster Management

Departmental Elective Course -6 (Semester - 8)	
EN404	Project Management
EN406	Industrial Waste Management
EN408	Environmental Biotechnology
EN410	Life Cycle Assessment

Minors Offered by Department of Environmental Engineering

Minor in Environmental Engineering			
S. No.	**Course Code**	**Course Title**	**Course Type**
1	EN207	Water Engineering: Design & Application	Compulsory
2	EN210	Wastewater Engineering: Design and Applications	Compulsory
3	EN204	Air Pollution & Control	Compulsory
4	EN205	Environmental Chemistry and Microbiology	Elective
5	EN208	Solid Waste Management	Elective
6	EN303	Environmental Management and Sustainable Development	Elective
7	EN305	Global Warming and Climate Change	Elective
8	EN302	Environmental Impact Assessment	Elective
9	EN304	Environmental Law and Policy	Elective
10	EN419	Non-Conventional Energy Systems	Elective
Minor in Sustainability and Environmental Management			
S. No.	**Course Code**	**Course Title**	**Course Type**
1.	EN303	Environmental Management and Sustainable Development	Compulsory
2	EN419	Non-Conventional Energy Systems	Compulsory
3	EN318	Environmental Risk Assessment	Compulsory
4	EN322	Green Technology	Elective
5	EN311	Environmental Pollution & e-waste Management	Elective
6	EN421	Disaster Management	Elective
7	EN314	Water and Soil Conservation	Elective
8	EN411	Risk and Reliability Analysis of Environmental System	Elective
9	EN405	Occupational Hazards, Health & Safety	Elective
10	EN410	Life Cycle Assessment	Elective
11	EN406	Industrial Waste Management	Elective
12	EN312	Surface & Ground Water Pollution	Elective
Minor in Environmental Remediation & Control			
S. No	**Course Code**	**Course Title**	**Course Type**
1	EN307	Soil Pollution & Remediation	Compulsory
2	EN315	Automobile Emission & Control	Compulsory
3	EN318	Environmental Risk Assessment	Compulsory
4	EN405	Occupational Hazards, Health & Safety	Elective
5	EN312	Surface & Ground Water Pollution	Elective
6	EN410	Life Cycle Assessment	Elective
7	EN308	Hazardous & Biomedical Waste Management	Elective
8	EN311	Environmental Pollution & e-waste Management	Elective
9	EN309	Environmental Toxicology	Elective
10	EN415	Noise Pollution & Control	Elective
11	EN419	Non-Conventional Energy Systems	Elective

Details of Courses

1st Year

Course Title	Course Structure			Pre - Requisite
	L	T	P	
Water and Wastewater Analysis (EN103)	1	0	2	-

Course Objective:
This course will provide B. Tech. (Environmental Engineering) students with basic hands-on experience in various aspects of Water and Wastewater testing and analysis, allowing them to apply theoretical knowledge, develop practical skills, and gain a deeper understanding of real-world environmental challenges.

Course Outcome (CO):

1. To demonstrate sampling and testing of water.
2. To perform sampling and testing of water.
3. To demonstrate sampling and testing of waste water.
4. To perform sampling and testing of waste water.
5. To monitor and analyse the water and wastewater samples.

S. No.	Content	Contact Hours
Unit 1	**UNIT-I - Water Engineering Lab.:** Determination of physical and chemical characteristics of water.	5
Unit 2	**UNIT-II - Water Engineering Lab:** Determination of biological characteristics of water.	5
Unit 3	**UNIT-III - Wastewater Engineering Lab.:** Determination of physical and chemical characteristics of wastewater.	5
Unit 4	**UNIT-IV - Wastewater Engineering Lab.:** Determination of biological characteristics of wastewater.	5
Total		**20**

Books:

1. IS 3025: Methods of Sampling and Test (Physical and Chemical) for Water and Wastewater, various parts.
2. IS 1622 (1981): Methods of sampling and microbiological examination of water.

Course Title	Course Structure			Pre - Requisite
	L	T	P	
Environmental Awareness (EN102)	3	1	0	-

Course Objective:
This course aims at providing fundamentals of principles of environmental protection and an introduction to the environmental related treaties, Conventions and Protocols. This will enhance students' awareness towards global and Indian Environmental Legislations.

Course Outcome (CO):

1. To explain National and International Legislations for Environmental Protection.
2. To apply environmental legislations in case studies.
3. To analyse basic components and principles of environmental legislations.
4. To evaluate effectiveness of national and international environmental legislations.

S. No.	Content	Contact Hours
Unit 1	**Global Environmental Treaties, Conventions and Protocols:** Convention on International Trade in Endangered Species of wild fauna and flora (CITES), 1973, Montreal Protocol on Substances that deplete the Ozone Layer (to the Vienna Convention for the Protection of the Ozone Layer), 1987, Basel Convention on Transboundary Movement of Hazardous Wastes, 1989, UN Framework Convention on Climate Change (UNFCCC), 1992, Convention on Biological Diversity, 1992, UN Convention on Desertification, 1994, International Tropical Timber Agreement and The International Tropical Timber Organisation (ITTO), 1983 (introduction only).	9 Hrs
Unit 2	**Indian Constitutional Perspective:** Environment Protection under Constitutional Framework of India, Fundamental Rights – Article 14 (Right to equality, non-arbitrary and non-discriminatory treatment), Article 19(1)(g) (Freedom to carry on trade or business), Article 21 (Right to life, livelihood and wholesome environment) and Article 32 (Right to Constitutional remedies), Directive Principles of State Policy – Article 47, 48-A, Fundamental Duty – Article 51-A(g) (introduction only).	9 Hrs
Unit 3	**Environmental Justice:** Article 226 (Powers of High Courts), Public Interest Litigation – Nature – Non-Adversarial, Collaborative, Co-operative and Investigative, Locus Standi – Pro Bono Publico, Representative Standing, Citizens' Standing (introduction only). **Principles of Environmental Protection** - Development v. Environment; Sustainable Development, Inter-generational and Intra-generational Equity, Precautionary Principle, Polluter Pays Principle, Public Trust Doctrine, Perspectives on ISO 14000, ISO 22000, Industry 4.0, Industry 5.0. Broad perspective on: Ecology &	8 Hrs

	Biodiversity, Ecotourism, Environmental Economics, Environmental Ethics.	
Unit 4	**Legal and Regulatory Framework for Environmental Protection in India:** Environmental (Protection) Act 1986, Water (Prevention and Control of Pollution) Act 1974, Air (Prevention and Control of Pollution) Act 1981, The Wildlife (Protection) Act, 1972, The Indian Forest Act, 1927, The Forest (Conservation) Act 1980, Hazardous Wastes (Management and Handling) Rules, 1989, The Biological Diversity Act, 2002, Energy and Mining Laws, EIA Notification 2006 (introduction only).	7 Hrs
Unit 5	**Administrative Framework for Environmental Management in India:** MoEFCC, Central Pollution Control Board, SPCBs/SPCCs, National Biodiversity Authority, National Tiger Conservation Authority, Animal Welfare Board of India, Forest Survey of India, Central Zoo Authority of India, The National Green Tribunal Act, 2010, The Public Liability Insurance Act, 1991, The National Environmental Tribunal Act, 1995, The National Environment Appellate Authority Act, 1997, Factories Act, 1948 and its Amendment in 1987 (introduction only).	7 Hrs
Total		**40**

Prescribed Legislations

1. The Water (Prevention and Control of Pollution) Act, 1974
2. The Air (Prevention and Control of Pollution) Act, 1981
3. The Environment (Protection) Act, 1986
4. The Public Liability Insurance Act, 1991
5. The National Green Tribunal Act, 2010
6. The Biological Diversity Act, 2002
7. The Wildlife (Protection) Act, 1972
8. The Forest (Conservation) Act, 1980
9. The Indian Forest Act, 1927
10. The Scheduled Tribes and Other Traditional Dwellers (Recognition of Forest Rights) Act, 2006.

Policies and reports

1. The National Environment Policy, 2006
2. The National Forest Policy, 1988
3. The National Water Policy, 2012
4. The Wildlife Conservation Strategy, 2002
5. The World Commission on Environment and Development, Our Common Future, 1987
6. IPCC Fifth Assessment Report (AR5). Synthesis Report: Climate Change 2014.

Prescribed Books

1. Philippe Sands and Jacqueline Peel, Principles of International Environmental Law (4th ed., 2018).
2. Shibani Ghosh ed., Indian Environmental Law: Key Concepts and Principles (2019).

3. Geetanjoy Sahu, Environmental Jurisprudence and the Supreme Court: Litigation, Interpretation, Implementation (2014)
4. Shyam Diwan and Armin Rosencranz, Environmental Law and Policy in India– Cases, Materials and Statutes (2nd ed., 2001)
5. P. Leelakrishnan, Environmental Law Case Book (2nd ed., 2010)
6. Gurdip Singh, Environmental Law in India (2nd ed 2016)
7. P. Leelakrishnan, Environmental Law in India (5th ed., 2019)
8. Stuart Bell & Donald Mc Gillivray, Environmental Law (7th ed., 2008)

Course Title	Course Structure			Pre - Requisite
	L	T	P	
Basic Environmental Engineering (EN104)	3	1	0	-

Course Objective:
This course aims at providing fundamentals of environmental engineering and an introduction to the services in environmental engineering. This will enhance student's awareness towards water and wastewater engineering, air and noise pollution and solid waste management and emerging fields in Environmental Engineering.

Course Outcome (CO):

1. To explain fundamentals of Environmental Engineering.
2. To apply fundamentals of Environmental Engineering to various environmental issues.
3. To analyse environment and pollution in each segment of the environment.
4. To evaluate environmental services required for water supply and treatment and control of environmental pollution.
5. To design various units for treatment of water, wastewater and for control of air and noise pollution.

S. No.	Content	Contact Hours
Unit 1	**Water Engineering:** Water demand and its variations. Population Forecasting, Physical, Chemical and Biological Quality Parameters, Drinking Water Quality Standards, Surface, subsurface, selection and development of sources.	8 hrs
Unit 2	**Wastewater Engineering:** Wastewater Sources, Flow Rates and variations in flow. Physical, Chemical and Microbiological characteristics of waste water. Effluent disposal and re-use, surface disposal, Disposal into rivers, self-purification, oxygen sag curve.	8 hrs
Unit 3	**Water Treatment:** Coagulation, mixing, flocculation, Sedimentation, Filtration, gravity and pressure filters. Water softening. Aeration, Disinfection, chlorination. **Wastewater Treatment:** Physical Treatment, screening, activated sludge, trickling filter, septic tanks, anaerobic sludge digestion, stabilization ponds and aerated lagoons.	8 hrs
Unit 4	**Solid Waste Management**: Sources and composition. Principal industrial and hazardous solid waste, collection, characteristics and disposal.	8 hrs
Unit 5	**Air and Noise Pollution:** Major air pollutants, sources and effects, measurement of air quality, criteria and standards, Atmospheric cleansing processes (Natural). Noise pollution standards effects and abatement.	8 hrs

Total	40

Books:

S. No.	Name of Books/Authors/Publisher
1.	Howard S. Peavy, Donald R. Rowe, and George Tchobanoglous: Environmental Engineering, McGraw-Hill Series in Water Resources and Environmental Engineering, McGraw-Hill. ISBN: 0071002316, 9780071002318
2.	Santosh Kumar Garg, Environmental Engineering (Vol.-I): Water Supply Engineering, Khanna Publishers, ISBN: 9788174091208, 8174091203
3.	Santosh Kumar Garg, Environmental Engineering (Vol. II): Sewage Waste Disposal and Air Pollution Engineering ISBN 9788174092304, 8174092304
4.	Dr. B.C. Punmia, Ashok Kr. Jain, and Arun Kr. Jain, Environmental Engineering-I: Water Supply Engineering, Laxmi Publications, ISBN: 81-7008-092-4
5.	Dr. B.C. Punmia, Ashok Kr. Jain, Environmental Engineering-II: Wastewater Engineering (Including Air Pollution), Laxmi Publications, ISBN: 81-7008-091-6
6.	E. W. Steel, and T. J. McGhee, Water Supply and Sewerage, McGraw-Hill. ISBN:9780070609297, 0070609292
7.	G. S. Birdie, and J. S. Birdie, Water Supply and Sanitary Engineering (Including Environmental Engineering, Water and Air Pollution, Laws and Ecology), Dhanpat Rai Publisher, ISBN:9788187433798, 8187433795
8.	Metcalf & Eddy, George Tchobanoglous, Franklin Burton, H. David Stensel, Wastewater Engineering: Treatment and Reuse, McGraw Hill Education, ISBN 9780070495395.

Course Title	Course Structure			Pre - Requisite
	L	T	P	
Air Pollution and Waste Management (EN106)	1	0	2	-

Course Objective:
This course will provide B. Tech. (Environmental Engineering) students with basic hands-on experience in various aspects of Air and Noise Pollution, Solid Waste Management, and GIS and Remote Sensing allowing them to apply theoretical knowledge, develop practical skills, and gain a deeper understanding of real-world environmental challenges.

Course Outcome (CO):

1. To demonstrate and perform measurement of air quality parameters.
2. To demonstrate and perform the operations for sampling and testing solid waste.
3. To demonstrate and perform skills for GIS based assessments.

S. No.	Content	Contact Hours
Unit 1	**UNIT-I - Air Pollution Monitoring Lab.:** Measurement of ambient air pollutants using appropriate monitoring equipment.	5
Unit 2	**UNIT-II - Noise Pollution Monitoring Lab.:** Sound Pressure Level Measurements.	5
Unit 3	**UNIT-III - Solid Waste Management Lab.:** Characterization of solid waste samples to determine composition and moisture content, calorific value, etc.	5
Unit 4	**UNIT-IV – System Simulation & GIS Lab.:** Basics of environmental modelling and systems thinking, Analysing and visualizing environmental data using GIS softwares.	5
Total		**20**

Books:

1. IS 5182: Methods for Measurement of Air Pollution, various parts.
2. IS 9234: Methods of Sampling and Test for Solid Waste, various parts.
3. Ramaswami A., Milford J.B. and Small M.J. (2005) Integrated Environmental Modelling, John
4. Wiley and Sons, Inc., New Jersey.
5. P. A. Burrough (1986) Principles of Geographical Information Systems for Land Resource Assessment, Oxford University Press.
6. Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind (2005) Geographical Information Systems: Principles, Techniques, Management and Applications, Wiley.

IInd Year

COURSE TITLE: Strength of Materials

1. **Subject Code:** EN201 **Course Title**: Strength of Materials
2. **Contact Hours:** L: 3 T: 0 P: 2
3. **Examination Duration (ETE) (Hrs.):** Theory: 3 Hrs. Practical: 0 Hr.
4. **Relative Weightage:** CWS: 15 PRS: 25 MTE: 20 ETE: 40 PRE: 0
5. **Credits:** 4
6. **Semester:** III
7. **Subject Area:** DCC
8. **Prerequisite:** Nil
9. **Course Objectives:**

- This course is designed to provide fundamental principles governing the mechanical behaviour of materials.
- Students will understand the ability of a material used in engineering design to resist external forces without breaking.
- The course covers material behaviour, stresses, strains, and deformations with simple applications in engineering designs.

10. **Detail of Course:**

Sl. N.	Contents	Contact Hours
1	**UNIT- 1: Stress and Strain** Statics, resolution and resultant of forces, FBD, mechanical properties of materials, simple stress and strain, stress-strain curve, elastic constants, complex stresses, Mohr's circle for finding principal stresses, bending stresses.	9
2	**UNIT- 2: Bending Moment and Shear Force** Types of beams, supports and loads, shear force and bending moments in beams, cantilever, simply supported and overhang beams, stresses in beams, theory of simple bending.	9

3	**UNIT- 3: Slope & Deflection** Deflection due to bending, deflection curve and slope of the curve, moment-curvature relationship, slope & deflection by double integration method, Macaulay's method, moment area method, and conjugate beam method.	9
4	**UNIT- 4: Columns and Struts** Types of columns, modes of failure of columns, effective length, slenderness ratio, Euler crippling load, Rankins's formula.	7
5	**UNIT- 5: Torsional stresses in Shafts** Analysis of torsional stresses in circular shafts, assumptions in torsion theory, resisting torque, power transmitted through shafts, design of shafts.	8
	TOTAL	**42 Hrs.**

Course Outcomes:

On successful completion of this course students will be able to:

CO1**:** Understand the concepts of stress and strain, and the stress-strain relationships for homogenous, isotropic materials.

CO2**:** Analyse the relationships between loads, member forces and deformations and material stresses and strains in structural members under axial loading, thermal expansion, flexural loadings, shear & torsion.

CO3**:** Evaluate failure of structural members under complex stress subjected to combined loadings.

CO4**:** Apply the above understanding to the designs and analysis of structural members based on strength and deformation criteria.

CO5**:** Demonstrate and understanding of the assumptions and limitations of the theories used in mechanics of materials, problem identification, formulation & solution and critical thinking.

Suggested Books:

- Punmia BC, Jain AK, Jain AK, 'Mechanics of Materials', Laxmi Publications (P) Ltd. (ISBN 978-81-318-0646-3).
- Rajput RK, Strength of Materials, S. Chand & Company Ltd (ISBN 978-93-525-3369-5).
- Vazirani VN, Ratwani MM & Duggal SK, Analysis of Structures, Vol-1, Khanna Publishers (ISBN 978-81-7409-140-8).
- Jindal UC, Strength of Materials, Pearson (ISBN 9788131759097).
- Gere J. M., Timoshenko S.P., Mechanics of materials, CBS Publication, 2nd edition (ISBN-8123908946).
- Kazimi SMA, Solid Mechanics, Tata McGraw-Hill Publishing Company Ltd. (ISBN 69-27-0494-7).

