

Department of Civil Engineering IIT Delhi
Master of Technology in Environmental Engineering and Management

Modified on: March 11, 2015

Overall credit structure

Category	PC	PE	OE	Total
New Credits	39	9	6	54

Semester	Course/credit structure/credit					Total
1	Environmental chemistry and microbiology (3)	Water engineering (3)	Air pollution and control (3)	PE1 (3)		12
2	Solid and hazardous waste management (3)	Environmental systems analysis (3)	Wastewater Engineering (3)	PE2(3)	OE1	15
Summer	Minor project (3)					3
3	Major thesis part1 (6)			PE3	OE2	12
4	Major thesis part2 (12)					12

Programme core

Course	Name	Structure	Credit
XX	Major thesis part1	0-0-12	6
XX	Major thesis part2	0-0-24	12
XX	Air pollution and control	3-0-0	3
XX	Solid Waste Engineering	3-0-0	3
XX	Water Engineering	3-0-0	3
XX	Wastewater engineering	3-0-0	3
XX	Environmental systems analysis	3-0-0	3
XX	Environmental chemistry and microbiology	1-0-4	3
XXXX	Minor project	0-0-6	3
	Total PC		39

Programme electives

Course	Name	Structure	Credit
XX	Environmental impact assessment	3-0-0	3
XX	Industrial waste management and audit	3-0-0	3
XX	Emerging technology for environmental management	3-0-0	3
XX	Thermal techniques for waste management	3-0-0	3
XX	Life cycle analysis and design for environment	3-0-0	3
XX	Environmental risk assessment	3-0-0	3
XX	Independent study (CEV)	0-3-0	3
XX	Fundamental of Aerosol: Health and climate change	3-0-0	3
XX	Advanced air pollution laboratory	1-0-4	3
XX	Advanced water and wastewater laboratory	1-0-4	3
XX	Quantitative microbial risk assessment	1-0-0	1
XX	Environmental quality modeling	3-0-0	3
XX	Environmental implications of engineered nanomaterials	2-0-0	2
XX	Water distribution and sewerage network design	3-0-0	3
XX	Environmental statistics and experimental design	2-0-2	3

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	WATER ENGINEERING
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	XX
6.	Status (<i>category for program</i>)	PROGRAMME CORE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEL795

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. M.Khare, Prof. B.J. Alappat, Prof. A.K. Mittal, Prof. A.K. Nema, Dr. G. Habib, Dr. Arun Kumar	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To introduce principles of water treatment processes 2. To provide a scientific basis for treating and designing water treatment plants.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Water quality parameters-conventional contaminants and emerging contaminants; Sedimentation; Coagulation and flocculation; Filtration-mechanisms and interpretations; Ion exchange and adsorption; Disinfection; Reverse osmosis, electrodialysis, desalination; Water treatment : Source selection process, selection of treatment chain, plant siting, Treatability studies. Design of physico-chemical unit operations	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Water quality parameters-conventional contaminants and emerging contaminants	2
2	Sedimentation	3
3	Coagulation and flocculation	3
4	Filtration-mechanisms and interpretations	3
5	Ion exchange and adsorption	5
6	Disinfection (chlorination, ozonation)	4
7	Reverse osmosis, electrodialysis and desalination	5
8	Water treatment : Source selection process, selection of treatment chain	4
9	Plant siting, Treatability studies	6
10	Design of physico-chemical unit operations	7
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Peavy, H.S., Rowe, D. R., and Tchobanoglous, G. Environmental Engineering. McGRAW-HILL Book Company, New York, NY. Latest edition.

Benjamin, M.M. and Lawler, D.F. Water Quality Engineering: Physical/chemical treatment processes. John Wiley & Sons, Inc. 2013

Ahluwalia, P. and Nema, A.K. Water and wastewater systems: Source, treatment, conveyance and disposal. S.K. Kataria & Sons. 1st edition. 2011.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Nil
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19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	yes

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	30
20.2	Open-ended problems	20
20.3	Project-type activity	20
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY
3.	L-T-P structure	1-0-4
4.	Credits	3
5.	Course number	XX
6.	Status (<i>category for program</i>)	PROGRAMME CORE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEP789

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. M.Khare, Prof. B.J. Alappat, Prof. A.K. Mittal, Prof. A.K. Nema, Dr. G. Habib, Dr. Arun Kumar	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To introduce concepts of environmental chemistry and microbiology in laboratory 2. To train students in determining environmental parameters in laboratory.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Chemical equilibria and kinetics fundamentals; Acids and bases; Titrations; Acidity; Alkalinity; Buffers and buffer intensity; Chemical equilibrium calculations; pC-pH diagram; Langelier index; Solubility diagram; Oxidation and reduction reactions; Cell structure; Types of microorganisms in environment; metabolic classification of organisms; laboratory procedure for determining chemical and microbial parameters, Introduction to advanced instruments	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Chemical equilibria fundamentals	1
2	Kinetics fundamentals	1
3	Acids and bases; Titrations; Acidity; Alkalinity; Buffers and buffer intensity	2
4	Chemical equilibrium calculations; pC-pH diagram; Langelier index; Solubility diagram;	2
5	Cell structure; Types of microorganisms in environment	2
6	Metabolic classification of organisms	1
7	Laboratory procedure for determining chemical parameters	3
8	Introduction to advanced instruments	2
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		14

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Laboratory safety guidelines, pH, acidity, alkalinity, hardness, color	4
2	Sulfate, chloride, residual chlorine	8
3	DO, BOD, COD	8
4	Total nitrogen, ammonia nitrogen, nitrate and nitrite ions	8
5	Bacterial indicators (microscopy, staining, fecal coliform through MPN and membrane filtration methods, E.coli determination)	8
6	Viral indicators (somatic coliphage detection)	4
7	Gaseous pollutants (SO ₂ , CO ₂ and CO)	4
8	Particulate matter in air	4
9	Introduction to advanced instruments (AAS, GSMS, TOC, HPLC, etc.)	8
10	NA	
COURSE TOTAL (14 times 'P')		56

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Sawyer, C.N., McCarty, P.L. and Parkin, G.F. Chemistry for Environmental Engineering and Science. 5th edition, McGraw-Hill Publishing Company. 2002.

Pelczar, M.J., Michael, Chan, E.C.S., and Krieg, N.R. Microbiology. The McGraw-Hill Companies, Inc. 5th edition. 2001.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Nil
19.2	Hardware	Nil

19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	yes (Environmental engineering laboratory)
19.5	Equipment	yes (Environmental engineering equipments)
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	yes

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	Nil
20.2	Open-ended problems	5
20.3	Project-type activity	10
20.4	Open-ended laboratory work	70
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	AIR POLLUTION AND CONTROL
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	CELXXX
6.	Status (<i>category for program</i>)	CORE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supersedes any existing course	CEL793

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. M. Khare, Dr. Gazala Habib	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To introduce the fundamentals of air pollution and control in ambient as well as source locations. To learn the importance of air pollutants in local air quality issue.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Air-pollution ; Air Pollution Effect on Plants; Air Pollution effect on Human health; Air quality monitoring ; Air Pollution Meteorology ; Gaussian Plume model; Urban Air Pollution; Air Pollution from Industries; Air Pollution control Air pollution indices; standards; norms; rules and regulations; Indoor Air Pollution	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Air-pollution – Historical Perspective , definition, sources, classification	3
2	Air Pollution Effect on Plants	1
3	Air Pollution effect on Human health	1
4	Air quality monitoring-Ambient and Stack monitoring; Emission inventory	3
5	Air Pollution Meteorology- Dynamics of Pollutant dispersion, Diffusion, Dispersion, Advection, Flux , Atmospheric Stability, ABL, Albedo, Bowen Ratio, wind rose	12
6	Gaussian Plume model	4
7	Urban Air Pollution- Air Pollution from vehicles; Air Pollution from Biomass burning ; Air Pollution from landfills	3
8	Air Pollution from Industries-case studies	2
9	Air Pollution control	5
10	Air pollution indices, standards, norms, rules and regulations	4
11	Indoor Air Pollution-Causes and Effects ; Case studies	4
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Vallero, D.A. Environmental Contaminants Assessment and Control. Academic Press, Elsevier, 2004.
2. T.J. Lyons and W.D. Scott .Principles of air-pollution meteorology, CBS Publishers, 2001
3. Wadden, R.A., Scheff, P.A., Indoor Air Pollution: Characterization, Prediction, Control. Wiley, New York, 1983
4. Vallero D., Fundamentals of Air Pollution, 4th edition, Academic Press, 2007

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19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	Nil

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	Nil
20.2	Open-ended problems	50%
20.3	Project-type activity	30%
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	20%

Date: 12.03.2015

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	SOLID WASTE ENGINEERING
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	* * *
6.	Status (<i>category for program</i>)	PROGRAMME CORE

7.	Pre-requisites (<i>course no./title</i>)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	CVL 212 (<5% overlap)
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEL 794

9.	Not allowed for (<i>indicate program names</i>)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. B. J. Alappat, Prof. A.K. Nema, Prof. A.K. Mittal	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1.To introduce the concepts and fundamentals of Integrated Solid Waste Management in a scientific way 2. To teach methods for planning and designing Solid Wastes Management Facilities based on the characteristics and scientific analysis.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Solid Wastes: Origin, Analysis, Composition and Characteristics. Integrated Solid Waste Management System: Collection, Storage, Segregation, Reuse and Recycling possibilities, Transportation, Treatment / Processing and Transformation Techniques, Final Disposal. Management of: Municipal, Biomedical, Nuclear, Electronic and Industrial Solid Wastes and the rules and regulations.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Solid waste generation, analysis and characterisation	4
2	Solid waste storage and transportation	3
3	Waste Reduction, Reuse and Recycling strategies	2
4	Processing techniques of solid wastes	8
5	Disposal techniques	5
6	Management of Municipal Solid Waste	3
7	Management of Biomedical waste	2
8	Management of Electronic waste	2
9	Management of Nuclear Solid Waste	2
10	Management of Fly ash	3
11	Management of industrial solid Waste	3
12	Solid waste management rules and regulations	5
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Tchobanoglous, G., Theisen, H., and Vigil, S.A. Integrated Solid Waste Management, McGraw Hills, 1993.
2. Vesilind, P.A., Worrell, W.A., and Reinhart, D.R. Solid Waste Engineering, CL Engineering, 2001.
3. Pichtel, J. Waste Management Practices, CEC Press, 2005.
4. LaGrega, M.D., Buckingham, P.L. and Evans, J.C., Hazardous Waste Management, Waveland Press, 2010.
5. Waltes, R.J. Hazardous Wastes - Sources, Pathways, Receptors, John Wiley and Sons, 1998.
6. Manuals, Rules and regulations in India for Municipal Solid Waste, Biomedical waste, fly ash, nuclear waste, hazardous waste and E-waste, Government of India.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	Yes

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	20
20.2	Open-ended problems	20
20.3	Project-type activity	30
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	30 (self study, etc.)