COURSE TITLE: Engineering & Environmental Surveying

1. **Subject Code:** EN203 **Course Title:** Engineering & Environmental Surveying
2. **Contact Hours:** **L: 3** **T: 0** **P: 2**
3. **Examination Duration (ETE) (Hrs.):** Theory 3 Hrs Practical 2 Hrs
4. **Relative Weightage:** CWS 15 PRS 25 MTE 20 ETE 40 PR 0
5. **Credits:** 4
6. **Semester:** 3 **7. Subject Area**: DCC **8. Prerequisite:** Nil

9. Course Objectives:

- To understand the definition, principle, importance, and types of surveying.
- To develop the ability to learn and work as a team in the Plane table surveying and leveling.
- To explain the different methods for calculation of area and volume for regular and irregular boundaries.
- To describe the basic concepts, types, and operations of Theodolite.
- To understand the principle and operation of Tacheometric surveying.

10. Details of Course

S. No.	Contents	Contact Hours
1.	**UNIT1: Introduction to Surveying:** Introduction: Object & scope of surveying, classification of Surveying, principles of surveying, surveying instructions, Basic Surveying Techniques: Chain Surveying; Instruments of chain surveying, corrections to measured lengths, measurement of offsets, limiting the length of offsets, fieldwork of chain surveying, booking of field notes, conventional symbols, obstacles in chain surveying, errors in chain surveying & their corrections. Compass surveying: instructions in compass surveying, a system of recording the bearing, determination of meridian compasses, traversing & graphical method of adjustment.	10
2.	**UNIT2: Plane table Surveying and Leveling:** Plane table Surveying: Plane table and its accessories, methods of plane tabling, two-point problem, three-point problems by different methods.	9

	Leveling: Introduction, types of leveling, leveling instruments, operations and adjustments of levels, ordinary leveling, errors of leveling, effect of earth's curvature and atmospheric refraction in leveling , precise leveling, modern leveling instruments, contouring: characteristics and uses of contour, modern methods of depicting relief on map.	
3.	**UNIT3: Areas and Volume:** Areas, Volume, and Earthquake Computations: Different methods of determination of areas from the plan, areas of irregular boundaries, areas of field notes by latitudes and departure methods, instrumental methods of determining areas, areas of cross-section, determination of earthquake volumes.	8
4.	**UNIT4: Theodolite Traversing:** Theodolite Traversing: Transit theodolites, operation, and adjustment of theodolites, horizontal angle by the method of repetition and reiteration, permanent adjustments of theodolite, theodolite traversing, traverse computations, sources of errors, check in a traverse, closing error and its adjustments, omitted measurements.	7
5.	**UNIT5: Tacheometric Surveying:** Tacheometric surveying: the principle of stadia method, instrument constants, Anallatic lens, Distance and elevation of stations, subtense method, tangential method, errors, subtense bar, and its use.	8
Total		**42**

Course Outcomes:

CO1: Enhanced understanding of fundamentals, principles, and types of surveying.

CO2: Measuring the distance by chaining, compass surveying, and plane table.

CO3: Analyzing the various methods of levelling, area, and volume.

CO4: Gaining the proper knowledge of operations, adjustment of the Theodolite, and calculation of heights & distances by using the Theodolite.

CO5: Calculating the distance and elevation by Tachometry surveying.

Suggested Books:

- Agor, R, "Surveying", Vol. I & II, Khanna Publications, Delhi.
- Arora, K.R., "Surveying", Vol. I & II, Standard Book House, Delhi.
- Bannister, A. and Baker, R., "Solving Problems in Surveying", Longman Scientific Technical, U.K.

- Kennie, T.J.M. and Petrie, G., “Engineering Surveying Technology”, Blackie & Sons Ltd, London.
- Surveying, S. K. Duggal Vol 1& 2, Tata Mcgraw Hill Publications,New Delhi
- Punmia, B.C., “Surveying”, Vol. I & II, Laxmi Publications, New Delhi.

COURSE TITLE: Environmental Chemistry and Microbiology

1. **Subject Code:** EN205 **Course Title:** Environmental Chemistry and Microbiology
2. **Contact Hours: L: 3 T: 0 P: 2**
3. **Examination Duration (ETE) (Hrs.):** Theory 3 Hrs Practical 2 Hrs
4. **Relative Weightage:** CWS 15 PRS 25 MTE 20 ETE 40 PR 0
5. **Credits:** 4
6. **Semester:** 3 7**. Subject Area**: DCC **8. Prerequisite:** Nil
9. **Course Objectives:**

- To learn the basics of aquatic chemistry.
- To learn about different pollutants of water and their effect on water quality.
- To learn the basics of atmospheric chemistry.
- To learn the basics of microbial structure and functions.
- To learn the utilization of microbes in environmental remediation processes.

10. **Detail of Course:**

S.N.	Contents	Contact Hours
1	**Unit-1: Aquatic chemistry** Hydrological cycle, Chemical structure of water molecules, unusual properties of water, solubility of solids and gases in water, Carbonate cycle, pH of water, Chemical Equilibrium, Redox reactions. Application of principles of chemistry for solving environmental engineering problems.	9
2	**Unit-2: Water Pollution** Chemistry of pollution due to nutrients (CNP), Oxygen demanding wastes, salts, detergents, heavy metals, pesticides, hydrocarbons, PCBs, and radioactive compounds.	6
3	**Unit-3: Atmospheric Chemistry** Composition of atmospheric layers, sources of air pollution, major pollutants of air, the chemistry of photochemical smog formation, acid rain, ozone depletion; greenhouse effect, and global warming.	9
4	**Unit-4: Environmental Microbiology** Microbial taxonomy, Classification of morphological aspects of bacteria, algae, fungi, protozoa, and other aquatic microflora; microbial growth	10

	and dynamics; pure and mixed cultures; Aerobic and Anaerobic metabolism; microbial transformation of organic matter (CNPS), acclimatization of waste; microbial inhibition mechanisms.	
5	**Unit-5: Role of Microbes in the Environment** Role of micro-organisms in wastewater treatment, and air pollution control (bio-scrubbers); microbial degradation of lignocellulosic material, pesticides, hydrocarbons; microbial precipitation of heavy metals.	8

Course Outcomes:

CO1: Theoretical knowledge and numerical calculations related to pH, equilibrium, solubility, dissociation, etc.

CO2: Knowledge of sources and mechanisms resulting in degradation of water quality.

CO3: Understanding the direct and indirect processes related to air pollution.

CO4: Identification of microbes, and regulation of microbial growth in the lab.

CO5: Application of microbes in waste treatment

Suggested Books:

- Environmental Chemistry: by Colin Baird (Freeman)
- Environmental Chemistry: by Manahan (CRC)
- Environmental Chemistry: by Vanloon & Duffy (Oxford)
- Microbilogy: by Pelczar (TataMcGraw Hill)
- Introduction to Environmental Engg. and Science: by Gilbert Masters (Pearson).

COURSE TITLE: Water Engineering: Design & Application

1. Subject Code: EN207 **Course Title:** Water Engineering: Design & Application

2. Contact Hours: L: 3 T: 0 P: 2

3. Examination Duration (ETE)(Hrs.): Theory 3 Hrs Practical 2 Hrs

4. Relative Weightage: CWS 15 PRS 25 MTE 20 ETE 40 PRE 0

5. Credits: 4

6. Semester: 3 **7. Subject Area:** DCC **8. Pre-requisite:** Nil

9. Course Objectives:

- To describe basic properties of drinking water.
- To calculate the population by various methods of population forecasting.
- To explain the definition, principle, design, and types of various unit processes/operations of water treatment.
- To understand the design of intake reservoirs and water distribution system.
- To understand the O & M of water treatment plants

10. Details of Course

S. No.	Contents	Contact Hours
1	**UNIT I: -** Water demand: Types of demands, factors affecting per capita demand, variations in demand; Population forecasting; Sources of water supply: estimation of water quantity, factors governing the selection of source; Water conservation measures.	8
2	**UNIT II: -** Intakes: Types of intakes, factors governing the location of intake; Reservoirs: types of reservoirs, capacity of reservoir; Water distribution system: requirements of a good distribution system, methods of distribution, layout, and design of water supply systems; Pipes: types of pipes for transporting water, pipe appurtenances, testing of pipelines.	9
3	**UNIT III:** Water Quality: Physical chemical and microbiological water quality parameters and their significance; Water borne diseases and their control; drinking water quality criteria and standards; Natural processes occurring for self-cleansing of water bodies.	6

4	**UNIT IV:** Water treatment: Sedimentation, theory of sedimentation, design of sedimentation tank, types of sedimentation tanks; Coagulation, theory of coagulation, types of coagulants and coagulant aids, and flocculation, design of flocculation tank; Filtration: theory of filtration, types of filters and their classification, filter operations.	9
5	**UNIT V:** Water softening: Chemical precipitation, ion exchange; reverse osmosis; Aeration of water to remove iron and manganese and taste and odor. Disinfection, disinfectants, and chlorination of water supplies, disinfection: types of disinfectants, chlorination, pre and post chlorination; Miscellaneous methods of water treatment; Site selection for treatment plant; layout considerations for treatment plant; Operation and maintenance of treatment plants, Domestic & Industrial water treatment.	10

Course Outcomes:

CO1: Gained knowledge of the properties of drinking water.

CO2: Analyze the various methods of population forecasting.

CO3: Understand the principle & design of various unit processes/operations of water treatment.

CO4: Design the intake reservoirs and water distribution system.

CO5: Differentiate domestic and industrial water treatment plants.

Suggested Books:

- Peavy, Rowe and Tchobanoglous: Environmental Engineering.
- Garg, S.K., Water Supply Engineering- Vol-I, Khanna Publishers, New Delhi.
- Punmia, B. C.: Water Supply and Wastewater Engineering.
- Steel, E.W, and Mc Ghee, T.J., Water Supply and Sewerage. McGraw Hill Book Co., New York.
- Birdie: Water Supply and Sanitary Engineering

COURSE TITLE: Environmental Monitoring

1. **Subject Code:** EN209 **Course Title:** Environmental Monitoring
2. **Contact Hours: L: 3 T: 0 P: 2**
3. **Examination Duration (ETE) (Hrs.): Theory :** 3 **Hrs. Practical:** 2 **Hrs**
4. **Relative Weightage: CWE: 15 PRS: 25 MTE: 20 ETE: 40, PRE:0**
5. **Credits: 4**
6. **Semester: 3 7. Subject Area: DCC 8. Prerequisite: Nil**

9. Course Objectives:

- Understand the fundamental principles of environmental measurements.
- Gain practical skills in applying instrumentation for environmental monitoring systems.
- Develop the ability to analyze environmental measurement systems.
- Critically evaluate measurement and instrumentation strategies.
- Cultivate the capability to develop innovative and tailored environmental monitoring solutions.

10. Details of Course:

Sr. No.	Subject Code : EN: 302 Instrumentation	Contact Hours
1	**Unit-I: Fundamentals**: The Significance and Application of Measurement. Functional Elements of Generalized Measuring System. Classification of Measuring Instruments, Introduction of Microprocessors and Advantages of Microprocessor-based instrumentation. Management of Data in quantitative analysis, accuracy, precision, types of errors, minimization of error, statistical analysis, and curve fittings.	9
2	**Unit-II: Measurement:** Standards of Measurement and its classification. Calibration of instruments and its importance. Transducers, measurement of non-electrical quantities like pressure, temperature, flow, level, etc.	8
3	**Unit-III: Spectro-analytical Method:** Colorimetry, Spectrophotometry, Flurometry, Nephlometry, Turbidimetry, Flame Photometry, Atomic, Absorption, and Emission Spectrophotometry	9
4	**Unit-IV: Chromatography Method:** Classification, Principles, and Application of Chromatography–Gas chromatography, GC-MS, HPLC, Ion Chromatography, Paper Chromatography, and Thin Layer Chromatography	8
5	**Unit-V: Electro Analytical Method:** Conductometry Potentiometry, Coulometry, and Polarography. Continuous Monitoring instruments and their principals: NDIR for CO, Chemiluminescence analysis for NO_X, and fluorescence analysis for SO_2	8

Course Outcomes:

CO1: Explain principles, importance, instruments, microprocessor benefits, error management, standards, calibration, and analysis techniques.

CO2: Apply instrumentation for monitoring systems, troubleshoot, analyze data, calibrate, and make decisions.

CO3: Analyze measurement systems, error analysis, statistics, calibration, and techniques for complex analyses.

CO4: Evaluate strategies for measurement, assess suitability, reliability, effectiveness, and make informed decisions.

CO5: Develop innovative solutions, synthesize principles, techniques, methodologies, and design specialized systems.

Suggested Books:

- A K Tayal (1999) Instrumentation, Mechanical Measurements and Control, 2nd Edition, Galgotia Publications Pvt Ltd, ISBN-10: 8175155701, ISBN-13: 978-8175155701
- Alan S. Morris (2001) Measurement and Instrumentation Principles, 3rd Edition, Butterworth-Heinemann, ISBN-10:0750650818, ISBN-13: 978-0750650816
- R. S. Khandpur (2006) Handbook of Analytical Instruments, India Professional Science & Technology Electrical Engineering, 2nd Edition, McGraw-Hill Professional ISBN-10: 0070604606, ISBN-13: 978-0070604605
- B. C. Nakra and K K Chaudhry (2016) Instrumentation Measurement And Analysis, Fourth Edition, McGraw Hill Education India Private Limited, ISBN-10: 9385880624, ISBN-13: 978-9385880629
- Francis Rouessac and Annick Rouessac (2022) Chemical Analysis: Modern Instrumentation Methods And Techniques, ISBN-10: 1119701333, ISBN-13: 978-1119701330

COURSE TITLE: Fluid Mechanics & Hydraulic Machines

1. Subject Code: EN202 **Course Title: Fluid Mechanics & Hydraulic Machines**

2. Contact Hours: L: 3 T: 0 P: 2

3. Examination Duration (Hrs.): Theory: 3 Hrs. Practical: 0 Hr.

4. Relative Weight: CWS: 15 PRS: 25 MTE: 20 ETE: 40 PRE: 0

5. Credits: 4

6. Semester: IV

7. Subject Area: DCC

8. Pre-requisite: NIL

9. Course Objective:

- The course is designed to familiarize the students the properties of fluids and various pressure measurement techniques.
- The students will understand nature of fluid statics, in particular problems dealing with hydrostatic forces, elementary kinematic and dynamic behavior through various laws of fluids like continuity, Euler's & Bernoulli's equations, energy and momentum equations and their applications for measuring fluid flow through various devises.
- The student shall be able to identify and analyse various types of fluid flow, turbulent and laminar flow through pipes & flow in open channels in order to predict relevant pressures, velocities and forces, besides the working and performance characteristics of hydraulic turbines and pumps.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**UNIT-1: Fluid property and fluid statics** Properties of fluids, types of fluids, and continuum principle, pressure and its measurements. Hydrostatics law, Pascal's law, Manometers, Hydrostatics forces on submerged surfaces, Buoyancy & floatation.	8
2	**UNIT-2: Kinematics of fluid flow** General description of fluid motion. Types of fluid flow, steady flow, uniform flow, streamline, streak line & path line, the principle of	7

	conservation of mass, velocity & acceleration, velocity potential and stream function, vorticity and circulation.	
3	**UNIT-3: Dynamics of fluid flow** Various forms of energies present in fluid flow, Euler's equation of motion**,** Bernoulli's theorem and its application, hydraulic and energy grade lines. Flow measurements-Pitot tube, Venturimeter, Orifices and mouthpieces, flow over weirs and notches.	8
4	**UNIT-4: Flow through pipes** Laminar flow through pipes, velocity distribution, turbulent flow, Reynolds equation, Prandtl's mixing length hypothesis, velocity distribution in pipe flow, flow losses in pipes- major and minor losses, pipes in series and parallel, friction factor and Reynold's number, water hammer.	6
5	**UNIT-5: Flow in open channel** Wetted perimeter in open channel, hydraulic radius, Chezy's formula, Manning's formula, empirical formulae for constant used in Chezy's formula, economical section of channels, Open channel section for constant velocity at all depth of flow, specific energy and critical depth of open channel, specific energy diagrams, streaming and shooting flows.	6
6	**UNIT-6: Hydraulic machines** Dynamic forces on curved and bends, elements of hydroelectric power plants, classification of turbines, head and efficiencies of hydraulic turbines, working proportion of Pelton Wheel turbine. Centrifugal and reciprocating pumps. Work done and discharge by centrifugal pump, heads and efficiency of centrifugal pump, multistage centrifugal pump. Work done and discharge by reciprocating pump, variation of velocity and acceleration in the suction and delivery head due to acceleration of the piston, indicator diagram.	7
	Total	42

Course Outcomes:

On successful completion of this course students will be able to:

CO1**:** Identify importance of various fluid properties and solve problems involving fluid properties and shear forces resulting from Newtonian fluids.

CO2: Derive magnitude and location of hydrostatic forces on surfaces immersed in a static fluid and equations of continuity, momentum and energy for various types of fluid flows.

CO3: Apply the above understanding in use of different fluid flow measuring devices.

CO4: Analyze a variety of practical fluid flow through pipes and flow in open channels using the integral form of the continuity, momentum and energy equations.

CO5: Evaluate the performance parameters of hydraulic turbines and centrifugal & reciprocating pump.

Suggested Books:

- Bansal RK, Fluid Mechanics and Hydraulics machines, Laxmi Publications (P) Ltd. (ISBN 81 7008 311 7).
- Garde RJ and Mirajgaoker AG, Engineering Fluid Mechanics, Nem Chand & Bros (ISBN 81 88429 01 5).
- Som SK and Biswas G, Fluid Mechanics, Tata McGraw Hill (ISBN 21 345 24561).
- Kumar KL, Engineering Fluid Mechanics, Eurasia Publishing House (P) Ltd. (ISBN 81 219 0100 6).
- Ojha CSP, Fluid Mechanics and Machinery, Oxford, University Press (ISBN 01 19 569963 7).
- Rajput RK, Fluid Mechanics, S. Chand & Company Ltd. (ISBN 81 219 1667 4).

COURSE TITLE: Air Pollution & Control

1. **Subject Code:** EN204 **Course Title:** Air Pollution & Control
2. **Contact Hours:** L: 3 T: 0 P: 2
3. **Examination Duration (ETE) (Hrs.):** Theory: 3 Hrs. Practical: 2 Hrs
4. **Relative Weightage:** CWE: 15 PRS: 25 MTE: 20 ETE: 40 PRE:0
5. **Credits: 4**
6. **Semester:** 4 **7. Subject Area: DCC** **8. Prerequisite: Nil**

9. Course Objectives:

- Introduction to Air Pollution and its effects, Sampling, and measurement.
- Study the Properties of the Atmosphere and Metrological Variables.
- To Develop an understanding of pollution control methods.
- To provide the concept of air & noise pollution managememt plan.