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	WASTEWATER ENGINEERING
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	XX
6.	Status (<i>category for program</i>)	PROGRAMME CORE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEL 796

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. M.Khare, Prof. B.J. Alappat, Prof. A.K. Mittal, Prof. A.K. Nema, Dr. G. Habib, Dr. Arun Kumar	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To introduce principles of wastewater treatment processes 2. To train students in designing of wastewater treatment plant design.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Wastewater quality parameters, Biological processes; Microbial growth kinetics; Modeling of suspended growth systems; concepts and principles of carbon oxidation, nitrification, denitrification, methanogenesis. Biological nutrient removal; Anaerobic treatment; Attached growth reactors; decentralised wastewater treatment systems; constructed wetlands; Design of pretreatment, secondary treatment, and tertiary disposal systems. Sludge stabilization, treatment, sludge thickening, sludge drying, aerobic and anaerobic digestion of sludges; reliability and cost effectiveness of wastewater systems; Emerging contaminants in wastewater-treatment issues	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Biological processes; Microbial growth kinetics	4
2	Modeling of suspended growth systems	4
3	Concepts and principles of carbon oxidation, nitrification, denitrification, methanogenesis. Biological nutrient removal;	4
4	Anaerobic treatment	4
5	Attached growth reactors	4
6	Decentralised wastewater treatment systems; constructed wetlands.	4
7	Design of pretreatment and secondary treatment systems	4
8	Design of tertiary disposal systems.	4
9	Sludge stabilization, treatment, sludge thickening, sludge drying	3
10	Aerobic and anaerobic digestion of sludges;	2
11	Reliability and cost effectiveness of wastewater systems	2
12	Emerging contaminants in wastewater-treatment issues	3
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Tchobanoglous, G. and Burton, F.L. Wastewater Engineering: Treatment, Disposal and Reuse. McGraw-Hill Publishing Company. 2002.

Maier, R.M., Pepper, I.L., and Gerba, C.P. Environmental Microbiology, Academic Press. 2000.

Pelczar, M.J., Michael, Chan, E.C.S., and Krieg, N.R. Microbiology. The McGraw-Hill Companies, Inc.. 2001.

Ahluwalia, P. and Nema, A.K. Water and wastewater systems: Source, treatment, conveyance and disposal. S.K. Kataria & Sons. 2011.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	yes

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	30
20.2	Open-ended problems	20
20.3	Project-type activity	20
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	ENVIRONMENTAL SYSTEMS ANALYSIS
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	* * *
6.	Status (<i>category for program</i>)	PROGRAMME CORE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEL886

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. A.K. Nema, Prof. B.J. Alappat; Prof M. Khare	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To provide a systems approach based mathematical framework for addressing environmental problems. 2. To train students in defining systems and their boundaries, apply appropriate algorithms and optimize systems for a set of constraints and objectives.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Introduction to natural and man-made systems. Systems modeling as applied to environmental systems. Nature of environmental systems, the model building process addressing to specific environmental problems. Strategies for analyzing and using environmental systems models. Fate and transport models for contaminants in air, water, and soil. Optimization methods (search techniques, linear programming, non-linear programming, dynamic programming) to evaluate alternatives for solid-waste management and water and air pollution control. Optimization over time. Integrated environmental	
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	management strategies addressing multi-objective and multi-stakeholder planning.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to natural and man-made systems.	2
2	Systems modeling as applied to environmental systems.	2
3	Nature of environmental systems, the model building process addressing to specific environmental problems.	2
4	Strategies for analyzing and using environmental systems models.	2
5	Fate and transport models for contaminants in air, water, and soil.	6
6	Introduction to Optimization methods to evaluate alternatives for solid-waste management and water and air pollution control	2
7	Search techniques	3
8	Linear programming	6
9	Non-linear programming	4
10	Dynamic programming	4
11	Optimization over time.	4
12	Integrated environmental management strategies addressing multi-objective and multi-stakeholder planning.	5
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Sven E. Jorgensen, A Systems Approach to the Environmental Analysis of Pollution Minimization. CRC Press, 1999
2. Tanimoto, Jun. Mathematical Analysis of Environmental System. Springer, 2014
3. Haith, D.A. Environmental Systems Optimization. Wiley, 1982.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	. Nil
19.2	Hardware	NII

19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	Yes

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	30
20.2	Open-ended problems	20
20.3	Project-type activity	20
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	ENVIRONMENTAL IMPACT ASSESSMENT
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	* * *
6.	Status (<i>category for program</i>)	PROGRAMME ELECTIVE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEL 797

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. A.K. Nema, Prof A.K. Mittal, Prof. B.J. Alappat; Prof M. Khare; Dr Gazala Habib; Dr Arun Kumar	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To expose the students with the methods of qualitative and quantitative assessment of environmental impacts due to developmental activities. (Emphasis will be given on quantitative evaluation systems for more tangible evaluation through direct measurement of environmental indicators and by development of environmental indices system.)	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Planning and Management of Environmental Impact Studies. Impact indentation methodologies: base line studies, screening, scoping, checklist, networks, overlays. Prediction and assessment of impacts on the socio-economic environment. Environmental cost benefit analysis. Decision methods for evaluation of alternatives. Case Studies. Environmental impact assessment at project level, regional level, sectoral level, and policy level. Sustainable development; Environmental policy in planned, mixed and market economies.	
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	Preventive environmental management.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction, definitions and concepts, rationale and historical development of EIA.	3
2	Initial environmental examination, environmental impact statement, environmental appraisal, environmental impact factors and areas of consideration.	4
3	Measurement of environmental impact, organization, scope and methodologies of EIA pertinent environmental factors.	4
4	Generic steps, descriptive checklists, simple interaction matrix, stepped matrix, Networks, Overlays, uniqueness ratio, habitat evaluation system.	8
5	Public involvement techniques, comprehensive environmental impact study, various project types, EIA Models.	4
6	EIA Regulations in India, TOR for EIAs	3
7	EIA Case studies	6
8	Principles, problems and strategies and remedial actions.	3
9	Environmental impact assessment at regional level, sectoral level, and policy level.	3
10	Sustainable development; Environmental policy in planned, mixed and market economies	2
11	Preventive environmental management	2
12	.	
COURSE TOTAL <i>(14 times 'L')</i>		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL <i>(14 times 'P')</i>		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Canter, L. W. Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1997.
2. Judith, P. and Eduljee, G. Environmental Impact Assessment for Waste Treatment and Disposal Facilities, John Wiley & Sons, 1994.
3. Burke, G., Singh, B.R., and Theodore, L. Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2000.

4. Eccleston, C.H.Environment Impact Statements: A Comprehensive Guide to Project and Strategic Planning, John Wiley & Sons, 2000.
5. Welford,R. Corporate Environmental Management - Systems and Strategies, Universities Press, 1996.
6. Whitelaw,K. and Butterworth, ISO 14001: Environmental System Handbook, 1997.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	Yes

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	10
20.2	Open-ended problems	20
20.3	Project-type activity	30
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	ENVIRONMENTAL IMPLICATIONS OF ENGINEERED NANOMATERIALS
3.	L-T-P structure	2-0-0
4.	Credits	2
5.	Course number	XXX
6.	Status (<i>category for program</i>)	PROGRAMME ELECTIVE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	No

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. M. Khare, Prof. A.K. Mittal, Dr. G. Habib, Dr. Arun Kumar	
12.	Will the course require any visiting faculty?	Yes

13.	Course objective (<i>about 50 words</i>): 1. To introduce concepts of environmental implications of engineered nanomaterials 2. To provide a systematic approach to estimate effects on ecosystems and human health.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Engineered nanomaterials, Occurrence of nanomaterials in environment, Fate of nanomaterials in environment, Exposure pathways-model development and parameter estimation, Dose-response effects of nanomaterials to humans and aquatic species; dose-response modeling and risk estimation of nanomaterials exposures; Risk management of nanomaterials pollution; Prioritization of nanomaterials for monitoring; Regulatory guidelines for implications assessment and pollution regulations; Emerging challenges for long-term management of nanomaterials exposure	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Engineered nanomaterials	1
2	Occurrence of nanomaterials in environment	2
3	Fate of nanomaterials in environment,	2
4	Exposure pathways-model development and parameter estimation	5
5	Toxic effects of nanomaterials to humans and aquatic species; dose-response modeling	5
6	Dose-response modeling and risk estimation of toxic effects of nanomaterials to humans and aquatic species	5
7	Management of nanomaterials pollution; Prioritization of nanomaterials for monitoring; Reduction at source, etc. methods	4
8	Regulatory guidelines for implications assessment and pollution regulations	4
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Valsami-Jones, E. and Lead, J.R. *Frontiers of Nanoscience*. Elsevier, 2014

Bowman, D. and Hull, W.A. *Nanotechnology Environmental Health and Safety* (Second Edition), Applied Science Publishers. 2014

Njughuna, J., Zhu, H. and Pielichowski, K. *Health and Environmental Safety of Nanomaterials*, Woodhead Publishing, 2014

Kammen, D.M. and Hassenzahal, D.M. (1999). *Should we risk it?: Exploring environmental, health, and technological problem solving*. Princeton University Press

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	yes

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	5
20.2	Open-ended problems	20
20.3	Project-type activity	20
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	ADVANCED WATER AND WASTEWATER LABORATORY
3.	L-T-P structure	1-0-4
4.	Credits	3
5.	Course number	XX
6.	Status (<i>category for program</i>)	PROGRAMME Elective

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEP790

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. M.Khare, Prof. B.J. Alappat, Prof. A.K. Mittal, Prof. A.K. Nema, Dr. G. Habib, Dr. Arun Kumar	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To train students in conducting batch and column studies for studying fate and transport of water contaminants, their associated uptake in bacteria 2. To teach determination of process parameters and conduct model studies.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Principles of instrumentation and application for water quality parameters measurements, Operation of batch scale models for various processes: Activated sludge process, Disinfection, Settlers, Coagulation, Filtration, Anaerobic digestion, Adsorption. Design and operation of treatability studies and microbial growth kinetics, microbial toxicity and bioaccumulation studies. Micropollutants detection; Package programmes for water and wastewater conveyance, treatment and disposal.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Principles of instrumentation and application for water quality parameters measurements; micropollutants detection and issues	3
2	Operation of batch scale models for various processes: Activated sludge process, Disinfection, Settlers, Coagulation, Filtration, Anaerobic digestion, Adsorption	5
3	Design and operation of treatability studies	2
4	Microbial growth kinetics, microbial toxicity and bioaccumulation studies	2
5	Modeling softwares for design of treatment systems	2
6		
7		
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		14

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Carbon and nitrogen -based BOD curve and parameter determination	4
2	Sedimentation studies	4
3	Coagulation-flocculation studies-dosage requirements	8
4	Adsorption studies-kinetics, isotherm and column studies	8
5	Filtration studies-removal and headloss determination	4
6	Disinfection studies	8
7	Bacterial growth parameters determination	8
8	Assessment of toxicity (bacteria)	4
9	Bioaccumulation studies (bacteria)	4
10	Estimation of micropollutants	4
COURSE TOTAL (14 times 'P')		56

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Sawyer, C.N., McCarty, P.L. and Parkin, G.F. (2002). Chemistry for Environmental Engineering and Science. 5th edition, McGraw-Hill Publishing Company.