10. Details of Course:

Sr. No.	Contents	Contact Hours
1.	**Unit-I:** Sources and classification of Air Pollution Effects of Air Pollution on Human health, plants, Animals and Property. Sampling and measurement in ambient, Workplace and stack.	08
2.	**Unit-II:** Meteorology- Concept of Atmosphere, wind movements, Windrose Diagram and Measurement of Meteorological Variables. Atmospheric lapse rates, Adiabatic lapse rate and their consequences, Plume behavior. Plume rise-equation, estimation of stack height, Gaussian plume equation	08
3.	**Unit-III:** Pollution control Method of a Particulate matter: Types of Particulate control methods-Settling chambers, cyclone separators, scrubbers, filters, and Electrostatic precipitators- Mechanism, Their design and application.	09
4.	**Unit-IV:** Gaseous Pollution control method and Automobile Pollution: Types of gaseous Pollution Control method- absorption, adsorption, and combustion process. Automobile pollution- Sources of pollution, composition of auto exhaust & control method.	08
5.	**Unit-V:** Air Pollution Legislation and Global Problem, Ambient Air Quality Standards and Emission Standards. Air Pollution, legislation, and regulation in India. Air Pollution Indices, Noise Pollution, Health Effects due to Noise Pollution, Noise Pollution Monitoring & Control Measures	09

Course Outcomes:

CO1: Understand the basics of Air Pollution, its effects, and measurement.

CO2: Analyse the trend of air quality data.

CO3: Evaluate the performance and effectiveness of air pollution control equipment.

CO4: Develop a plan for awareness and management of air pollution.

Suggested Books:

- Fundamental of Air Pollution by Arthur C. Stern. Publisher: Academic Press Inc.
- Air Pollution: - M.N. RAO and H.V. RAO, M C Graw Hill Education.
- Introduction to Environmental Engineering and Science: - G. M. Masters
- Environmental Pollution Control Engineering: CS Rao
- Environmental Engineering, By: Howard S. Peavy, Donald R. Rowe, George Tchobanoglous. McGraw-Hill- International Edition
- Environmental Engineering (Vol. II) Sewage Waste Disposal and Air Pollution Engineering. Latest Edition. By S. K. Garg, Khanna Publishers.

COURSE TITLE: GIS & Remote Sensing

1. **Subject Code:** EN206 **Course Title:** GIS & Remote Sensing
2. **Contact Hours: L: 3 T: 0 P: 2**
3. **Examination Duration (ETE) (Hrs.):** Theory 3 Hrs
4. **Relative Weightage:** CWS 25 PRS 0 MTE 25 ETE 50 PRE 0
5. **Credits:** 4
6. **Semester:** 4 **7. Subject Area**: UEC **8. Prerequisite:** Nil

9. **Course Objectives:**

- Understand the fundamental principles and technologies of remote sensing and GIS.
- Demonstrate the use of geospatial models and their applications.
- Analyze geospatial data and integrate remote sensing and GIS technologies.
- Evaluate the quality, accuracy, reliability, and relevance of geospatial data in remote sensing and GIS.
- Develop innovative and effective solutions using remote sensing and GIS technologies.

10. **Detail of Course:**

Sr. No.	Contents	Contact Hours
1	**Unit-1: Remote Sensing-Principles and Technologies:** Remote Sensing and Remote Sensing System, Multi-concept of remote sensing, Advantages and Disadvantages of Remote Sensing, Electromagnetic radiation, Polarisation, Thermal radiation, Remote Sensing Platforms, Passive and Active sensors, Spatial resolution, Spectral resolution, Radiometric resolution, Temporal resolution, Global Positioning System.	7
2	**Unit-2: Visual Image Interpretation and Digital Image Processing:** Visual Image Interpretation Techniques, Types of Data Products, Image Interpretation Elements, Applications of Aerial Photo and Satellite Imagery, Digital Image Processing, Characteristics of Digital Images, Preprocessing Techniques like Geometric and Radiometric Corrections, Image Enhancement, Spatial Filtering, and Transformations	9
3	**Unit-3: Application of Remote Sensing**	8

	Digital Image Processing, Application of Remote Sensing in Land use and Land cover mapping, Groundwater mapping, Urban growth studies, Wasteland mapping, Disaster Management, Agriculture, and Forestry application	
4	**Unit-4: Geographic Information System Fundamentals:** Fundamentals of GIS, Definitions, Terminology, and Architecture, Components of GIS, Input data for GIS, Theoretical Models and Categories of GIS, GIS data types, Data representation, Data sources, Geo-referencing of GIS data, GIS database, Database Management System, Data analysis terminology, GIS software packages, GIS application	9
5	**Unit-5: Integration of Remote Sensing and GIS for Spatial Analysis:** Integration of Remote Sensing and GIS, Raster and Vector Data Integration, Urban and Municipal Applications of Remote Sensing and GIS, Role of Satellite Imagery in Urban Analysis, Case Studies, Themes like Transportation, Land Use, Water Resources, and Socio-Economic Conditions	9

Course Outcomes:

CO1 Explain the fundamental principles and technologies of remote sensing and geographical information systems for spatial analysis.

CO2 Demonstrate geospatial models, applications, and systems for specific environmental, urban, and socio-economic challenges.

CO3 Analyze geospatial data, remote sensing and geographical information systems and their integration for spatial analysis in diverse applications.

CO4 Evaluate data quality, accuracy, reliability, and relevance to specific spatial analysis objectives and applications of remote sensing and geographical information systems

CO5 Develop solutions using remote sensing and geographical information systems.

Suggested Books:

- M. Anji Reddy (2008) Textbook of Remote Sensing and Geographical Information Systems, Third Edition, BS Publications, ISBN:81-7800-135-7
- George Joseph and C Jeganathan (2018) Fundamentals of Remote Sensing, Third Edition, The Orient Blackswan, ISBN-10: 9386235463, ISBN-13: 978-9386235466
- A. M. Chandra, S. K. Ghosh (2006) Remote Sensing and Geographical Information System, Reprint Edition, Alpha Science, ISBN-10: 1842652788, ISBN-13: 9781842652787
- C. P. Lo & Albert K.W. Yeung (2016) Concepts and Techniques of Geographic Information Systems, Second Edition, Pearson Education, ISBN-10: 9789332581883, ISBN-13: 978-9332581883

- Kang Tsung Chang (2017) Geographic Information System, Fourth Edition, McGraw Hill Education, ISBN-10:0070658986, ISBN-13: 978-0070658981

COURSE TITLE: Solid Waste Management

1. **Subject Code:** EN208 **Course Title:** Solid Waste Management
2. **Contact Hours: L: 3 T: 0 P: 2**
3. **Examination Duration (ETE) (Hrs.):** Theory 3 Hrs Practical 2 Hrs
4. **Relative Weightage:** CWS 15 PRS 25 MTE 20 ETE 40 PRE 0
5. **Credits:** 4
6. **Semester:** 4 **7. Subject Area**: DCC **8. Prerequisite:** Nil
9. **Course Objective:**

- To educate the students on the basics of solid waste including characteristics, principles involved in the management of municipal solid waste
- Students will be able to identify sources of solid waste.
- Students will be understand various methods of disposal of waste.
- At the end of the course, students will be able to design an engineered landfill for solid waste management.

10. **Detail of Course:**

S.N.	Contents	Contact Hours
1	**UNIT – I** Sources, Composition & Properties of Municipal solid waste. Handling & Separation of solid waste, Municipal Waste (Management & Handling Rules, 2000), Integrated solid waste management (SWM) System, Hierarchical approach for SWM. Solid Waste Collection & Transportation: Types of collection systems (Hauled- container system & Stationary container system), Collection routes & their Layout, Solid waste transfer stations.	10
2	**UNIT – II** Solid waste generation and collection rates; Waste handling and separation, storage and processing at source, solid wastes collection methods, separation, processing, and transformation of solid wastes, transfer and transport of solid wastes	10
3	**UNIT – II** Methods of Disposal of Municipal Solid Waste Landfills: Classification, Types & methods, Site selection, Site preparation, Composition, Characteristics, Generation, & Control of Landfill gases;	11

	Composition, Formation, Movement & control of leachate in landfills; landfill design. Re-vegetation of closed landfill sites, long term post closure plan, Groundwater monitoring during & after closure.	
4	**UNIT – IV** Transformation and recycling of waste materials; Composting: Theory of composting, Manual and mechanized composting, Design of composting plan, Recovery of bioenergy from organic waste. Thermal Conversion Technologies: Incineration, Pyrolysis & Gasification Systems. Types & design of Incinerators.	11

Course Outcomes:

CO1: To make the students understand the fundamentals of solid waste and the types, needs, and sources of solid waste.

CO2: To understand the methods of waste characterization and source reduction and to study the various methods of generation of waste.

CO3: To understand in detail the storage, collection, and transport of wastes and to study the methods used for handling and segregation of wastes.

CO4: To know about the basics of waste disposal options and a detailed study on the disposal in landfills and to learn about landfill remediation.

CO5: To understand the waste transformation and material/energy recovery technologies regarding municipal solid wastes

Suggested Books:

- George Tchobanoglous, Hilary Theisen, Samuel A. Viquel, “Integrated Solid Waste Management: Engineering, Principles & Management issues”, McGraw-Hill- International Edition.
- CPHEEO Manual on Municipal Solid Waste Management.
- Michael D. LaGrea, Phillip L. Buckingham, Jeffrey C. Evans, “Hazardous Waste Management and Environmental Resource Management”, McGraw-Hill- International Edition.
- Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, “Environmental Engineering”, McGraw-Hill- International Edition.
- Mackenzige L. Davis, David A. Cornwell, “Introduction to environmental engineering”, McGraw-Hill-International Edition.
- Arcadio P. Sincero, Gregoria A. Sincero, “Environmental Engineering, A Design Approach”, Prentice Hall India.

- William P. Cunningham, Mary Ann Cunningham, “Principles of Environmental Science”, TMH. India.
- Richard T. Wright, “Environmental Science”, Pearson Education.
- Bala Krishnamoorthy, “Environmental Management, Textbook and Cases”, PHI Publication.

COURSE TITLE: Wastewater Engineering: Design and Applications

1. **Subject Code:**EN210 **Course Title:** Wastewater Engineering: Design and Applications
2. **Contact Hours: L: 3 T: 0 P: 2**
3. **Examination Duration (ETE) (Hrs.):** Theory 3 Hrs Practical 2 Hrs
4. **Relative Weightage:** CWS 15 PRS 25 MTE 20 ETE 40 PRE 0
5. **Credits:** 4
6. **Semester:** 4 **7. Subject Area**: DCC **8. Prerequisite:** Nil
9. **Course Objectives:**

- To explain the principles of wastewater treatment and design of various unit operations and processes.
- To understand the design of sludge digestion.
- To enable students to implement these skills in the planning and designing of sewers.
- To explain the concept of Common Effluent Treatment Plants (CETP)

10. **Detail of Course:**

S.N.	Contents	Contact Hours
1	**UNIT I:** Design of primary treatment units: Design of various preliminary and primary units in a Sewage Treatment Plant, types of screens and its design; assessment of head loss through screen; classification of Grit chambers, their application and its design; oil and grease removal tank, theory and its design; design of primary sedimentation tank.	9
2	**UNIT II:** Design of secondary treatment units: Design of secondary sedimentation tank, Aerobic Treatment; Activated sludge process, sludge concentrator unit, Trickling filter, Oxidation lagoons, oxidation pond.	8
3	**UNIT III:** Design of Anaerobic treatment units: Design of Imhoff Tank, Septic Tank, RBC etc. Upflow Anaerobic Sludge Blanket,	8
4	**UNIT IV:** Design of sludge digestion: Design of sludge digestion, Incineration etc. Application of the concepts of nonlinear optimization to wastewater treatment design.	8
5	**UNIT V:** Design of sewer: Different types of sewage and types sewerage systems, variation in sewage flow, sewer appurtenance, estimation of wastewater discharge in a sewer in sewerage system,	9

	estimation of storm water discharge in urban area, separate and combined sewerage systems, laying and testing of sewers. O & M of Water treatment plants, Domestic & Industrial water treatment. Concept of Common Effluent Treatment Plants (CETP), concept of zero discharge.	

Course Outcomes

CO1: Understand the design of various physical treatment processes of wastewater.

CO2: Acquainted with the design of various secondary treatment processes of wastewater.

CO3: Gained knowledge of the design of various biological treatment processes of wastewater.

CO4: Design the sludge digestion.

CO5: Design the sewer systems.

Suggested Books:

- Manual on Sewerage and Sewage disposal-CPHEEO, Govt. of India.
- Metcalf and Eddy, Wastewater Engineering: Treatment, disposal, and reuse. TMH, New Delhi.
- Wastewater Treatment Concept and design approach – G.L. Karia and R.A. Christian, PHI Publications
- Fiar, G.M., and Geyer, J.C., Water and Wastewater engineering, Vol-I & II, John Wiley and sons, New York.
- Anaerobic Sewage treatment by Van Haandel and Lettinga, John Wiley & Sons Publication
- Eckenfelder, Activated sludge treatment of industrial wastewater
- Steel, E.W, and Mc Ghee, T.J., Water Supply and Sewerage. Mc Graw Hill Book Co., New York.
- Hammer, M.J., Water and Wastewater Technology. John Wiley and sons-Inc, New York.

III Year: Fifth Semester

Course Title	Course Structure			Pre-Requisite
	L	T	P	
HYDROLOGY & GROUNDWATER ENGINEERING (EN301)	3	1	0	-

Course Objective:

1. To introduce the concept of hydrological Equation, national and international water balance.
2. To study various forms of precipitation, frequency analysis, adequacy of rain gauges, evaporation process, transpiration, infiltration and run off.
3. To describe the hydrograph, unit hydrograph, flood and estimation of the unit hydrograph and flood using different methods.
4. To understand the source of ground water pollution, confined and unconfined aquifers.

Course Outcome (CO):

1. Enhanced understanding of hydrological equation, precipitation, infiltration, evaporation, run-off, flood & groundwater

2. Analysis the factors affecting precipitation, infiltration, evaporation and ron-off.

3.Estimate the precipitation, infiltration, evaporation, ron-off and flood by different methods.

4. Develop the Hydrograph & unit hydrograph of different duration.

S.No.	Content	Contact Hours
Unit 1	Precipitation**:** Scope of hydrologic cycle, World water balance, India's water balance, Types and forms of precipitation, Measurement of precipitation, Types of rain gauges, Adequacy of rain gauges, Adjustment and filling in of missing data, Average rainfall over an area, Basic statistics and frequency analysis.	7
Unit 2	Evaporation**:** Evaporation and its measurements, Estimation of evaporation. Formulae of Penman, Thornwaite and Balaney-Criddle medod. Evaporation control. Infiltration: Factors affecting infiltration, Infiltrometers, Infiltration indices.	9
Unit 3	Run Off: Surface run off, factors affecting run off, Hydrographs, flow rating curves and flow duration curves. Mass curve. Rainfall run-off relationship. Stream gauging: measurement of stage and velocity.	9
Unit 4	Unit Hydrograph: Unit hydrograph. Derivation of unit hydrograph. Synthetic UH, IUH. Floods: Flood flow formulae, Frequency analysis using external type and log pearson type III distribution.	9

Unit 5	Ground Water: Elements of Ground Water modeling:-Darcy's law, unconfined and confined aquifers, and their properties, steady and unsteady flow in wells, ground water quality, sources of pollution, remedial and preventive measures, ground water budgeting and recharging of ground water	8
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1	Hydrology: Principles, Analysis and Design, by Raghunath .H.M, New Age Publications, 2006.
2	Groundwater Hydrology: Devid Keith Todd
3	Hydrology by V.T. Chow, McGraw Hill
4	Engineering Hydrology by K.Subramanya, Tata McGraw Hill
5	Hydrology by J.Ram Redy, Laximi Publishers
6	Water Resources Engineering by Wurbs and James, PHI Publications.
7	Water Resources & Ground water by M.C. Chaturvedi, Tata Mc Graw Hill.

Course Title	Course Structure			Pre-requisite
	L	T	P	
Environmental Management and Sustainable Development (EN303)	3	1	0	

Course Objectives	
1.	Developing fundamental knowledge about EMS, stimulating to discuss and reflect on the possibilities and limitations of EMS, and train their critical thinking.
2.	To impart knowledge of systems approach to Environmental Management and skills for environmental performance in terms of legal compliance, pollution prevention and continual improvement.
3.	Enabling students to develop environmental management systems for organizations as per ISO 14001 and to carry out Environmental Audit.
4.	To aware the students about various engineering tools related to environmentally sustainable urban environment and to assess and design them.
5.	To aware them about the role of technology towards environmental sustainability and to understand their social responsibilities towards sustainable development.