Pelczar, M.J., Michael, Chan, E.C.S., and Krieg, N.R. (2001). Microbiology. The McGraw-Hill Companies, Inc. 5th edition.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Nil
19.2	Hardware	Nil

19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	yes (Environmental engineering laboratory)
19.5	Equipment	yes (Environmental engineering equipments)
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	yes

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	Nil
20.2	Open-ended problems	5
20.3	Project-type activity	10
20.4	Open-ended laboratory work	70
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	EMERGING TECHNOLOGIES FOR ENVIRONMENTAL MANAGEMENT
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	CVL ***
6.	Status (<i>category for program</i>)	PROGRAMME ELECTIVE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEL889

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. M. Khare, Prof. A.K. Mittal, Prof. A.K. Nema, Prof. B.J. Alappat, Dr. G. Habib, Dr. Arun Kumar	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To introduce the contemporary environmental issues and the scientific - technical advancements in analysing 2. To teach methods to address environmental issues and provide solutions	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Contemporary micro and macro environmental issues of importance, global environmental and resource sharing issues, international treaties and protocols. Emerging contaminants and emerging technologies for waste management, Case studies of environmental pollution and innovative management strategies. Environmental technology transfer, Non-conventional Energy, Emission trading, Adaptation to climate change.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Micro and macro environmental issues	3
2	Global environmental issues	6
3	International treaties and protocols	4
4	Emerging contaminants and its management	4
5	Adaptation to Climate change and technology transfer	2
6	Case studies on waste management	6
7	Carbon sequestration and emission trading	2
8	Non-conventional Energy	5
9	Advanced technologies for environmental monitoring and analysis	4
10	Advanced environmental technologies	6
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Under standing Carbon Credits, Gurmit Singh, Aditya Books, New Delhi, 2009.
2. Mishra, K.B.Clean Production: Environmental and Economic Perspective, Springer, 1996.
3. Asolekar, S.R. and Gopichandra, R. Preventive Environmental Management, S R Asolekar and R. Gopichandra, Center for Environmental education, Ahmedabad, 2005.
4. Sukhatme, S.P.Solar Energy, Tata-McGraw Hill, New Delhi, 1996.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil

19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	Yes

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	10
20.2	Open-ended problems	20
20.3	Project-type activity	30
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	40 (self study, etc.)

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	FUNDAMENTAL OF AEROSOL : HEALTH AND CLIMATE CHANGE
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	CEVXXX
6.	Status (<i>category for program</i>)	PE

7.	Pre-requisites (course no./title)	No
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supersedes any existing course	CEL887

9.	Not allowed for (indicate program names)	-
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Dr. Gazala Habib and Dr. M. Khare	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To teach formation and dynamic behaviour of aerosol in atmosphere 2. To learn role of aerosol in public health and climate change. 3. To learn the application of synthetic aerosol in industries.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): This course will introduce the students with fundamentals of aerosols, Difference in gas and partical motion in the air, physio-chemical and optical properties of individual and mixed particles, behaviour of non-spherical paricles, thermodynamic properties of aerosol, particle formation, application of aerosol fundamentals and properties in research and industries, impact of aerosol properties on indoor/outdoor air quality, health and climate.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction of Aerosol	2
2	Gas and Particle Motion: Straight line acceleration and curvilinear aerosol motion Application of Newtons and Stock-Navier Equation in aerosol motion	6
3	Fundamentals of receptor modelling	4
4	Mass, Size and number statistics of aerosol	4
5	Forces on aerosol and behaviour of non spherical particle	3
6	Nucleation, coagulation, condensation and evaporation of aerosol and its characteristics	3
7	Electrical and chemical and optical properties of aerosol and its applications	4
8	Bioaerosol, atmospheric aerosol and Respiratory Deposition	3
9	Case studies-Aerosol properties and health implications	3
10	Case studies- Aerosol Properties and impact on local air quality	3
11	Case studies- Aerosol, regional and global climate change	3
12	Production of test aerosol, manufacturing of materials by Aerosol Processes, Radioactive Aerosols, Radon and Its Short-Lived Decay Product Aerosols, Pharmaceutical and Diagnostic Aerosols	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

None

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Hinds W. C. Aerosol Technology: Properties, Behaviour, and measurement of airborne particles, 2nd edition, Wiley-Interscience Publication, New York, USA, 1998.

Friedlander S. K. Smoke, Dust and Haze: Fundamentals of Aerosol Dynamics, 2nd edition, Oxford University press, New York, USA, 2000.

Aerosol measurement: Principles, Techniques, and applications, 2nd edition, Wiley-Interscience Publication, New York, USA, 2005.

Clinics in Occupational and Environmental Medicine, Ed. Scott D. Phillip and Gary R. Kroeger, Vol 4. No. 4, 2004, Elsevier

Seinfeld, J. H. and Pandis, S. N., Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 2nd Edition, Wiley-Interscience, 2006
 Integrated Air Quality Management Asian Case Studies, Edited by N. T. K. Oanh, CRC Press, Taylor and Francis Group, FL, USA, 2013.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	available
19.2	Hardware	available
19.3	Teaching aides (videos, etc.)	y
19.4	Laboratory	available
19.5	Equipment	Not Required
19.6	Classroom infrastructure	y
19.7	Site visits	Not Required

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	30%
20.2	Open-ended problems	30%
20.3	Project-type activity	20%
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	20% (Independent-outside the class)

Date: 12.03.2015

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	ENVIRONMENTAL STATISTICS AND EXPERIMENTAL DESIGN
3.	L-T-P structure	2-0-2
4.	Credits	3
5.	Course number	CEVxxx
6.	Status (<i>category for program</i>)	PE

7.	Pre-requisites (course no./title)	No
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	None

9.	Not allowed for (indicate program names)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Dr. Gazala Habib, Dr. Arun Kumar, Prof. M. Khare, Prof. A. K. Nema, Prof. A. K. Mittal, Prof. B. J. Alappat	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To learn statistical methods for environmental data analysis, and experiment design and its application environmental data from case studies.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): introduction on environmental data, environmental statistics estimation (concentration, frequency of detection, minimum detection limit, sample size), frequency and probability distributions, inferences concerning mean and variance, confidence Interval estimation, hypotheses test, ANOVA, regression, goodness of fit, factorial experimentation, exceedance factor, intervention model, Case studies	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to Environmental data; introduction to basic statistics, mean, geomean, standard deviation	3
2	frequency distribution	2
3	Probability distribution: Random variables, normal and log-normal distributions, Binomial distribution, Mean and variance of probability distribution, Poisson approximation to the binomial distribution	4
4	inferences concerning mean and variance, interval estimation, ANOVA	3
5	hypothesis testing	3
6	linear and non-linear regression, goodness of fit	3
7	factorial experimentation	4
8	exceedance factor, intervention models	2
9	Published case studies on application of statistics and experimental design in environmental data analysis	4
10		
11		
12		
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

None

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Introduction to SPSS	4
2	Introduction to R	4
3	Model parameter and examples in SPSS and R	2
4	Air quality data analysis using SPSS or R	6
5	Water quality data analysis using SPSS or R	6
6	Solid waste data analysis using SPSS and R	6
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Johnson, R. A., Probability and statistics for engineers, 8th edition, Pearson Education, Inc., NJ, USA, 2011.

Ott, W. R., Environmental Statistics and Data Analysis, CRC Press, 1994

Reimann, C., Filzmoser, P., Garrett, R., Dutter, R., Statistical Data Analysis Explained: Applied Environmental Statistics with R, John Wiley & Sons, 2011

Joseph, A. J., Health, Safety, and Environmental Data Analysis: A Business Approach, • CRC Press, 1997.

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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	available (SPSS, R-project)
19.2	Hardware	available
19.3	Teaching aides (videos, etc.)	y
19.4	Laboratory	Not Required
19.5	Equipment	Computers available
19.6	Classroom infrastructure	y
19.7	Site visits	Not Required

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	Nil
20.2	Open-ended problems	40%
20.3	Project-type activity	40%
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	20% (Outside class)

Date: 12.03.2015

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	ADVANCED AIR POLLUTION LABORATORY
3.	L-T-P structure	1-0-4
4.	Credits	3
5.	Course number	CEPXXX
6.	Status (<i>category for program</i>)	CORE

7.	Pre-requisites (<i>course no./title</i>)	CEL783, CEL887
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	No

9.	Not allowed for (<i>indicate program names</i>)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. M. Khare, Dr. Gazala Habib	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To teach advance techniques of determination of air pullutants. 2. To enhance understanding on role of measured parameters in local air quality, health and climate assessment.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Monitoring of TSP using HVS, Monitoring of PM2.5 using cyclone based sampler, Size sagregated particle collection and data analysis using histogram, inversion program, Personal exposure assessement, determination of count and geometric mean diameter, determination of chemical species in air samples, Determination of emission factors of particle and gases for combustion sources, Determination of TVOC; Determination of indoor air quality paprameters, determination of Bioaerosol; Monitoring and analysis of meteorological paprameters,	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Experiment Design for gaseous pollutant	1
2	Principle of gaseous pollutant measurement	1
3	Aerosol Mass measurement techniques	2
4	Aerosol Number measurement techniques	2
5	Advances in aerosol instrumentation and weather monitoring	2
6	Chemical analysis: Instrumentation and data analysis	6
7		
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		14

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Monitoring of TSP using HVS	4
2	Monitoring of PM _{2.5} using cyclone based sampler	8
3	Size segregated particle collection with mini MOUDI (56 nm to 10 micrometer) and data analysis using histogram, inversion program	4
4	Personal exposure assessment and link with indoor air quality parameters	4
5	Determination of count and geometric mean diameter using optical particle counter and Scanning mobility particle sizer (10 nm-20 micrometer)	4
6	Determination of chemical species ions, trace elements, total organic carbon, water soluble organic carbon, polycyclic aromatic hydrocarbon using (IC, AAS, HPLC, GC, TOC) in air samples,	12
7	Determination of emission factors of particle and gases for combustion sources,	4
8	Determination of TVOC and bioaerosol;	8
9	Monitoring and analysis of meteorological parameters	4
10	Receptor Modelling for source identification and quantification	4
COURSE TOTAL (14 times 'P')		56

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Hinds W. C. Aerosol Technology: Properties, Behaviour, and measurement of airborne particles, 2nd edition, Wiley-Interscience Publication, New York, USA, 1998.

Aerosol measurement: Principles, Techniques, and applications, 2nd edition, Wiley-Interscience Publication, New York, USA, 2005.

Methods for determination of indoor air pollutants, William T Winberry, Jr. et.al. Noyes Data Corporation, New Jersey, USA, 1992

Introduction to Environmental Analysis, Roger Reeve, Wiley, 2002

Sampling and Calibration for Atmospheric Measurements, John K Taylor, ASTM, 1987
 Air Pollution: Measurement, Modelling and Mitigation, Third Edition, Jeremy Colls, Abhishek Tiwary, 2010, Routledge, NY, USA

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	Available
19.2	Hardware	Available
19.3	Teaching aides (videos, etc.)	Available
19.4	Laboratory	Available
19.5	Equipment	Available
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	No

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	Nil
20.2	Open-ended problems	Nil
20.3	Project-type activity	20%
20.4	Open-ended laboratory work	80%
20.5	Others (please specify)	Nil

Date: 12.03.2015

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	ENVIRONMENTAL RISK ASSESSMENT
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	XXXXXX
6.	Status (<i>category for program</i>)	PROGRAMME ELECTIVE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEL 899