Course Outcomes	
6.	Describe, develop and interpret methods of the Environmental Management Systems according to ISO 14001 standards.
7.	Critically evaluate methods and possibilities within Environmental Management Systems from a systems perspective.
8.	Develop, Implement, maintain and audit Environmental Management systems for Organizations.
9.	Building an inter-disciplinary perspective on understanding sustainable development concerns and challenges worldwide
10.	Prepare students with current debates and perspectives in analyzing constraints and opportunities for sustainable development

S. No.	**Contents**	**Contact Hours**
Unit 1	Introduction to Environmental Management System, Need of EMS, Barriers to EMS adoption, Framework for Environmental Management Systems, Approach for developing an Environmental Management System, The Precautionary Principle, The Polluter Pays Principle, Pollution control Vs Pollution Prevention – Four Stages and nine approaches of Pollution Prevention – source reduction, raw material substitution, toxic use reduction and elimination, process modification -Material balance – Technical, economic and environmental feasibility, Application of EMS	9
Unit 2	The introduction and implementation of ISO 14000 family, Components of ISO 14000, Global ISO certifications and its relevance to Businesses, EMS specification Standards: ISO 14001 and its implementation and benefits, Introduction to Environmental Auditing, Category "A" & "B" types of projects. Procedures and Guidelines to conduct Environmental Audit, Environmental management system audit as per ISO 19011 – Roles and qualifications of	9

	auditors – Environmental performance indicators and their evaluation – Nonconformance – Corrective and preventive actions -compliance audits	
Unit 3	Definition, Purpose of LCA, Evolution of LCA, Applications and advantages of LCA, Procedure for LCA, Variants of LCA approach, strategic framework for LCA and LCA-a tool for sustainability-Case study Cradle to Cradle Analysis,, Certifications, Case studies related to LCA, Eco-labelling	6
Unit 4	Evolution, History and Definitions of sustainability, Brundtland commission report, Principles and Objectives of sustainable development, Boundaries of sustainable development, Pillers of sustainable development, Impediments to achieving sustainability, Frameworks to measure sustainable development and Applications of Sustainable Strategies, The IUCN/UNEP strategies for Sustainable Development, Policy Measures for Achieving Sustainable Development	8
Unit 5	Issues of environmentally sustainable urban environment, Engineering tools for assessment and design for environment and Sustainability Strategies for promoting environmentally sustainable development, Social and environmental, responsibilities towards environmentally sustainable development, Importance of incorporating sustainability in design, Case studies of Sustainable design, Role of local Government, Sustainability in the Third World, Steps for adopting a sustainability approach, Sustainability and development indicators and SDGs, United Nation's outlook of sustainable development and efforts, , UN SDGs - structure, governance and partnerships; communities / society: ensuring resilience and primary needs in society; biosphere: development within planetary boundaries; strengthening institutions for sustainability; shaping a sustainable economy.	10
Total		42

Books and References:

S. No.	Name of Books/Authors/Publisher
1.	Ken Whitelaw, ISO 14001 Environmental Systems Handbook, Elsevier Butterworth-Heinemann, 2004
2.	Marek Bugdol and Piotr Jedynak, Integrated Management Systems, Springer International, 2015.
3.	W. Lee Kuhre, ISO 14001 Certification - Environmental Management Systems: A Practical Guide for Preparing Effective Environmental Management Systems (Prentice Hall ... Management System Standards
4.	Christopher Sheldon and Mark Yoxon, "Installing Environmental management Systems – a step by step guide" Earthscan Publications Ltd, London, 1999.
5.	Barrow, C. J.. Environmental Management for Sustainable Development. Taylor and Francis, Oxon, UK, 2006
6.	Environmental Management Systems: An Implementation Guide for Small and Medium Sized Organizations, Second Edition, NSF International, Ann Arbor, Michigan, January 2001
7.	ISO 14001/14004/: Environmental management systems – Requirements and Guidelines -International Organization for Standardization, 2015

8.	ISO 19011: Guidelines for quality and/or Environmental Management System Auditing, Bureau of Indian Standards, New Delhi, 2015
9.	Abdul Malik, Elisabeth Grohmann. Environment protection strategies for sustainable development by. ISBN 978-94-007-1591-2.
10.	Sylvie Faucheux, Martin O' Corner Jan van der strateen. Sustainable development: concepts, rationalities, and strategies, ISBN 978-94-017-3188-1.
11.	Jennifer A. Elliott. An introduction to sustainable development. ISBN-13: 978-0415590730.
12.	Chopra, K., and Kadekodi, G.K. (1999), Operationalisting Sustainable Development, Sage Publication, New Delhi.

Course Title	Course Structure			Pre-requisite
	L	T	P	
Global Warming and Climate Change (EN305)	3	1	0	-

Course Objectives	
1.	To understand the fundamental science of climate systems.
2.	To analyze anthropogenic GHG emissions from various sectors.
3.	To evaluate international and national regulatory frameworks.
4.	To apply engineering principles to design mitigation technologies.
5.	To develop adaptation strategies for engineering systems.

Course Outcomes	
1.	Explain the fundamental mechanism of global warming.
2.	Calculate GHG emissions and analyze sectoral emission patterns.
3.	Analyze climate impacts and evaluate vulnerability using risk assessment methods.
4.	Demonstrate a thorough understanding of the carbon market.
5.	Design climate mitigation technologies for carbon emission reduction and Develop decision-making frameworks for climate risk management.

S. No.	Contents	Contact Hours
Unit 1	**Climate Science Fundamentals & Regulatory Framework:** Introduces Earth's energy balance, greenhouse effect, radiative forcing, feedbacks, and variability. Covers IPCC AR6 findings, carbon cycle, and paleoclimate evidence. Explains UNFCCC origins, Kyoto Protocol mechanisms (CDM, JI, ETS), Paris Agreement structure, Nationally Determined Contributions, carbon credit markets (CERs, EUA), and regulatory implications for engineering projects.	10
Unit 2	**GHG Emissions Quantification & Life-Cycle Assessment:** Focuses on IPCC GHG inventory methods: Scope 1-2-3 accounting, emission factors for fuel combustion, industrial processes, and electricity. Conversion to CO_2-equivalents using GWP, uncertainty analysis, and software tools (Excel, Python). Introduces life-cycle assessment (ISO 14040) for engineering systems, functional unit definition, impact categories, and interpretation. Includes case studies on transportation and manufacturing footprints, and evaluation of carbon offset projects..	8
Unit 3	**Climate Change Impacts & Vulnerability Assessment:** Effects of warming on infrastructure: buildings (thermal stress), transport (pavement damage), water networks (flood risk), and energy systems (demand shifts). Sea-level rise, urban heat island, and probabilistic risk analysis. Vulnerability indices, and adaptation cost assessment.	10

Unit 4	**Mitigation Technologies & Carbon Management:** Provides engineering design of mitigation solutions: solar PV, wind turbines, biomass, energy-efficiency retrofits, and carbon capture (post-combustion, BECCS, DAC). Covers carbon credit generation, MRV protocols, registry systems, and financial mechanisms (carbon tax, cap-and-trade). Includes simulation projects on hybrid renewables and CCS capture efficiency.	10
Unit 5	**Adaptation & Resilient Engineering Design:** Adaptation Planning, Resilient Design Criteria, Heat resilient materials, Compliance with adaptation components of NDCs, Case studies of different adaptation techniques adopted.	4
Total		42

Books and References:

S. No.	Name of Books/Authors/Publisher
1.	Climate Change: The physical Science Basis, IPCC (Latest report)
2.	Global Warming: The Science of Climate Change - 1st Edition, CRC Press, By: Drake F
3.	Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, Wiley. By J. H. Seinfield and S. N. Pandis
4.	Climate Change: Impacts, Adaptation and Vulnerability, IPCC (Latest report)
5.	Introduction to Environmental Engineering and Science, Pearson, By: Gilbert M Masters

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Soil Pollution and Remediation (EN307)	3	0	2	

Course Objective:
The course aims to develop students' understanding of:
- the hydrogeological factors associated with contaminant transport
- methods for characterization of contaminated soils
- construction and operation of landfills
- different methods for waste containment and remediation

Course Outcomes:
1. Understand the basics behavior of subsurface contaminants in respect of soil and groundwater
2. Analyze the Risk associated and suggest suitable intervention
3. Construct and operate a landfill
4. Design an effective waste containment plan, and remediate the brownfields

S. No.	Content	Contact Hours
Unit 1	Introduction Soil Formation, Fundamental properties of soil, Hydrogeological settings, Sources of surface and subsurface contamination, Groundwater, Mechanisms of Soil contamination, Physical-chemical and biological interactions in soils, Effect of contamination on geotechnical and environmental properties of soil, Contaminant Transport and Fate, design a sustainable barrier system to restrict subsurface contamination	11
Unit 2	Characterization of Polluted Sites General Methodology, Preliminary Assessment, Exploratory and Detailed Site investigation, Surveying and Field Testing, Geophysical Methods, Piezometers and monitoring wells, Chemical Analysis, Soil Resistivity Analysis, Risk Assessment of contaminated sites	11
Unit 3	Landfill Construction and Operation Landfills, Types of Landfills: Natural attenuation landfill, Containment landfills, Secure Landfills, Bioreactor Landfills, Siting Criteria for landfills, Liner material and design of landfill elements, Operation of Landfill, Monitoring, Landfill Sealing, Post-closure monitoring, Leachate Treatment, Collection of Landfill Gas and its treatment	10
Unit 4	Waste Containment and Remediation Control of soil contamination, Detection, control and remediation of subsurface contamination, Various types of barrier systems, Reclamation of contaminated sites, Restoration, Bioremediation, Economic analysis, Case Studies	10
Total		42

Books:

S. No.	Name of Books / Authors / Publisher
1	Geo Environmental Engineering: Principles and Applications, L.N. Reddi and H.I.Inyang, Marcel Dekker, Inc. New York
2	Design, Construction and Monitoring of Landfills, Amalendu Bagchi, John Willey & Sons, Inc.
3	Geo Environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, Hari D. Sharma and Krishna R. Reddy
4	Final Covers for solid waste landfills and abandoned dumps, R.M. Koerner and David E. Daniel, ASCE press

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Environmental Toxicology (EN309)	3	1	0	NIL

Course Objective: The course aims to develop students' understanding of:

- the fate of contaminants and environmental toxicology
- different modes of exposure and health risks associated
- bioremediation of contaminated environments
- analysis of data and risk management

Course Outcomes:

1. Understand the basics of environmental toxicology and its environmental importance
2. Analyze the different exposure pathways and evaluate toxicity associated with diverse pollutants
3. Develop a suitable assessment methodology for risk characterization
4. Design an effective assay for and assess environmental quality based on indicators
5. Confirm the data reliability through statistical operations

S. No.	Content	Contact Hours
Unit 1	Introduction Historical context and importance of environmental toxicology, Environmental contaminants, classification and types, Fate of contaminants in environmental media, bioaccumulation, and bioavailability in multiphase systems.	11
Unit 2	Unit 2: Dose-Response Relationship Dose-response relationship and Toxicity Testing, Hazard and risk; Routes of exposure, oral route, dermal route, inhalation route, distribution, elimination, absorption, and bioavailability; Mechanism of action, endocrine disruption, cytotoxic, enzyme inhibition, reproductive toxicology, teratology, biotransformation, and secondary effect, Toxico-kinetics, Toxico-dynamics, Sub-lethal effects to individuals and organisms, Mutation, Acute and chronic lethal effects to individuals, Effects on population, Effects of communities and ecosystems, Landscape to global effects, Antibiotic resistance genes and mitigation measures.	11
Unit 3	Bioremediation of polluted environments Environmental applications of bioremediation, types of bio-remediation, mechanisms of microbial metal resistance and detoxification, bioremediation of oil spills, limitations of bioremediation, bioremediation and genetic engineering.	10
Unit 4	Data Analysis and Risk Management Integrated exposure assessment (case studies), Introduction to quantitative risk assessment, Application of statistical and Monte Carlo simulations and other techniques for probabilistic exposure assessment; Microbial risk assessment - Risk characterization, Uncertainty and Sensitivity Analysis; Communication, Decision making and Risk Management.	10
Total		42

Books:

S. No.	Name of Books / Authors / Publisher
1	A Textbook of Modern Toxicology. E. Hodgson (Ed.). John Wiley & Sons, Inc. 4th Edition, 2010.

2	Hayes' Principles and Methods of Toxicology, Hayes, A. W., Kruger, C.L., CRC Press, Taylor and Francis, 6th edition, 2014.
3	Fundamentals of Ecotoxicology: The Science of Pollution, Michael C Newman and Michael A Unger, Lewis Publishers (CRC Press), 2nd Edition, 2003.
4	Principles of Ecotoxicology, Walker, C.H., Sibly, R.M., Hopkin, S.p., Peakall, D.B., CRC Press, 2012

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Environmental Pollution & E-Waste Management (EN311)	3	1	0	NIL

Course Objective:

This course aims to develop students' understanding of hazardous, radioactive, biomedical, and electronic waste characteristics, impacts, and regulations. It equips them to apply treatment, transport, disposal, and recovery technologies, evaluate safety and legal frameworks, and design integrated waste management plans for sustainable and environmentally sound waste handling practices.

Course Outcome (CO):

1. Explain sources, characteristics, and regulations for hazardous, radioactive, biomedical, and e-waste, including Basel Convention and Indian waste management rules.
2. Apply suitable treatment, transportation, and handling methods for hazardous, biomedical, radioactive, and e-waste considering their specific physical and chemical properties.
3. Analyze environmental and health impacts of hazardous, radioactive, biomedical, and e-waste, and assess the effectiveness of disposal and recovery technologies.
4. Evaluate safety standards, legal frameworks, and minimization strategies for hazardous, radioactive, biomedical, and e-waste management at national and global levels.
5. Design integrated waste management plans incorporating segregation, treatment, transport, disposal, and recovery methods for hazardous, radioactive, biomedical, or e-waste.

S.No.	Content	Contact Hours
Unit 1	Hazardous waste management - Definition and characteristics, Sources and type-based categorization, Treatment technologies: Physico-chemical, thermal, biological, sea and land disposal, Hazardous Waste (Management & Handling) Rules, Basel convention	9
Unit 2	Nuclear or Radioactive Waste - Principles of radioactivity, Sources, Characteristics of nuclear waste, Radioactive materials and its decay, Health effects of ionizing Radiation, Factors affecting radiation doses, Safety standards	9
Unit 3	Detection and Analysis of radioactive materials - Low-level Radioactive waste, High-level radioactive waste, transport of Radioactive Materials, Storage and Disposal of radioactive waste.	8
Unit 4	E-waste - toxicity due to hazardous substances in e-waste and their impacts, domestic e-waste disposal, e-waste management	8
Unit 5	Technologies for recovery of resource from electronic waste, guidelines for environmentally sound management of e-waste, occupational and environmental health perspectives of recycling e-waste in India	8
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	G. Buttiglieri, T.P. Knepper, (2008), Removal of emerging contaminants in Wastewater Treatment: Conventional Activated sludge Treatment, Springer-Verlag Berlin Heidelberg, Hdb Env Chem, vol. 5, Part S/2:1-35, DOI: 10.1007/698_5_098
2.	Alok Bhandari; Rao Y. Surampalli; Craig D. Adams; Pascale Champagne; Say Kee Ong; R. D. Tyagi; and Tian Zhang, Eds., (2009) Contaminants of Emerging Environmental Concern, American Society of Civil Engineers, ISBN (print): 978-0-7844-1014-1, ISBN (PDF): 978-0-7844-7266-8

3.	Dimitra A. Lambropoulou, Leo M. L. Nollet Eds. () Transformation Products of Emerging Contaminants in the Environment: Analysis, Processes, Occurrence, Effects and Risks, 1st Edition, Wiley, ISBN-13: 978-1118339596, ISBN-10: 1118339592

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Advance Surveying (EN313)	3	0	2	Surveying

Course Objective:

1. To introduce basic concepts of Triangulation Surveying.
2. To understand the meaning, importance and scope of Triletration.
3. To explain the definition, classification ad laws of accidental errors.
4. To demonstrate the Field Astronomy.
5. To introduce the definition, principle and types of Photogrammetry.

Course Outcome (CO):

1. Understand the fundamental, principle of Triangulation Surveying.
2. Explain the importance and scope of Triletration.
3. Study the classification and laws of accidental errors.
4. Demonstrate the field astronomy.
5. Understand the definition, principle and types of Photogrammetry.

S.No.	Content	Contact Hours
Unit 1	**TRIANGULATION:** Classification, figures, signals and towers. Indivisibility and height of stations. Satellite station, Base line measurement, corrections to the measured length. Trigonometrical levelling.	8
Unit 2	**TRILETRATION:** Definition and principle. General requirements and procedure. E.D.M. Instruments, project survey, route surveys. Survey for canals, high-ways, railways, and transmission lines. Setting out buildings, culverts, bridges, Tunnels, Hydrographic surveying.	9
Unit 3	**ERRORS AND ADJUSTMENT:** Definitions, Classifications and laws of accidental error. Most probable value, Probable error, standard errors, laws of weight. Principle of least squares, Determination of most probable values by the method of normal equation and method of correlates. Station and Figure adjustment.	8
Unit 4	**FIELD ASTRONOMY;** Spherical triangle and its solution. Coordination system, solution of astronomical triangle. Determination of time, Azimuth and latitude.	8

Unit 5	**PHOTOGRAMMETRY:** Definition of terms used, terrestrial and aerial photographs. Scale of photographs, stereoscopy, parallax and relief displacement, Flight planning, plotting instruments. Use of photogrammetric and Remote sensing techniques.	9
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1	Kennie, T.J.M. and Petrie, G., "Engineering Surveying Technology", Blackie & Sons Ltd, London.
2	Punmia, B.C., "Surveying", Vol. I & II, Laxmi Publications, New Delhi.
3	olving Problems in Surveying", Longman Scientific Technical, U.K.
4	I & II, Standard Book House, Delhi.
5	II, Khanna Publications, Delhi.

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Automobile Emission and Control (EN315)	3	1	0	Nil

Course Objective:

1. To provide knowledge on various automobile emissions, their measurement units, and applicable emission standards.
2. To explain the chemical processes leading to the formation of different vehicular pollutants and their associated health impacts.
3. To develop understanding about the role of meteorology in dispersion of automobile pollutants and estimation of line source emissions.
4. To introduce students to various automobile emission control technologies and their practical applications.
5. To create awareness about sustainable and green technologies for reducing vehicular emissions.

Course Outcome (CO):

1. Acquire the knowledge on various automobile emissions, their measurement units and emission standards.
2. Understanding the chemistry behind formation of different pollutants in automobiles and health impact assessment parameters.
3. Understanding the importance of meteorology in air pollutant dispersion and also estimating the concentration of air pollution from any line source (automobiles).
4. Acquiring knowledge on different emission control technologies in automobiles.
5. Familiarize with different green technology-based solutions to reduce emissions.