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Dr. Arun Kumar; Prof. A.K.Nema	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To introduce concepts of environmental risk assessment 2. To teach mathematical approaches to quantify different risk assessment components.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Basic concepts of environmental risk and definitions; Human health risk and ecological risk assessment framework; Hazard identification procedures and hazard prioritization; Environmental risk zonation; Consequence analysis and modelling (discharge models, dispersion models, fire and explosion models, effect models etc). Estimation of incident frequencies from historical data, frequency modelling techniques e.g., Fault tree analysis (FTA) and Event tree analysis (ETA), Reliability block diagram. Human factors in risk analysis; Risk management & communication. Rules, regulations and conventions.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Basic concepts of environmental risk and definitions	1
2	Human health risk assessment framework;	6
3	Ecological risk assessment framework	6
4	Hazard identification procedures and hazard prioritization	3
5	Environmental risk zonation	2
6	Consequence analysis and modelling-introduction	1
7	Consequence modelling(discharge models, dispersion models, fire and explosion models, effect models etc)	8
8	Estimation of incident frequencies from historical data, frequency modelling techniques-introduction	3
9	Fault tree analysis (ETA).	2
10	Event tree analysis (ETA).	2
11	Reliability block diagram	2
12	Risk management, communication; Rules, regulations and conventions	6
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Devore, J.L. Probability and Statistics for Engineering and the Science. Latest edition, Thomson Learning Inc.

Kammen, D.M. and Hassenzahal, D.M. Should we risk it?: Exploring environmental, health, and technological problem solving. Latest edition, Princeton University Press

DeGroot, M.H. and Schervish, M.J. Probability and Statistics. Latest edition, Addison-Wesley.

Johnston, J. and DiNardo, J. Econometric methods. Latest edition, The McGraw-Hill Companies, Inc.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	Nil

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	Nil
20.2	Open-ended problems	15
20.3	Project-type activity	20
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	30% (self study, etc.)

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	INDUSTRIAL WASTE MANAGEMENT AND AUDIT
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	* * *
6.	Status (<i>category for program</i>)	PROGRAMME ELECTIVE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	CVL 312 (<15% overlap)
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEL 879

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. A. K. Mittal, Prof. B. J. Alappat, Prof. A.K. Nema, Prof. M. Khare, Dr. G Habib, Dr. Arun Kumar	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To introduce the fundamentals of industrial pollution 2. To teach methods to assess and reduce pollution in various industries.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Industrial Wastes: Nature and characteristics, Prevention and Control, Tools for clean processes: reuse, recycle, recovery, source reduction, raw material substitution, process modification, Flow sheet analysis, Energy and resources audit, Waste audit, emission inventory and waste management hierarchy for process industries, Zero discharge, Environmental indicators, Industrial ecology and ecoparks, rules and regulations, Case studies: Dairy, Fertilizer, Distillery, Pulp and Paper, Iron and steel, Metal plating, Refineries, Thermal power plants, etc.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Industrial wastes: nature and characterisation	4
2	Tools for clean processes	3
3	Raw material substitution and process modifications	5
4	Energy and resources audit	4
5	Waste audit and emission inventory	4
6	Zero discharge	4
7	Environmental indicators and industrial ecology	4
8	Rules and regulations	4
9	Industrial pollution case studies-Air and water	6
10	Industrial pollution case studies-Solid waste	4
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Nemerow, N.L. Industrial water pollution: Origin, characteristics and treatment, R.E. Kreiger Pub. Co., 1987.
2. Freeman, H. Industrial pollution prevention handbook, McGraw Hill, 1994.
3. Pain, A.K. and Hazra, S. Industrial Ecology: concepts and practices, ICFAI University Press, 2008.
4. Eckenfelder Jr., W. Industrial water pollution control, McGraw Hill, 1999.
5. Shen, T.T. Industrial pollution prevention, Springer, 1999.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Nil
19.2	Hardware	Nil

19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	Yes

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	20
20.2	Open-ended problems	20
20.3	Project-type activity	30
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	30 (self study, etc.)

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	LIFE CYCLE ANALYSIS AND DESIGN FOR ENVIRONMENT
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	* * *
6.	Status (<i>category for program</i>)	PROGRAMME ELECTIVE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEL 898

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. A.K. Nema, Prof A.K. Mittal, Prof. B.J. Alappat; Prof M. Khare; Dr Gazala Habib; Dr Arun Kumar	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1.To inculcate the basic principles of life cycle based design of projects, products and services. 2. To expose students to various qualitative and quantitative methods LCA.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Engineering products and processes : Environmental health and safety, Product life cycle stages, Material toxicity, pollution, and degradation, Environmentally conscious design and manufacturing approaches, Sustainable development and industrial ecology. System life-cycles from cradle to reincarnation, Product life-extension, Organizational issues. Pollution prevention practices, Manufacturing process selection and trade-offs. Design for Environment : Motivation, concerns, definitions, examples, guidelines, methods, and tools. Recyclability assessments, Design for recycling practices. Re- manufacturability assessments, Design for Remanufacture / Reuse	
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	practices. Industrial ecology and Eco-industrial parks. Eco-Labels and Life-Cycle analysis (LCA) : LCA methodology, steps, tools and problems, Life-Cycle Accounting and Costing. ISO 14000 Environmental Management Standards. New business paradigms and associated design practices.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to environmental health and safety issues associated with various stages of the engineering products and processes	3
2	Material toxicity, pollution, and environmental degradation indicators	4
3	Environmentally conscious design and manufacturing approaches,	3
4	System life-cycles from cradle to grave to reincarnation	3
5	ISO 14000 Environmental Management Standards	2
6	Life-Cycle analysis (LCA) : LCA methodology, steps, tools and problems, Life-Cycle Accounting and Costing.	5
7	Concepts of industrial ecology	4
8	Eco-industrial parks. Case studies	6
9	Product life-extension, Pollution prevention practices, Manufacturing process selection and trade-offs.	2
10	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.	6
11	Eco-Labels	2
12	New business paradigms and associated design practices	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Mary Ann Curran, Environmental Life-cycle Assessment, McGraw-Hill Inc. (1996)
2. Bakshi, B. R., Gutowski, T. G., and Sekulic, D. P., Thermodynamics and the Destruction of Resources, Cambridge University Press, Cambridge, UK, 2011.
3. Allwood, J. M., and Cullen, J. M., Sustainable Materials – With Both Eyes Open, UIT Cambridge Ltd., UK, 2012.
4. Ashby, M. F., Materials and the Environment, Second ed. Butterworth-Heinemann, London, 2013.
5. Gutowski, T. G., Sahni, S., Allwood, J., Ashby, M., Worrell, E., The Energy Required to