S.No.	Content	Contact Hours
Unit 1	Types of air pollutants, criteria air pollutants, measurement units for pollution, formation of primary & secondary pollutants from automobiles, Factors affecting vehicular emissions, impact of automobile emissions on global warming, greenhouse gases, photochemical smog. Emission norms - Euro & Bharat norms.	9
Unit 2	Pollutant formation in Engine, mechanism of HC, CO and NO in engine and factors affecting the emission, types of NOx in automobiles, fuel knocking, EKMA approach, crankcase emission, unburned hydrocarbons, importance of mixture formation, lean and rich mixture. Automobile emissions and their effect on human health, concept of health assessment parameters like PEFR, FEV1, FVC.	9
Unit 3	Lapse rates, impact of meteorology in pollutant dispersion, horizontal and vertical dispersion, box model, concept of flux, diffusion laws, Gaussian dispersion modelling and its derivation for infinite line source (automobiles).	11
Unit 4	Catalytic convertors, cyclonic separator, Electrostatic Precipitator (ESP), Selective Catalytic Reduction (SCR), Diesel Particulate Filer (DPF), Selective Non- Catalytic Reduction (SNCR), Lean NOX catalyst technology, Exhaust Gas Recirculation (EGR).	7
Unit 5	Green technologies and alternative fuels for automobiles: Concept of alternative fuels in automobiles - Bioethanol, Green Hydrogen, Green Ammonia, Bio-CNG and Fuel Cells. Electric Vehicles: Pros and Cons in air pollution management.	6
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	Air Pollution Control Engineering; Noel de Nevers, Waveland Press.
2.	Atmospheric Chemistry and Physics: From Air Pollution to climate change; John H Seinfeld, Sypros N Pandis.
3.	Engine Emissions: Pollution formations and advances in control technology, B. P. Pundir Narosa Book Distributors Pvt Ltd.
4.	Internal combustion engine fundamentals, John B. Heywood, TMH
5.	James D. Halderman, "Automotive Fuel and Emissions Control Systems", 4th Edition, Prentice Hall, Pearson Education, 2016.

III Year: Sixth Semester

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Environmental Impact Assessment (EN302)	3	0	2	

Course Objective:

This course aims to develop students' competence in understanding, applying, analyzing, evaluating, and designing Environmental Impact Assessment and Audit processes. It emphasizes legal frameworks, analytical tools, and mitigation strategies, enabling learners to critically assess and create sustainable solutions for minimizing environmental impacts of diverse development projects.

Course Outcome (CO):

1. Explain the principles, processes, and tools of Environmental Impact Assessment and Audit.
2. Apply EIA tools and legal frameworks to assess, mitigate, and monitor environmental impacts of various development projects.
3. Analyze environmental data, legal frameworks, and EIA reports to identify, compare, and evaluate impacts and mitigation strategies for development projects.
4. Evaluate environmental impact assessments and audit reports to judge compliance, effectiveness, and sustainability of development projects.
5. Design comprehensive Environmental Impact Assessment and Audit frameworks integrating legal requirements, analytical tools, and mitigation strategies for sustainable development projects.

S.No.	Content	Contact Hours
Unit 1	Definition and history of environmental impact assessment, related law necessary for EIA, Objectives of Environmental Impact Assessment, Process for EIA, TOR, IEE, Components of EIA Reports.	9
Unit 2	Tools for assessment of environmental impacts: checklist, networks, matrices, overlays, baseline study, scoping & scales, network overlays, index methods. Planning of environmental Factors.	9
Unit 3	Prediction and assessment of impacts on air and noise; soil and land use; water quantity and quality; biological: terrestrial ecology-forest and wildlife, aquatic ecology-plankton, nekton, benthos and importance of coastal habitat; human use, quality of life, socio-economic. Consideration of human values in design & execution of projects.	9
Unit 4	Mitigation and Monitoring process for environmental impact assessment	7
Unit 5	Environmental Impact Analysis-laws & statuses in India, Elements of Environmental Auditing, Impact Analysis of hydropower, thermal power projects, etc.	8
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	Canter L.W. Environmental Impact Assessment. McGraw-Hill, Inc.
2.	Eccleston, H.C. 2000. Environmental Impact Statements. John Wiley & Sons, Inc.
3.	Lee, N. and C. George (editors). 2000. Environmental Assessment in Developing and Transitional Countries. John Wiley & Sons Ltd.
4.	Wathern P. 1995. Environmental Impact Assessment: Theory and Practice. Biddles Ltd, Guildford and King's Lynn.
5.	Westmman W. E.1985.Ecology, Impact Assessment, and Environmental Planning. John Wiley & Sons, Inc.

Course Title	Course Structure			Pre-requisite
	L	T	P	
Environmental Law and Policy (EN304)	**4**	**0**	**0**	

Course Objectives	
1.	Developing fundamental knowledge about national and international law, policy and institutions in the conservation and management of natural resources as well as pollution control
2.	To sensitize the students to different national and international environmental issues and the application of relevant laws to address those issues.
3.	To equip the students with the skills needed for interpreting laws, policies and judicial decisions

Course Outcomes	
1.	Knowledge of existing national & international laws, policies and institutions in protecting the different segments of environment
2.	Acquire the skills needed for interpreting laws, policies and judicial decisions in a holistic perspective
3.	Ability to evaluate the role of law and policy in conservation and management of natural resources and prevention of pollution
4.	Application of law-based strategies to govern natural resources and pollution across international borders.
5.	Apply analytical approaches and governance tools in real-world environmental challenges.

S. No.	Contents	Contact Hours
Unit 1	An introduction to the legal system; Constitution, Acts, Rules, Regulations; Indian Judiciary, Doctrine of precedents, judicial review, Writ petitions, PIL– liberalization of the rule of *locus standi*, Judicial activism. Introduction to environmental laws in India; Constitutional provisions, Stockholm conference; Bhopal gas tragedy; Rio conference. General principles in Environmental law: Precautionary principle; Polluter pays principle; Sustainable development; Public trust doctrine, Overview of legislations and basic concepts	9
Unit 2	Wildlife and Biodiversity related laws: Evolution and Jurisprudence of Forest and Wildlife laws; Colonial forest policies; Forest policies after independence Statutory framework on Forests, Wildlife and Biodiversity: IFA, 1927; WLPA, 1972; FCA, 1980; Biological Diversity Act, 2002; Forest Rights Act, 2006. Strategies for conservation–Project Tiger, Elephant, Rhino, Snow leopard.	9
Unit 3	Air, Water and Marine Laws: National Water Policy and some state policies Laws relating to prevention of pollution, access and management of water and institutional mechanism: Water Act, 1974; Water Cess Act, 1977, EPA, 1986. Pollution Control Boards Ground water and law Judicial remedies and procedures Marine laws of India; Coastal zone regulations. Legal framework on Air pollution: Air Act,1981; EPA, 1986	6
Unit 4	Environment protection laws and large ProjectsLegal framework on environment protection-Environment Protection Act as the framework legislation–strength and weaknesses; EIA; National Green tribunal The courts infrastructure projects.	8

Unit 5	Hazardous Substances and Activities Legal framework: EPA and rules; PLI Act, 199 Principles of strict and absolute liability. An introduction to international law; sources of international law; law of treaties; signature, ratification Evolution of international environmental law: Customary principles; Common but differentiated responsibility, Polluter pays.	10

Books and References:

S. No.	Name of Books/Authors/Publisher
1.	Birnie P. (2009) et al., International Law and the Environment, 3rd ed., Oxford.
2.	Leelakrishnan P. (2006) Environmental Law Case Book, 2nd ed, Lexis Nexis, India.
3.	Sands P. (2002) Principles of International Environmental Law, 2nd ed, Cambridge

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Planning and Design of Environmental Engg. Works (EN306)	3	1	0	NIL

Course Objective:
This course aims to equip students with the knowledge and skills to plan, design, analyze, evaluate, and develop integrated environmental engineering works, focusing on resource management, pollution control, land use, water optimization, and utility management to achieve sustainable development goals and address complex environmental challenges effectively.

Course Outcome (CO):
1. Gain knowledge of sustainability concepts including SDGs, circular economy, carbon neutrality, LCA, and EIA for environmental decision-making.
2. Learn tools for population forecasting, master planning, smart cities, and eco-building design compliant with NBC/ECBC and MoHUA guidelines.
3. Apply project life cycle, CPM/PERT, cost estimation, and procurement planning for environmental projects within CPCB/public norms.
4. Develop skills to design water reuse, DEWATS, solid waste management, and air pollution control systems using national standards.
5. Integrate planning, design, costing, and compliance into project reports, addressing EIA/EMP, smart cities, and carbon-neutral infrastructure.

S. No.	Contents	Contact Hours
Unit 1	**Fundamentals & Sustainability**: Environment, Human and Sustainability, Circular Economy, 5 R's, MDG, Sustainability Development goals (SDG), Sustainable Practices, Net-zero carbon, Carbon neutrality, Zero Liquid Discharge, Basics of LCA, EIA, Carbon Credits, Net-zero carbon, Carbon neutrality, Zero Liquid Discharge	8
Unit 2	**Planning & Green Infrastructure**: Population Forecasting, Carrying Capacity, Short/long-term & master plans; urbanization & smart city concepts; green building design (LEED/BEE); passive design & rainwater harvesting; nature-based solutions; NBC & ECBC building guidelines; MoHUA sustainable city norms; eco-building project concept.	9
Unit 3	**Project Management & Inventory**: Project lifecycle stages; CPM/PERT scheduling; budgeting & cost estimation; digital inventory & procurement planning; waste minimization; CPCB C&D waste norms; public procurement rules; types of environmental projects; inventory & budget plan preparation.	8
Unit 4	**Design with Green Innovations**: Sustainable water supply & DEWATS; water reuse; Zero Liquid Discharge; solid waste segregation, MRF & waste-to-energy; air pollution control devices (cyclones, scrubbers, biofilters); IoT & smart monitoring; CPHEEO water/sewer guidelines; CPCB STP effluent, SWM 2016 & air quality standards; preliminary system design project.	9
Unit 5	**Capstone Projects & Emerging Trends**: Three full projects: (i) Decentralized STP (ii) Green building & rainwater plan (iii) Integrated SWM system; MoEFCC EIA Notification 2006 compliance; NBC/ECBC codes; CPCB & CPHEEO norms; project report with technical design, inventory, cost, EIA & EMP; smart city & carbon-neutral infrastructure trends.	8
	Total	42

Books and References:

S.No.	Name of Books / Authors / Publisher
1.	G. Buttiglieri, T.P. Knepper, (2008), Removal of emerging contaminants in Wastewater Treatment: Conventional Activated sludge Treatment, Springer-Verlag Berlin Heidelberg, Hdb Env Chem, vol. 5, Part S/2:1-35, DOI: 10.1007/698_5_098
2.	Alok Bhandari; Rao Y. Surampalli; Craig D. Adams; Pascale Champagne; Say Kee Ong; R. D. Tyagi; and Tian Zhang, Eds., (2009) Contaminants of Emerging Environmental Concern, American Society of Civil Engineers, ISBN (print): 978-0-7844-1014-1, ISBN (PDF): 978-0-7844-7266-8
3.	Dimitra A. Lambropoulou, Leo M. L. Nollet Eds. () Transformation Products of Emerging Contaminants in the Environment: Analysis, Processes, Occurrence, Effects and Risks, 1st Edition, Wiley, ISBN-13: 978-1118339596, ISBN-10: 1118339592

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Hazardous & Biomedical Waste Management (EN308)	3	1	0	Solid Waste Management

Course Objective: The course aims to develop students' understanding of:

- the sources, types, and composition of solid waste, along with global and local waste generation trends
- hazardous waste management and waste treatment and disposal technologies including landfill design
- plastic and e-waste management strategies, and innovations in e-waste recycling
- biomedical waste, its segregation criteria, transport, treatment, and disposal

Course Outcomes:

1. Understanding of types of waste and its characterization
2. Identification of risk associated with hazardous and biomedical waste
3. Devising waste treatment methods, and safe disposal of hazardous waste
4. Designing effective handling and transport of hazardous and biomedical waste

S. No.	Content	Contact Hours
Unit 1	Introduction Definition and types of hazardous waste; sources and composition of hazardous waste; global and local waste generation trends; overview of relevant laws and regulations; health and environmental issues related to hazardous waste management; health and safety protocols during waste collection and sampling; environmental risks associated with improper waste collection and sampling; waste characterization challenges.	11
Unit 2	Hazardous Waste and its Treatment Definition, classification, and sources of hazardous waste; environmental and health impacts of hazardous waste; treatment and disposal methods; storage and transport; hazardous waste site remediation, e-waste; global trends in e-waste generation; innovations in e-waste recycling technologies; design of e-waste monitoring, segregation, and recycling system; role of circular economy in reducing plastic and e-waste	11
Unit 3	Biomedical Waste Biomedical waste: Introduction: definition, Classification, types and composition, Types of solids, liquids, sharps, blood and blood tissue, radioactive material, biological and chemical material; Documentation of Biomedical waste types and guidelines; Storage of hospital waste; Types of bags and containers used for storage; Segregation of biomedical waste into different type; Handling and transport of hospital waste; Transport of medical waste: Authorization and accidental spilling reporting	10
Unit 4	Biomedical Waste Treatment Biomedical waste treatment/disposal methods: Incineration, autoclaving, microwave radiations, chemical treatments; Biomedical Waste Treatment Facility: record keeping, collection, transport and storage facilities; Hospital Effluent treatment plant: Its structure and Functioning; Hazardous waste (Management and Handling) Rules; Bio-medical wastes (Management and Handling) Rules	10
Total		42

Books:

S. No.	Name of Books / Authors / Publisher
1	Blackman, W.C. (2001) Basic Hazardous Waste Management. CRC Press, USA.
2	Pichtel, J. (2005) Waste Management Practices: Municipal, Hazardous, and Industrial. CRC Press, USA.

3	Pruss, A., Giroult, E. and Rushbrook, P. (1999) Safe Management of Wastes from Healthcare Activities. World Health Organization, Geneva
4	Acharya, D.B. and Singh, M. (2003) Hospital Waste Management. Minerva Press, Delhi.

Course Title	Course Structure			Pre-requisite
	L	T	P	
Transportation and Traffic Engineering (EN310)	**3**	**0**	**2**	

Course Objectives
1. To introduce basic concepts of highway and its design and planning components. 2. To develop a basic fundamental understanding to railway, airways and waterways. 3. To aware students about the environmental aspects of different transport systems. 4. To develop analytical skill to analyses the transport associated environmental problem and come up with solutions.

Course Outcomes
1. Understanding of basic fundamentals of highway planning and its various components. 2. Learn the basic fundamentals of railways and airways designing. 3. Understanding the Traffic Noise- Measurement, Patterns, control and Traffic impact. 4. Students will learn the procedure to design Waterways. 5. Students will know the routes navigation requirements.

S. No.	Contents	Contact Hours
Unit 1	Highway: Highway planning in India, Highway Alignment, Geometric design of highways. Highway construction materials: Bituminous and concrete (With emphasis on the use of environmental friendly industrial waste material) Design of flexible and rigid pavements,. Soil stabilized roads Highway drainage and maintenance Roads on hills: Alignment, Geometry, Drainage.	9
Unit 2	Railways: Introduction to rails, sleepers track, fitting and fastenings, Ballast, Formation, track drainage, soil stabilization by environmental friendly waste materials, points and crossings, turnouts. Railway signaling and interlocking Modernization of railway track for high speed.	9
Unit 3	Airways: Planning and design of runways. Aprons and Taxi-Track, Typical layout, marking and lighting,. Traffic Engg: Traffic characteristics and traffic study, Traffic operations and control devices. Design of intersections at grade and grade separated Highway Lighting.	9
Unit 4	Traffic Noise- Measurement, Patterns and control, Traffic impact and Traffic Management.	7
Unit 5	Waterways: Types of developments, Open Channel and river developments, locks navigation, routes navigation requirements.	8

Books and References:

S. No.	Name of Books/Authors/Publisher
1.	Dr. L.R. Kadyali and Dr. N.B. Lal. Principles and Practices of Highway Engineering. Khanna Publishers. ISBN no.: 81-7409-165-3
2.	S.K. Khanna and C.E.G. Justo. Highway Engineering. Nem Chand & Bross, Civil Lines, Roorkee, India. ISBN No. 978-81-85240-63-3

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Surface and Groundwater Pollution (EN312)	3	1	0	-

Course Objective:

1. Understand the hydraulics relates to surface & ground water.
2. Study the development of ground water resources and aquifers.
3. Explain the basics of the transport process in solute transfer and hydro chemical behavior of contaminants in the surface & ground water.
4. Modelling of surface & ground water quality.

Course Outcome (CO):

1.Understand the fundamentals of surface & Ground water.

2. Demonstrate the development of ground water resources and aquifers.

3. Analyze the transport process in solute transfer and hydro chemical behavior of contaminants in the surface & ground water.

4. Modelling of surface & ground water quality.

S.No.	Content	Contact Hours
Unit 1	**Introduction to groundwater hydrology;** Porous media, distribution of subsurface water, porosity and related properties of soils, subsurface hydrological cycle, hydrogeologic formations. **Darcy's law and continuity relation;** Darcy's law, hydraulic head and gradient, factors affecting hydraulic conductivity, heterogeneity and anisotropy, limitations to the validity of Darcy's law, Storage in confined aquifers, general continuity equation, continuity equation with a change in total stress. Groundwater management models. **Hydrologic Cycle and Flow net:** Hydrologic Cycle, Flow nets-Graphical construction, Flow nets by numerical simulation, steady state Regional Ground water Flow, Steady state hydrologic, budgets-Fluctuations in ground water levels.	9
Unit 2	**Vadose zone and groundwater recharge:** Soil water in vadose Zone, soil water characteristics curve, Darcy's law and Richard's equation, Infiltration models, evaporation and desorption models, water balance and groundwater recharge.	8
Unit 3	**Groundwater contamination:** Sources of subsurface contamination, mass transport processes, general continuity equation, solute partitioning, degradation losses. **Solute transport by advection:** Potential theory, potential functions, stream functions, travel time along stream lines, residence time distribution theory, standard flow patterns.	8

Unit 4	**Solute transport by Diffusion** Fick's law, molecular diffusion coefficients, diffusion in porous media, diffusion in multiphase systems, application of diffusion equations to point and constant source of contamination, volatization losses of soil contamination. Governing Equations for flow and transport in surface water, chemicals and biological process models, simplified models for lakes, streams and estuaries. Model complexity: Selection and development, model resolution, coupled and uncoupled models, linear and nonlinear models, solution techniques, data requirements for calibration, application and evaluation of environment control.	9
Unit 5	**Advection dispersion Transport and Models:** One dimensional flow and column experiments, transverse dispersion, mechanical dispersion tensor, moments of transport equation, analytical models of chemical spills, and contaminant plumes **Chemicals Properties and Principles:** Constituents-chemical equilibrium- Association and Dissociation of dissolved species- effects of concentration gradients-Mineral dissolution and solubility-Oxidation and Reduction Process-Ion exchange and Adsorption	8
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1	David Keith Todd and Larry W. Mays, "Groundwater Hydrology John Wiley and Sons.
2	K.R Rushton, "Groundwater Hydrology", John Wiley & sons, Ltd.
3	Karanth, "Ground Water Assessment, Development and Management". McGraw Hill Companies.
4	Allen Freeze, R. and John A. Cherry, "Ground Water". Prentice Hall. Inc. 1979.
5	Randall J. Charbeneau, "Ground Water Hydraulics and Pollutant Transport", 2000.

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Water & Soil Conservation (EN314)	3	1	0	-

Course Objective:

5. Introduction to various aspects of land and water resources.
6. Study the causes of land and water degradation.
7. Develop innovative & effective monitoring and management practice for soil and water conservation.

Course Outcome (CO):

1. Understand the land and water resources of India.
2. Demonstrate and understand the problems related to land and water resources.
3. Analyze the causes of soil and water degradation.
4. Design the suitable management practices for soil and water conservation.

S.No.	Content	Contact Hours
Unit 1	Earth Resources: Atmosphere, lithosphere, hydrosphere Interior of Earth, geological work of wind and water, underground water, igneous, sedimentary and metamorphic rocks, mineral types, mineral resources of India, erosion and weathering, soil formation, soil profiles, types of erosion, estimation of soil loss, land use and land use planning, earth resource mapping and the use of remote sensing and GIS.	9
Unit 2	Water Resources: Hydrology, the hydrological cycle and its components, drainage systems, classification of water resources, characteristics of water resources. Surface run-off, stream flow estimation, problems of water and ground water resource depletion, watershed types and functions.	8
Unit 3	Causes & Improvement of degraded Soil: Release of salts from rocks & minerals, composition of rain water, river water, canal or reservoir water and sea water. Properties of different salts – Chlorides, carbonates, sulphates, bicarbonates & nitrates of calcium, magnesium, sodium & potassium. Role of soil slope, minerals, quality of irrigation water, climate and vegetation cover on salinity & alkalinity of soil. Reclamation of saline & sodic soils.	9
Unit 4	Soil Loss Measurement: Soil losses due to erosion & extent of erosion – water and wind erosion. Estimation of soil losses – universal soil loss equation, causes of soil loss-soil erodability, rain fall erosivity, estimation of soil losses by wind erosion.	8
Unit 5	Applications for management: Soil and water conservation measures, erosion control, case studies in water resource conservation and management, flood management and control,	8

	landslide control and mitigation measures, coastal zone management, watershed management and case studies, earthquake mitigation for buildings and dams, forest fire mitigation and management, RS and GIS techniques in forest fire mapping, management hazards such as controlled burns escaping	
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1	Schwab, Fravert Edminster & Barnes (1981). Soil & water conservation engineering John Wiley & Sons Publication.
2	Soil taxonomy, basic system of soil classification for making & interpreting soil survey Agriculture Handbook No. 36, Nbss & Lup Publication New Delhi.
3	Singh, Rajvir (2000). Watershed Planning and Management. Yash Publishing House.
4	Ramarao, M.S.V. (1962). Soil conservation in India I.C.A.R New Delhi.
5	Roy, A.B. (2010). Fundamentals of Geology. Narosa Publications.

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Ecology and Bio-monitoring Techniques (EN316)	3	0	2	Environmental Chemistry and Microbiology

Course Objective: The course aims to develop students' understanding of:

- structural and functional attributes of ecosystem and environment
- distribution of different communities and their succession
- ecological processes towards biomonitoring
- common bioindicators in respect of environmental quality

Course Outcomes:

1. conceptualize the structure and function of ecosystem and determine the ecosystem characteristics on field
2. analyze population dynamics, including growth patterns, species interactions, and environmental influences
3. evaluate the structure, dynamics, and interactions within ecological communities.
4. assess the significance of environmental contamination across different ecosystems.
5. apply biomonitoring to address environmental quality issues.

S. No.	**Content**	**Contact Hours**
Unit 1	Introduction Introduction to Ecology, Structure and Functions of Ecosystems- Abiotic and Biotic components, Ecological energetics, Energy and material cycling. Productivity, Species interactions, Exposure to different types of ecosystems, ecosystem Regulation	11
Unit 2	Community Ecology Community characteristics, composition. Qualitative and quantitative characters, community classifications, methods of studying vegetation; survey and assessment of frequency, abundance, dominance etc, Diversity indices, Ecological succession.	11
Unit 3	Application of Ecological Principles Ecosystem response to environmental contamination (deoxygenation, eutrophication). Principles of Biomagnification and Biotransformation, Biomonitoring – a tool for environmental monitoring, Ecological restoration – from theory to practice, bioremediation of environmental contaminants.	10
Unit 4	Biomonitoring for Water Quality Bioindicators of water quality, bio-surveys, bio-assay test, similarity indices, coefficients of community loss, and comparisons of lists of dominant taxa. Measures of existing community structure such as species richness, presence or absence of indicator taxa, and distribution of trophic feeding groups, biomarkers for exposure assessment	10
Total		42

Books:

S. No.	Name of Books / Authors / Publisher
1	Biological monitoring. Steven Sadhra ed., Oxford Academic Books, 2022
2	Environmental Exposure, Biomonitoring and Exposure Assessment. Maaike van Gerwen, Roel Vermeulen, Lauren Petrick (Eds.), MDPI AG, 2024 (ISBN: 9783725817436)

3	Biological Monitoring in Water Pollution. John Cairns, Jr. (1982), Pergamon Press. (ISBN: 978-0-08-028730-0)

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Environmental Risk Assessment (EN318)	3	1	0	NIL

Course Objective:

1. To introduce students with concepts of risk and its measurement with regard to environmental systems
2. To familiarize students with characterization of various types of environmental risk and their consequences, vulnerability of environmental hazards.
3. To familiarize students with various aspects of analysis of environmental risk assessment.
4. To familiarize students with various case studies environmental risks in various processes/industries.

Course Outcome (CO):

1. Developing an introductory background of environmental risk assessment framework.
2. Understanding the different aspects of the risk identification and assessment process.
3. Learning about different procedures adopted for risk assessment.
4. Developing an understanding of the risk management concept.
5. Exposure to case studies where risk assessment played an important role.

S.No.	Content	Contact Hours
Unit 1	Introduction: Sources of Environmental hazards, Environmental and ecological risks, Environmental risk assessment framework, Regulatory perspectives and requirements, Risk Analysis and Management and historical perspective; Social benefit v/s technological risks; Path to risk analysis; Perception of risk, risk assessment in different disciplines.	8
Unit 2	Elements of Environmental Risk Assessment : Hazard identification and accounting, Fate and behaviour of toxics and persistent substances in the environment, Properties, processes and parameters that control fate and transport of contaminants, Receptor exposure to Environmental Contaminants, Dose Response Evaluation, Exposure Assessment, Exposure Factors, Slope Factors, Dose Response calculations and Dose Conversion Factors, Risk Characterization and consequence determination, Vulnerability assessment, Uncertainty analysis.	8
Unit 3	Different Analysis for Risk Assessment: Cause failure analysis, Event tree and fault tree modeling and analysis, Multimedia and multipathway exposure modeling of contaminant migration for estimation of contaminant concentrations in air, water, soils, vegetation and animal products, Estimation of carcinogenic and non carcinogenic risks to human health. Methods for Risk Assessment: HAZOP and FEMA methods, Methods in Ecological risk assessment, Probabilistic risk assessments, radiation risk assessment, Data sources and evaluation.	10
Unit 4	Risk Management: Risk communication and Risk Perception, comparative risks, Risk based decision making, Risk based environmental standard setting, Risk Cost Benefit optimization and tradeoffs, Emergency Preparedness Plans, Emergency	8

	planning for chemical agent release, Design of risk management programs, risk based remediation; Risk communication, adaptive management, precaution and stake holder involvement.	
Unit 5	Application: Case studies on risk assessment and management for hazardous chemical storage, Chemical industries, Tanneries, Textile industries, Mineral processing and Petrochemical plants, Hazardous waste disposal facilities, nuclear power plants, contaminated site remediation, Case histories on Bhopal, Chernobyl, Seveso, Three Mile Island.	8
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
2.	Kolluru Rao, Bartell Steven, Pitblado R and Stricoff, Risk Assessment and Management Handbook, McGraw Hill Inc., New York, 1996.
3.	Kofi Asante Duah, Risk Assessment in Environmental management, John Wiley and sons, Singapore, 1998.
4.	Kasperson, J.X. and Kasperson, R.E. and Kasperson,R.E., Global Environmental Risks, V.N.University Press, New York, 2003.
5.	Risks and Decisions for Conservation and environmental management, Mark Burman, Cambridge University Press.
6.	Susan L Cutter, Environmental Risks and Hazards, Prentice Hall of India, New Delhi, 1999.
7.	Joseph F Louvar and B Diane Louver, Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey, 1997

Course Title:	Course Structure			Pre-Requisite
	L	T	P	
Design of Water Distribution Network (EN320)	3	1	0	Water Treatment and Design (EN201)

Course Objective:
To equip students with comprehensive knowledge and analytical skills for planning, designing, and evaluating water distribution and sewerage systems, integrating foundational principles, practical applications, advanced analytical techniques, and sustainability considerations, enabling them to develop innovative, efficient, and context-specific solutions for urban water supply and wastewater conveyance challenges.

Course Outcome (CO):

1. Explain the foundational principles, concepts, and distinctions related to water supply planning, demand assessment, distribution systems, and wastewater conveyance planning.
2. Apply their knowledge to implement water supply and sewerage planning and design principles, applying practical solutions for real-world scenarios in urban water distribution and wastewater conveyance systems.
3. Analyze principles, factors, system types, and performance aspects of water supply and sewerage, applying advanced analytical techniques for system design, optimization, and sustainability evaluation in both urban water distribution and wastewater conveyance systems.
4. Evaluate the effectiveness of water supply and sewerage planning and design strategies, critically analyzing their impact on system performance, sustainability, and overall efficiency in urban water distribution and wastewater conveyance systems.
5. Develop innovative and comprehensive solutions, incorporating advanced principles and techniques, design efficient and sustainable water supply and sewerage systems.

S.No.	Content	Contact Hours
Unit 1	Planning of water supply sources and demand assessment, water demand forecasting, types of water distribution systems, intermittent and continuous water supply systems.	8
Unit 2	Design and analysis of water mains. Steady state analysis of pipe networks. Design and analysis of water distribution system. Analysis of water deficient systems. Optimal design of water distribution systems. On-line monitoring of water supply parameters. Retrofitting of the existing water supply systems.	9
Unit 3	Planning of wastewater conveyance system in urban areas, combined and separate systems for storm and sewage. Hydraulic Modelling of Water Distribution Systems	9
Unit 4	Design and analysis of wastewater conveyance systems, optimal design of wastewater conveyance system.	9
Unit 5	Operation and maintenance issues, retrofitting of the sewerage system. Consideration of sustainability criteria (economic, environmental, technical, social, temporal).	7
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	Pramod R. Bhave and Rajesh Gupta Analysis of Water Distribution Networks, Alpha Science Int'l Ltd, 2006
2.	Nicklow, Boulos Muleta, Comprehensive Sewer Collection Systems Analysis Handbook for Engineers and Planners, 2004
3.	CPHEEO Manual of water supply and treatment. Latest edition.
4.	CPHEEO Manual on sewerage and sewage treatment, Part a,b,c Latest edition.

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Green Technology (EN322)	3	1	0	NIL

Course Objective:

This course aims to develop students' understanding of green technologies, nanotechnology, sustainable energy, and eco-friendly industrial practices. It emphasizes innovation, environmental management, international sustainability frameworks, and green financing, enabling learners to apply principles and tools for designing sustainable processes, products, and systems that address global environmental challenges effectively.

Course Outcome (CO):

1. Explain principles, goals, and limitations of green technology, including WEHAB innovations, eco-restoration, and design for sustainability.
2. Apply green nanotechnology techniques to synthesize nanoparticles, characterize green materials, and develop nano-based energy storage and renewable energy applications.
3. Analyze linkages between biodiversity, ecosystems, global warming, and greenhouse gases to assess sustainable development strategies and international energy conventions.
4. Evaluate green management practices, including ISO standards, green financing, environmental reporting, and project management strategies for sustainable industrial and business operations.
5. Design green industrial processes for textiles, polymers, pharmaceuticals, pesticides, and wastewater treatment for minimizing pollution and promoting eco-friendly production methods.

S.No.	Content	Contact Hours
Unit 1	Introduction of Green protocol: Need, Goal and Limitation of Green Technology, Principles of Green Technology with their explanations and examples. Green Innovation & Sustainability: Criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends – process/product innovation, technological/environmental leap-frogging; Eco/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity- WEHAB (eco-restoration/ phyto-remediation, ecological sanitation, renewable energy technologies, industrial ecology, agro ecology and other appropriate green technologies); design for sustainability.	9
Unit 2	Green Nanotechnology: Nano particles preparation techniques, Greener Nano synthesis, Nanoparticle characterization methods, Green materials: biomaterials, biopolymers, bioplastics, and composites. Nano materials for Fuel Cells and Hydrogen; Generation and storage, Nano strcutures for efficient solar hydrogen production, Metal Nano clusters in Hydrogen Storage Applications, Metal Nano particles as Electro catalysts in Fuel Cells	9
Unit 3	Green Energy And Sustainable Development: The inseparable linkages of life supporting systems, biodiversity and ecosystem services and their implications for sustainable development: global warming; greenhouse gas emissions, impacts, mitigation and adaptation ; future energy Systems- clean/green energy technologies; International agreements/conventions on energy and sustainability- United Nations Framework Convention on Climate Change (UNFCC); sustainable development.	8
Unit 4	Green Management: The concept of green management; evolution; nature, scope, importance and types; developing a theory; Definition green management in India; relevance in twenty first century, Green techniques and methods; green tax incentives and rebates (to green projects and Companies); green project management in action; Environmental reporting and ISO 14001; climate change business and ISO 14064; green financing; financial initiative by UNEP; green energy management; green product management	9
Unit 5	Green Industrial Processes: Pollution statistics from various industries, polymer	7

	industry, textile industry, greener approach of dyeing, eco-friendly pesticides, pharmaceutical industry, waste water treatment	
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	Kelliher, F., Reinl, L. Green Innovation and Future Technology. ISBN 978-1-137-47982-2
2.	Leo A. Meyer. The Green Energy Management. ISBN 0880690534.
3.	Jadhav, Nilesh Y. Green and Smart Buildings. ISBN 978-981-10-1002-6.
4.	Sengupta, Amretashis, Sarkar, Chandan Kumar. Introduction to Nano. ISBN 978-3-662-47314-6.
5.	Kalia, Susheel, Kaith, B. S., Kaur, Inderjeet. Cellulose Fibers: Bio- and Nano-Polymer Composites. ISBN 978-3-642-17370-7.

IV Year: Seventh Semester

Course Title	Course Structure			Pre-requisite
	L	T	P	
Occupational Hazards, Health & Safety (EN405)	3	1	0	

Course Objectives
1. To develop an understanding of Occupational Hazards and Its Prevention. 2. To give the concept of legislation in India regarding Occupational safety and health. 3. To give the concept of Health protection and prevention of Occupational diseases. 4. To develop an understanding of occupational Hazards and safety management for different industries.

Course Outcomes
1. Basic knowledge about different types of Occupational Hazards. 2. Developed a deep understanding of Indian legislations related to Occupational safety and health. 3. Consciousness among students about the various occupational diseases and their prevention & control. 4. Equipped with analytical ability to assess hazard and health problems in different industries.

S. No.	**Contents**	**Contact Hours**
Unit 1	Occupational Hazards: Definition of Occupational Hazard, Different type of occupational Hazards such as Physical Hazard, Chemical Hazards, Biological Hazards, Radiational Hazard, Ergonomic Hazards psycho-social Hazard and their prevention.	8
Unit 2	Occupational safety and Health Act, Occupational Safety and Health Administration, Right to know laws, Indian Acts, Labour Act, Factories Act The Employes state Insurance Act, ILO Act, OSHA accident causation, Investigation method and Different model.	8
Unit 3	Occupational Diseases: Definition of Occupational Diseases, Different types of occupational Diseases silicosis, Anthrocosis, Byssinosis, Asbestosis, Farmer's Lungs, Lead Poisoning, occupational cancer, occupational dermatitis.	9
Unit 4	Protection and Prevention: Measure for health protection of workers by nutrition, Environmental Sanitation. Health education, etc. Prevention of	8

	occupational disease by Medical measuring, Engineering Measure and legislation.	
Unit 5	Assessment of hazards and health problem of different types of Industries-construction, textile, food processing, Agriculture industries, Pharmaceutical Industries and waste water treatment plant, .Survey of two industries for occupational hazards and safety management.	8
	Total	42

Books and References:

S. No.	Name of Books/Authors/Publisher
1.	Principles of Occupational Health and Hygine: An Introduction: Cherilyn Tillman Allen & Unwin
2.	Environmental Pollution Health and Toxicology: S. V. S. Rana , Narosa Publication.
3.	Preventive and Social Medicine: K. Park.

Course Title	Course Structure			Pre-Requisite
	L	T	P	
System Simulation & Modeling (EN407)	3	0	2	Water Engineering, Wastewater Engineering, Air & Noise Pollution & Control, Solid Waste Management

Course Objective:

This course aims to develop students' ability to understand, apply, analyze, and design mathematical and simulation models for environmental systems. Emphasis is placed on air, water, and sub-surface quality modeling, model calibration and verification, and the use of modern software tools for effective environmental quality management.

Course Outcome (CO):

1. Explain concepts, scope, and objectives of environmental system modeling, including types of models and their role in environmental quality management.
2. Apply model-building stages, calibration, and verification techniques to develop reliable environmental system models considering limitations and assumptions.
3. Analyze air quality models, including dispersion, receptor, and indoor mass balance models, to assess and predict pollution levels effectively.
4. Evaluate surface water quality models like DO sag, BOD, eutrophication, QUAL2K, and WASP for varied aquatic environmental conditions.
5. Design contaminant transport and sub-surface flow models using governing equations, simulation tools, and case studies for environmental pollution management.

S.No.	Contents	Contact Hours
Unit 1	Environmental systems - Introduction, overview of mathematical models applied to various environmental issues, Concept, Need, Scope and objectives of environmental modeling, Role of mathematical models in environmental quality management	9
Unit 2	Model Classification - Brief review of different types of models, Mathematical (Deterministic), Numerical, Stochastic and Physical Models. Different stages involved in model building, Calibration and verification of model, Limitations in modelling.	8
Unit 3	Fundamentals of air quality modeling - Receptor and Dispersion modeling: AERMOD, ADMS-Urban, CALINE, CALPUFF, CMAQ, CMB, PMF. Fundamentals of indoor air quality modeling techniques – mass balance model.	9
Unit 4	Surface Flow Models - Dissolved oxygen models – DO sag model, BOD model, Streeter Phelps equation for point and distributed sources. Eutrophication models for lakes and flowing water; Use of QUAL2K and Water Quality Analysis Simulation Program (WASP).	8
Unit 5	Contaminant transport and sub-surface models - Transport phenomenon, Diffusion, Dispersion, Advection, Adsorption, Conservative and non-conservative pollutants. Surface water quality modeling – River and streams, Estuaries and lakes. Governing Equations for sub-surface flow and transport of pollutants, Simplified models for sub-surface plume movements. Case studies using appropriate software for sub-surface flow and transport of pollutants.	8
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	Ramaswami A. "Integrated Environmental Modelling", John Wiley, New York.
2.	Chapra S.C., "Surface water quality modelling", McGraw Hill., New York.
3.	Rumynin B.G., "Subsurface Solute Transport Model", Springer, Netherlands.
4.	Schnoor J., "Environmental Modelling", John Wiley, New York.
5.	Jacobson M.Z., "Fundamentals of Atmospheric Modelling", Cambridge University Press, New York.
6.	Schnelle K.B. and Dey P.R., "Atmospheric Dispersion Modelling Compliance (1999) Guide", McGraw-Hill, New York
7.	Gordon Geoffrey, "System Simulation", Prentice Hall (Higher Education Division, Pearson Education)

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Advanced Open Channel Hydraulics (EN409)	3	0	2	Fluid Mechanics & hydraulics

Course Objective:

1. To introduce the concept of geometric shapes of channel sections, pressure distribution and application of Manning's and Chezy's formulae.
2. To study the specific energy concept with channel transitions and conveyance.
3. To understand the various flow profiles in gradually varied flows.
4. To study the formation of hydraulic jump in rapidly varied flows. for the design of various hydraulic structures.

Course Outcome (CO):

1. Develop conceptual knowledge regarding the different types of surface flows and their applications.
2. Demonstrate the specific energy concept with channel transitions and conveyance.
3. Understand the various flow profiles in gradually varied flows.
4. Develop the hydraulic jump in rapidly varied flows.
5. Design of various hydraulic structures.

S.No.	Contents	Contact Hours
Unit 1	Types of flows in open channel, geometrical properties of channel sections, velocity distribution and pressure distribution in open channel, continuity equation.	7
Unit 2	Chezy's equation, Manning's formula, Manning's roughness coefficients, equivalent roughness, hydraulically efficient different channel sections. Normal depths and their computations.	9
Unit 3	Specific energy, critical depth, concept of specific force, alternate depths, specific energy diagram. Application of momentum principle in hydraulic jump, properties of jumps.	9
Unit 4	Introduction to differential equations of GVF, different types of flow profiles. Flumes and their application. Rapidly varied flow:	9
Unit 5	Introduction, Sharp crested weir, Ogee spillway, broad crested weirs, Critical depth flume, Sluice gate flow, culvert hydraulics.	8
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1	K Subramanya "Open channel flow", McGraw HILL. (ISBN 10 0-7-008695-8), 2014
2	Rajesh Srivastava "Flow through open channel" Oxford University Press. (ISBN 0-19-569038-9), 2000
3	Vee T Chow., "open channel flow" Tata pMcGraw Hill. (ISBN 21 345 24561), 2014
4	Open Channel Hydraulics, by Richard French H., McGraw Hill
5	A Treatise on Applied Hydraulics, by Addison H., Asia Publishing House

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Risk and Reliability Analysis of Environmental System (EN411)	3	1	0	

Course Objective:
This course aims to equip students with knowledge and skills to assess, analyze, and manage environmental risks and system reliability. It emphasizes hazard identification, contaminant fate, exposure modeling, probabilistic methods, and risk communication, enabling learners to design effective risk management strategies and apply lessons from real-world environmental disasters.

Course Outcome (CO):

1. Explain concepts of environmental hazards, risk perception, regulatory perspectives, and frameworks for assessing ecological and technological risks across disciplines.
2. Apply risk assessment elements including hazard identification, contaminant fate, exposure, dose–response evaluation, risk characterization, vulnerability assessment, and uncertainty analysis.
3. Analyze failure modes, event tree, fault tree, and multimedia exposure models to estimate human health risks from environmental contaminants.
4. Evaluate ecological, radiation, and probabilistic risk assessment methods, including HAZOP and FEMA, to ensure reliability of environmental systems.
5. Design risk management plans incorporating communication, decision-making, emergency preparedness, and remediation strategies, supported by real-world case studies of environmental disasters.

S.No.	Contents	Contact Hours
Unit 1	Introduction to Environmental Risk - Sources of hazards; ecological and technological risks; regulatory perspectives; historical development; risk assessment frameworks; social benefit vs. technological risks; perception of risk across disciplines.	8
Unit 2	Elements of Environmental Risk Assessment - Hazard identification; contaminant fate and transport; receptor exposure; dose–response evaluation; exposure assessment; risk characterization; consequence determination; vulnerability assessment; uncertainty analysis.	8
Unit 3	Risk Analysis Methods - Failure analysis, event tree and fault tree modeling; multimedia and multi-pathway contaminant exposure modeling; estimation of carcinogenic and non-carcinogenic health risks.	9
Unit 4	Risk Assessment Techniques - HAZOP, FEMA, ecological and radiation risk assessment, probabilistic methods; data sources, evaluation approaches, and reliability analysis for environmental systems.	9
Unit 5	Risk Management and Applications - Risk communication and perception; decision-making, cost–benefit optimization, emergency preparedness and planning; risk-based remediation; case studies (Bhopal, Chernobyl, Seveso, Three Mile Island, hazardous industries).	8
Total		42

Books:

S.No.	Name of Books / Authors / Publisher

1.	Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
2.	Kolluru Rao, Bartell Steven, Pitblado R and Stricoff, Risk Assessment and Management Handbook, McGraw Hill Inc., New York, 1996.
3.	Kofi Asante Duah, Risk Assessment in Environmental management, John Wiley and sons, Singapore, 1998.
4.	Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V.N. University Press, New York, 2003.
5.	Risks and Decisions for Conservation and environmental management, Mark Burman, Cambridge University Press.
6.	Susan L Cutter, Environmental Risks and Hazards, Prentice Hall of India, New Delhi, 1999.
7.	Joseph F Louvar and B Diane Louver, Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey, 1997.

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Environmental Economics (EN413)	3	1	0	Engineering Economics

Course Objective:

This course aims to develop students' understanding of the interaction between economy and environment, focusing on pollution control, resource management, sustainability, and development planning. It equips learners with tools for environmental valuation, cost–benefit analysis, and policy appraisal to design economically viable and environmentally sustainable strategies for long-term development.

Course Outcome (CO):

1. Explain development of environmental economics, sustainable and circular economy concepts, and economic approaches to pollution control through standards, taxes, and permits.
2. Apply valuation methodologies to measure environmental damage, assess pollution control policies, and evaluate future discounting in environmental decision-making.
3. Analyze economics of natural resources, including renewable and exhaustible resources, species extinction, and approaches to mitigate resource scarcity.
4. Evaluate development–environment linkages, sustainability challenges, irreversibility issues, and carrying capacity-based planning, especially in developing countries.
5. Conduct cost–benefit analysis of environmental projects, appraise sustainable development initiatives, and assess preventive, punitive, and social costs of environmental changes.

S.No.	Contents	Contact Hours
Unit 1	Economy and Environment- The historical development of environmental economics; circular economy, sustainable economy. Economics of Pollution: optimal level of pollution, market achievement of optimal pollution, Taxation and optimal pollution, Environmental standards, Taxes and subsidies, Marketable pollution permits,	9
Unit 2	Measuring environmental damage- Total economics volume and valuation methodology, pollution control policy in mixed economics. Environmental Values Ethics; discounting the future, alternative to adjusting discounting rates.	8
Unit 3	Economics of Natural Resources: - Renewable resources, Extinction of species, Optimal use of exhaustible resource Measuring and mitigation natural resources scarcity.	8
Unit 4	Development and Environment: - Development, Preservation and conversation, Irreversibility and sustainability, Environmental and the developing countries. Carrying capacity based developing planning.	9
Unit 5	Cost Benefit Analysis of Environmental Changes; Appraisal of Sustainable Development Projects; Principles of Cost Allocation, Preventive, Punitive and social costs.	8
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	Charles D. Kolstad, Environmental Economics, Volume 1, Oxford University Press, 2000, ISBN 0195119541, 9780195119541
2.	Tom Tietenberg, Lynne Lewis, Environmental and Natural Resource Economics, 11th Edition, 2018, Imprint Routledge, DOI https://doi.org/10.4324/9781315208343 Pages 586, eBook ISBN 9781315208343

3.	Karpagam M., Environmental Economics: A Textbook, Sterling Publishers Pvt. Ltd, 1991, ISBN:8120721462, 9788120721463
4.	Kumar, S., Technological Change and the Environment, Routledge Handbook of Environmental Economics in Asia, edited by S. Managi, Routledge, 2015
5.	Field, B.C. & Field, M.K. (2017). Environmental Economics: An Introduction (7th Ed.). McGraw-Hill Education, 2024, ISBN10: 1266543066 | ISBN13: 9781266543067.

Course Title	Course Structure			Pre-requisite
	L	T	P	
Noise Pollution & Control (EN415)	3	1	0	

Course Objectives
1. To develop basic knowledge about sound and noise **2.** To aware the current scenario of noise in India as well as in other countries along with different monitoring techniques. **3.** To aware about the traffic noise generation process, its effects and its modelling part. **4.** To create a clear understanding about the train and aircraft noise as well as its modelling part. **5.** To generate the skill to control the different noise generation from different sources

Course Outcomes
1. Understanding about the basics about sound and noise, worldwide scenario of noise pollution and different monitoring techniques. **2.** clear-cut understanding about traffic noise, its adverse effects and its modelling part. **3.** The students will have a clear understanding about the train and aircraft noise as well as its modelling part. **4.** They will be able to suggest the control measures to different noise generated from different sources.

S. No.	**Contents**	**Contact Hours**
Unit 1	Basics of Sound, Sound propagation in air, Sound power, Sound intensity, Sound pressure levels, Point and Line sources, Outdoor and indoor noise propagation, Fundamentals of Noise, Difference between sound and noise, Measurement of noise, Sources of noise, Ambient noise level standards	8
Unit 2	Noise pollution in India, Factors Affecting Noise Pollution, Road Traffic Noise Monitoring, Ambient Noise Monitoring, Occupational Noise Monitoring, , traffic noise data analysis, health effects of noise	8
Unit 3	Highway Traffic Noise: noise from vehicles, effects of operating conditions on vehicle noise levels, individual sources of vehicle noise, assessment of road traffic noise, traffic noise rating, practical aspects of traffic noise measurement, prediction of noise levels due to highway traffic	9

Unit 4	Train Noise: introduction, elements of train noise, diesel engine noise, transmission noise, rail-wheel interaction noise, vibration from railway vehicles, modelling of train noise Aircraft Noise: introduction, assessment of community reaction to aircraft noise, sources of aircraft noise, aircraft noise prediction, control of aircraft noise	9
Unit 5	Noise Control Measures, Industrial noise control, Principles of Noise Pollution Control, Sound Absorption, Basics about Noise Barrier, Design of Noise Barrier, Vibration Damping, Muffling, Green Belt for Noise Attenuation	8
	Total	42

Books and References:

S. No.	Name of Books/Authors/Publisher
1.	S.K. Agarwal (2009). Noise Pollution. ISBN No. 817648833X.
2.	S.P. Singal .Noise Pollution and Control Strategy. ISBN No. 81-7319-645-1.
3.	Lawrence K. Wang, Norman C. Pereira, Yung-Tse Hung. Advance air and noise pollution control, Vol. 2., eISBN 1-59259-779-3.
4.	Charles E. Wilson. Noise Control: Measurement, analysis and control of sound and vibration. ISBN 0-06-047155-7.

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Irrigation and Drainage Engineering (EN417)	3	1	0	Engineering Hydrology, Soil Mechanics, Transportation Engineering, Airport Engineering

Course Objective:

This course aims to equip students with knowledge and skills in irrigation principles, channel and headworks design, water logging control, canal lining, and cross-drainage works. Emphasis is placed on applying hydraulic theories, design methods, and drainage techniques to develop efficient, sustainable, and site-appropriate irrigation and drainage infrastructure.

Course Outcome (CO):

1. Explain principles of irrigation, soil-water-plant relationships, irrigation methods, efficiencies, crop water requirements, and use of seepage or wastewater for irrigation.
2. Apply hydraulic theories and design principles to diversion headworks, barrages, weirs, spillways, silt control devices, and associated structural components.
3. Analyze irrigation channel design using Kennedy's and Lacey's theories, considering silt factor, canal profiles, balancing depths, and breach repair methods.
4. Evaluate causes, effects, and remedies of water logging, and design lined canals, canal falls, and regulation works for efficient irrigation.
5. Design suitable cross-drainage works, surface and sub-surface drains, and drainage systems for roadways and airports based on hydraulic and site conditions.

S.No.	Contents	Contact Hours
Unit 1	Introduction - Irrigation Principles: Basic Soil-water plant relation, consumptive use, depth and frequency of irrigation, various methods of application of irrigation water, irrigation efficiency, principal Indian crops and their water requirements, Standards of irrigation water, use of seepage and waste water for irrigation. duty and delta, methods of improving duty, irrigation efficiencies.	9
Unit 2	Diversion Head Works - Weir and Barrage, component parts, Types of failures of floor, Bligh's theory, Lane's weighted theory, Khosla theory, Pressure calculations, corrections Design of sloping glacis Weir, impervious floor, launching apron, Inverted filter, proportioning of bays in barrage, anal head regulator, Spillways, Under sluices portion and silt control devices.	9
Unit 3	Silt Theories and Design of Irrigation Channel - Kennedy's theory, draw backs, Lacey regime theory, comparison between Kennedy and Lacey theories, Design of channel based on Kennedy and Lacey theories, Effect of silt factor, L-Section of canal, Balancing depths, Use of Garrets diagram in channel design, cross section of an irrigation channel. Channel breaches and their repair.	8
Unit 4	Water Logging, Canal Lining & Regulation Work - Losses in canal, water logging, its causes and effects remedies of water logging. Lining of canal, advantages and disadvantages of lining, Types of lining. Design of lined canal. Necessity of canal falls, types of fall, Design of sarda type fall.	8
Unit 5	Cross Drainage Works - Types of cross-drainage works, selection of suitability of type of C.D. work. Design of transition when water depth is	8

	constant and when varied, design of surface and sub-surface drains, roadway and airport drainage.	
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	Design of Irrigation Works By R. S. Varshney.
2.	Irrigation Engg. & Hydraulic Structure by S. K. Garg.
3.	Irrigation and Water Power Engg. By Dr. B. C. Punmia and Dr. Pande.
4.	Irrigation Engg. By Birdei and Dass.

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Non-Conventional Energy Systems (EN419)	3	1	0	

Course Objective:

1. Understand the meaning, importance and scope of the Non-Conventional Energy Systems.
2. Explain the principal of solar energy, wind energy, biomass energy, geothermal energy, hydroelectric, tidal energy and nuclear energy.
3. Describe the basic concept of Energy scenario in India.

Course Outcome (CO):

1. Describe the environmental aspects of renewable energy resources.
2. Explore the concepts involved in solar energy, wind energy conversion system by studying its components, types and performance.
3. Illustrate hydro-electric energy, tidal energy and explain the operational methods of their utilization.
4. Acquire the knowledge on Geothermal energy, Biomass Energy & Nuclear Energy.

S.No.	Contents	Contact Hours
Unit 1	Introduction; Conventional and Non-conventional sources; Global energy trends; Energy scenario in India. Solar Energy: Introduction; Measurement of solar radiation; Solar energy collectors-concentrating and non-concentrating; Principles and systems of solar photo-thermal and photovoltaic conversion; storage of solar energy	9
Unit 2	Wind Energy: Introduction; Principles of wind energy conversion; Site-selection considerations; Basic components of WECS; Design considerations of horizontal and vertical-axis machines; Environmental implications of wind energy, Biomass Energy: Introduction; Potential in India; Types of biomass and biomass conversion technologies; Biogas generation; Design considerations and types of biogas plant; Energy plantation; Bio-hydrogen production; Environmental aspects of biomass energy	9
Unit 3	Geothermal Energy: Introduction; Nature and classification of geothermal fields; vapour-dominated and liquid-dominated systems; Limitations; Prospects in India	8
Unit 4	Hydro-electric and tidal energy: Introduction; Principles of conversion; Classification and Components of conversion systems; OTEC; Advantages and limitations; Potential in India.	8
Unit 5	Nuclear Energy: Introduction; fission and fusion reactions, Principles and Components; Energy release rates, Advantages and limitations; present status and future possibilities	8
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	Principles of Energy conversion, A. W. Culp Jr.,, McGraw Hill, 1996
2.	Non-Convention EnergyResources, Shobh Nath Singh, Pearson, 2018
3.	Renewable Energy Sources & Conversion Technology: N.K.Bansal, Manfred Kleenman&Michael Meliss, TMH Publication.
4.	Non-Conventional Energy Resources: D.S. Chauhan and S.K.Srivastava, New Age International
5.	Energy, Godfrey Boyle, Oxford University Press
6.	Non-Conventional Energy Systems: G.D.Rai, Khanna publications
7.	Renewable Energy Sources and Emerging Technology: D.P.Kothari and etal., PHI.
8.	Hand Book of Renewable Energy Technology, Ahmed F Zooba, R C Bansal World scientific.
9.	Fiar, G.M., and Geyer, J.C., Water and Wastewater engineering, Vol-I & II, John Wiley and sons, New York.
10.	Anaerobic Sewage treatment by Van Haandel and Lettinga, John Wiley & Sons Publication
11.	Eckenfelder, Activated sludge treatment of industrial wastewater
12.	Hammer, M.J., Water and Wastewater Technology. John Wiley and sons-Inc, New York.

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Disaster Management (EN421)	3	1	0	

Course Objective:

This course aims to provide students with knowledge of natural and man-induced hazards, disaster impacts, and management strategies. It emphasizes preparedness, mitigation, response, and rehabilitation, along with institutional roles, GIS applications, and sustainable community-based approaches, enabling learners to design effective disaster risk reduction and resilience-building strategies for India and beyond.

Course Outcome (CO):

1. Explain concepts, causes, distribution, and impacts of natural hazards such as earthquakes, floods, cyclones, droughts, and volcanic eruptions.
2. Analyze man-induced hazards including soil erosion, chemical releases, nuclear accidents, sedimentation, and biological hazards, proposing appropriate conservation and corrective measures.
3. Apply disaster management approaches across pre-disaster, emergency, and post-disaster stages to prepare, mitigate, respond, and rehabilitate effectively.
4. Evaluate disaster reduction strategies, institutional roles, integrated planning, GIS applications, and community involvement for effective hazard prediction and mitigation.
5. Assess regional disaster scenarios in India and design sustainable, community-based strategies integrating ecological planning, policies, and rural development initiatives.

S.No.	Contents	Contact Hours
Unit 1	Natural Hazards and Disasters: Concept of Environmental Hazards, Environmental stress & Environmental Disasters. Types of Environmental hazards & Disasters: Natural hazards and Disasters, Volcanic Hazards/ Disasters, - Causes and distribution of Volcanoes, - Hazardous effects of volcanic eruptions, -Environmental impacts of volcanic eruptions, Earthquake Hazards/ disasters, - Causes of Earthquakes, -Distribution of earthquakes, - Hazardous effects of earthquakes, Earthquake Hazards in India, Human adjustment, perception & mitigation of earthquake, Cumulative atmospheric hazards/ disasters- Lightning, Hailstorms, Cyclones: - Tropical cyclones & Local storms, - Destruction by tropical cyclones & local storms (causes , distribution human adjustment, perception & mitigation), Cold waves, Heat waves, Floods, Causes of floods, Flood hazards in India, - Flood control measures (Human adjustment, perception & mitigation), Droughts: - Impacts of droughts, - Drought hazards in India, - Drought control measures	9
Unit 2	Man induced hazards & Disasters: Mechanics & forms of Soil Erosion, - Factors & causes of Soil Erosion, Conservation measures of Soil Erosion, Chemical hazards/ disasters— Release of toxic chemicals. nuclear explosion, Sedimentation processes, - Global Sedimentation problems, Regional Sedimentation problems, Sedimentation & Environmental problems, Corrective measures of 23 Erosion & Sedimentation, Biological hazards/ disasters, Population Explosion	8
Unit 3	Emerging approaches in Disaster Management- Three Stages: **I.** Pre-	8

	disaster stage (preparedness)-(a) Preparing hazard zonation maps, Predictability/ forecasting & warning, b) Preparing disaster preparedness plan, c) Land use zoning, d) Preparedness through (IEC) Information, education & Communication Pre-disaster stage (mitigation) Disaster resistant house construction, Population reduction in vulnerable areas, Awareness 2. Emergency Stage:- a) Rescue training for search & operation at national & regional level, b) Immediate relief; c) Assessment surveys 3. Post Disaster stage-Rehabilitation- a) Political Administrative Aspect, b) Social Aspect, c) Economic Aspect d) Environmental Aspect	
Unit 4	Natural Disaster Reduction & Management: a) Provision of Immediate relief measures to disaster affected people, b) Prediction of Hazards & Disasters, c) Measures of adjustment to natural hazards Mitigation-discuss the work of following Institution-(a) Meteorological observatory, (b). Seismological observatory, (c). Volcanology institution, (d). Hydrology Laboratory, (e.) Industrial Safety inspectorate,(f). Institution of urban & regional planners, (g). Chambers of Architects, (h). Engineering Council, (i) National Standards Committee, Integrated Planning- Contingency management Preparedness :-a) Education on disasters, b) Community involvement, c) The adjustment of Human Population to Natural hazards & disasters, Role of Media. Application of Geographical Information System(GIS) in Disaster risk management	9
Unit 5	A regional survey of Land Subsidence, Coastal Disaster, Cyclonic Disaster & Disaster in Hills with particular reference to India, Ecological planning for sustainability & sustainable development in India-Sustainable rural development: A Remedy to Disasters, Role of Panchayats in Disaster mitigations. Environmental policies & programmes in India- Institutions & National, Centres for Natural Disaster reduction	8
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	Savinder Singh Environmental Geography, Prayag Pustak Bhawan, 1997
2.	Kates B.I & White, G.F The Environment as Hazards, oxford, New York, 1978
3.	R.B. Singh (Ed) Disaster management, Rawat-Publication, New Delhi, 2000
4.	R.B. Singh, Space Technology for Disaster Mitigation in India (INCED), University of Tokyo, 1994
5.	A.S. Arya Action Plan For Earthquake, Disaster, Mitigation in V.K. Sharma (Ed)
6.	Disaster Management IIPA Publication New Delhi, 1994
7.	R.K. Bhandani, An overview on Natural & Man-made Disaster & their Reduction, CSIR, New Delhi
8.	M.C. Gupta Manuals on Natural Disaster management in India. National Centre for Disaster Management, IIPA. New Delhi.

IV Year: Eighth Semester

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Project Management (EN404)	3	0	2	

Course Objective:

This course aims to equip students with skills in estimation, rate analysis, project planning, scheduling, cost and resource management, economic evaluation, and contract administration. Emphasis is placed on applying modern project management tools, legal frameworks, and quality control measures to deliver efficient, safe, and sustainable construction projects.

Course Outcome (CO):

1. Explain estimation types, specifications, and methods for civil engineering works, including buildings, reinforced concrete structures, and associated material requirements.
2. Apply rate analysis, resource planning, market rates, and cost indices to prepare accurate estimates for construction and infrastructure projects.
3. Analyze project planning, scheduling, and monitoring techniques including bar charts, milestone charts, PERT, CPM, GERT, AOA, and AON networks.
4. Evaluate project cost planning, financing methods, economic comparisons, depreciation, and break-even analysis for effective decision-making in construction projects.
5. Design contract strategies, tender documents, and project management plans addressing legal aspects, land acquisition, labor safety, and quality control measures.

S.No.	Contents	Contact Hours
Unit 1	Importance of estimation, different types of estimates, specification: general and detailed. Methods of estimation, Estimates of RC works, Estimates of building.	8
Unit 2	Analysis of rates, prime cost, work charge establishment, quantity of materials per unit of work for major civil engineering items, Resource planning through analysis of rates, market rates, PWD schedule of rates and cost indices for building material and labor. Introduction to valuation.	8
Unit 3	Project cycle, organization, planning, scheduling, monitoring, updating and management system in construction Bar chart, Milestone chart, Work down structure and preparation of networks. Application of network, Techniques like PERT, GERT, CPM, AON and AOA techniques.	8
Unit 4	Project monitoring; cost planning, resources allocation through network techniques. Time value of money, present economy studies, Equivalent concept, financing of projects, economic comparison, present worth method, equivalent annual cost method, discounted cash flow method, depreciation and break even cost analysis. Quality Control, Productivity, Operation Cost.	9
Unit 5	Legal aspects of contracts, their relative advantages and disadvantages, Different types of contracts, their relative advantages and disadvantages, Elements of tender preparation, process of tendering, pre-qualification of contracts, Evaluation of tender preparation, process of tendering, Evaluation of tender, contract negotiation and award of work, Land acquisition, Labor safety and welfare.	9
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	Estimating and costing by B.N.Datta.
2.	PERT and CPM principle and application by L.S.Srinath.
3.	PERT and CPM principle and application by B.C. Punmia.
4.	Construction planning and management by U.K. Srivastva.
5.	Estimating, costing and Valuation in Civil Engineering by M. Chakraborty.
6.	Construction, planning, equipment and method by R.L. Peurify.
7.	Network analysis techniques by S.K. Bhatnager.

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Industrial Waste Management (EN406)	3	0	2	

Course Objective:

1. To introduce the principles, sources, and characteristics of Industrial Wastes.
2. To provide comprehensive knowledge of waste minimization strategies.
3. To develop understanding of treatment technologies and design principles.
4. To familiarize students with regulatory frameworks and compliance requirements.
5. To enable practical application of engineering principles in designing, operating, and troubleshooting industrial waste treatment systems.

Course Outcome (CO):

1. Remember and explain the sources, characteristics, and environmental impacts of various industrial wastes.
2. Apply waste minimization principles and cleaner production techniques.
3. Evaluate and select appropriate treatment technologies (physical, chemical, biological, advanced) for specific industrial waste.
4. Design industrial waste treatment systems, and process flow diagrams to meet CPCB/SPCB compliance standards.
5. Analyze operational challenges in industrial waste treatment plants and develop troubleshooting strategies and maintenance protocols for sustainable plant operation.

S.No.	Contents	Contact Hours
Unit 1	Industrial Pollution Sources, Impacts & Regulatory Framework: Industrial waste classification, characteristics of effluents from major sectors (textile, chemical, pharmaceutical), CPCB regulatory standards and discharge limits, Water Act 1974 and Environment Protection Act 1986 provisions, Compliance requirements for different industry categories (Red, Orange, Green classification).	8
Unit 2	Waste Minimization & Cleaner Production Strategies: Waste hierarchy principles (reduce, reuse, recycle), source reduction strategies, and cleaner production technologies. Covers process modification techniques, raw material substitution, water conservation methods, and industrial symbiosis concepts. Includes life cycle assessment (LCA) methodology, circular economy implementation, material flow analysis, and economic evaluation of waste minimization programs. Case studies of successful waste minimization in Indian industries and eco-industrial park development.	8
Unit 3	Industrial Wastewater Treatment Technologies: Coverage of treatment technologies starting from pre-treatment (equalization, oil separation, pH control) to advanced processes. Includes physico-chemical treatment (coagulation, precipitation, adsorption), biological systems (activated sludge, UASB, SBR), advanced oxidation processes (ozonation, Fenton, UV), and membrane technologies (RO, UF, MF). Covers sector-specific treatment approaches for textile, pharmaceutical, and food industries, plus Common Effluent Treatment Plants (CETP) design and operation principles.	12
Unit 4	Solid & Hazardous Waste Management: industrial solid waste characterization, storage, collection and transportation systems. Detailed	10

	coverage of Hazardous Waste Management Rules 2016, waste classification criteria, TCLP testing procedures. Treatment technologies (stabilization, incineration, bioremediation), specialized waste streams (biomedical, e-waste, C&D waste, plastic waste), secure landfill, and contaminated site remediation techniques. Covers TSDF operations and regulatory compliance requirements.	
Unit 5	**Advanced Treatment & Zero Discharge Systems:** Zero Liquid Discharge (ZLD) concept, technology configurations including multi-effect evaporation, crystallization, and brine management. Emerging technologies like nanotechnology applications in water treatment, Evolving regulatory frameworks for sustainable industrial operations.	4
Total		42

Books:

S.No.	Name of Books / Authors / Publisher
1.	Frank Woodard (2001) Industrial Waste Treatment Handbook, Butterworth–Heinemann, ISBN 0-7506-7317-6
2.	WEF Manual of Practice No. FD-3, Industrial Wastewater Management, Treatment, And Disposal, Water Environment Federation, Third Edition, McGraw Hill
3.	Eckenfelder W. Jr. (1999) Industrial Water Pollution Control, Environmental Engineering and Water Resources Series, 3rd Edition, McGraw-Hill Science/Engineering/Math, ISBN-13: 978-0070393646, ISBN-10: 0070393648
4.	Patwardhan AD, Industrial Waste Water Treatment, PHI Learning Private Ltd, India, ISBN 9788120333505
5.	Metcalf & Eddy, Wastewater Engineering- Treatment and Reuse (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill.
6.	Nemerow, N. L., “Industrial Waste Treatment: Contemporary Practice and Vision for the Future”
7.	CPCB Standard for Discharge of Environmental Pollutants

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Environmental Biotechnology (EN408)	3	0	2	Environmental Chemistry and Microbiology

Course Objective:

- Basics of application of biotechnology in environmental monitoring
- Environmentally harmful chemicals and their microbial degradation
- Field-scale applications of environmental biotechnology
- Integration of biotechnology with other environmentally-significant processes
- Biodegradable and environment-friendly products

Course Outcomes:

1. Understand the basics of environmental biotechnology and its applications
2. Analyze the method suitable for treatment/removal of diverse pollutants
3. Develop green and innovative methods suitable for commercial applications
4. Design sustainable environment-friendly solutions using plants
5. Comply with ethical guidelines related to environmental biotechnology

S. No.	Contents	Contact Hours
Unit 1	Definition and importance of Environmental biotechnology, Biosensors in detection of environmental pollutants: Biomarkers, Biosensors of pollution- BOD, ammonia, methane. Role of microbes in sequestering carbon dioxide, Role of biotechnology in conservation of species: in-situ and ex-situ conservation.	8
Unit 2	Biodegradation: Recalcitrance of xenobiotics, Biodegradation of Halogenated hydrocarbons, substituted aromatic compounds, Polycyclic aromatic hydrocarbons, Pesticides, Surfactants. Emerging Environmental Biotechnologies: Application of microbial enzymes, Bio-membrane reactors.	8
Unit 3	Bioremediation of polluted environments: Environmental applications of bioremediation, types of bio-remediation, mechanisms of microbial metal resistance and detoxification, bioremediation of oil spills, limitations of bioremediation, bioremediation and genetic engineering.	9
Unit 4	Biotechnology and radioactive pollution: Bioleaching; Biosorption and Biotreatment of soils contaminated by radio elements. Phytoremediation: Phytoremediation of xenobiotics and bioaccumulation of metals using plants	8
Unit 5	Development of biodegradable and eco-friendly products: Fermentation technology; biomass production; Biofuel and Biodiesel-plant derived fuels, bioethanol, biohydrogen; biofertilizers; biopesticides; bio-polymers. Bioethics in Environmental biotechnology: Bioethics issues - Genetically engineered microbes and GM Crops	9
Total		42

Books:

S. No.	Name of Books / Authors / Publisher
1.	A. Scragg. (2005). Environmental Biotechnology, 2nd Edition, Oxford University

	Press
2.	B. Rittman, P. L. McCarty. (2000) Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill.
3.	I. S. Thakur. (2006). Environmental Biotechnology: Basic Concepts and Applications. I K International Publications.
4.	B.C. Bhattacharya and R. Banerjee (2007). Environmental Biotechnology. Oxford University Press, 2007.
5.	J. M. Lynch, A. Wiseman. (1998). Environmental Bio-monitoring: The Biotechnology Ecotoxicology Interface, Cambridge University Press

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Life Cycle Assessment (EN410)	3	0	2	NIL

Course Objective:

- To introduce the concept of environmental health & safety issues.
- To learn about the pollution prevention practices.
- To introduce the concept of Life Cycle Assessment
- To introduce eco-labels, new business paradigms and design practices.

Course Outcome (CO):

1. Explain the fundamental concepts of environmental health, safety issues, material toxicity, and pollution indicators associated with engineering products and processes.
2. Demonstrate knowledge of sustainable design and manufacturing through product life cycle evaluation and pollution prevention strategies.
3. Apply Life Cycle Assessment (LCA) methodologies, accounting, and costing tools to analyze environmental impacts of products and manufacturing processes.
4. Design sustainable products by integrating principles of recyclability, remanufacturability, and reuse, while assessing eco-industrial strategies.
5. Critically evaluate eco-labels, emerging business paradigms, and advanced design practices to promote sustainable engineering solutions

S.No.	Contents	Contact Hours
Unit 1	Introduction to environmental health and safety issues associated with various stages of the engineering products and processes, Material toxicity, pollution, and environmental degradation indicators.	8
Unit 2	Environmentally conscious design and manufacturing approaches, System life cycles from cradle to grave to reincarnation, Product life-extension, Organizational Issues, Pollution prevention practices, manufacturing process selection and trade-offs.	10
Unit 3	Life-Cycle analysis (LCA) methodology, steps, tools and problems, Life-Cycle Accounting and Costing. Product life-extension, Pollution prevention practices, Manufacturing process selection and trade-offs.	9
Unit 4	Design for Environment: Motivation, concerns, definitions, examples, guidelines, methods, and tools. Recyclability assessments, Design for recycling practices. Re- manufacturability assessments, Design for Remanufacture / Reuse practices, Eco-industrial parks	8
Unit 5	Eco-Labels, New business paradigms and associated design practices	7
Total		**42**

Books:

S.No.	Name of Books / Authors / Publisher
1.	Mary Ann Curran, Environmental Life-cycle Assessment, McGraw-Hill Inc. (1996)
2.	Henrikke Baumann, Anne-Marie Tillman, The Hitch Hiker's Guide to LCA An

	Orientation in Life Cycle Assessment Methodology and Application, Professional Publishing House. (2004)
3.	Frieder Rubik, Paolo Frankl, The Future of Eco-labelling Making Environmental Product Information Systems Effective, Taylor & Francis. (2017)
4.	Herman Koren, Michael S. Bisesi, Handbook of Environmental Health and Safety Principles and Practices, CRC-Press. (1996)

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