Produce Materials: Constraints on Energy Intensity Improvements, Parameters of Demand, Phil. Trans. R. Soc. A. 371, 2013.

6. Hendricson, C. T., Lave, L. B., and Matthews, H. S., Environmental Assessment of Goods and Services; An Input-Output Approach, Resources for the Future, 2006.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	Yes

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	20
20.2	Open-ended problems	20
20.3	Project-type activity	20
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	WATER DISTRIBUTION AND SEWERAGE NETWORK DESIGN
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	* * *
6.	Status (<i>category for program</i>)	PROGRAMME ELECTIVE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	No

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. A.K. Nema, Prof A.K. Mittal, Prof. B.J. Alappat; Prof M. Khare; Dr Gazala Habib; Dr Arun Kumar	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): 1.To teach principles of planning to students 2.To teach students fundamentals and guidelines for designing of water distribution systems and wastewater conveyance systems.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Planning for water supply sources and demand assessment. Water demand forecasting. Types of water distribution systems. Intermittent and continuous water supply systems. Design and analysis of Water mains. Design and analysis of water distribution system. Analysis of water deficient systems. Optimal design of water distribution systems. On-line monitoring of water quality parameters. Retrofitting of the existing water supply systems. Planning for wastewater conveyance system in urban areas. Combined and separate systems for storm and sewage. Design and analysis of wastewater conveyance system. Optimal design of wastewater conveyance systems.	
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	Operation and maintenace issues. Retrofitting of the sewerage system.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Planning for water supply sources and demand assessment.	2
2	Water demand forecasting.	4
3	Types of water distribution systems.	3
4	Intermittent and continuous water supply systems.	4
5	Design and analysis of Water mains. Design and analysis of water distribution system. Analysis of water deficient systems.	7
6	Optimal design of water distribution systems. On-line monitoring of water quality parameters. Retrofitting of the existing water supply systems	4
7	Planning for wastewater conveyance system in urban areas	3
8	Combined and separate systems for storm and sewage.	3
9	Design and analysis of wastewater conveyance system.	4
10	Optimal design of wastewater conveyance systems.	4
11	Operation and maintenance issues.	2
12	Retrofitting of the sewerage system.	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Pramod R. Bhawe 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.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	Yes

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	30
20.2	Open-ended problems	20
20.3	Project-type activity	20
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	THERMAL TECHNIQUES FOR WASTE MANAGEMENT
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	CVL ***
6.	Status (<i>category for program</i>)	PROGRAMME ELECTIVE

7.	Pre-requisites (<i>course no./title</i>)	Nil
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEL891

9.	Not allowed for (<i>indicate program names</i>)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. B.J. Alappat, Dr. G. Habib	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): 1. To teach concepts and fundamentals of thermal techniques for wastes treatment 2. To teach and train students in designing of treatment facilities.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Fundamentals of Thermodynamics, Heat Transfer and Combustion as applied to Waste Incineration. Introduction to fuels, reactor design, fluidization engineering and furnace technology. Combustion of gaseous, liquid and solid fuels. Wastes as fuels. Low, medium and high temperature thermal treatment techniques, Energy recovery, pollution control techniques for thermal facilities, Design of thermal treatment facilities with pollution control devices.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Fundamentals of thermodynamics	2
2	Fundamentals of Heat Transfer	3
3	Fundamentals of Combustion Engineering	3
4	Fundamentals of fluidization engineering	4
5	Fuels and thermal characteristics	4
6	Waste as Fuel	3
7	Combustion of gaseous, liquid and solid fuels and wastes	3
8	Stoichiometric principles	3
9	Thermal treatment techniques	3
10	Incineration technique	6
11	design of Incineration facilities	6
12	Energy recovery and economics	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Neissen, W.R. Combustion and Incineration Processes, CRC Press, 2010.
2. Rubel, F.N. Incineration of Solid wastes, Noyes Data Corporation, 1979.
3. Tillman, D.A., Rossi, A.J., and Vick, K.M. Incineration of Municipal and Hazardous Solid wastes, Academic Press Inc., 1989.
4. Tchobanglous, G., Theissen, G. and Vigil, S. Integrated Solid Waste Management, McGraw Hill International Editions, 1993
5. Calvin R. Brunner, Handbook of Incineration Systems, McGraw Hill, Inc., 1991.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	Yes

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	30
20.2	Open-ended problems	20
20.3	Project-type activity	30
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	20 (self study, etc.)

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	QUANTITATIVE MICROBIAL RISK ASSESSMENT
3.	L-T-P structure	1-0-0
4.	Credits	1
5.	Course number	XXX
6.	Status (<i>category for program</i>)	PROGRAMME ELECTIVE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	No

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. M. Khare, Prof. A.K. Mittal, Prof. A.K. Nema, Dr. G. Habib, Dr. Arun Kumar	
12.	Will the course require any visiting faculty?	Yes

13.	Course objective (<i>about 50 words</i>): 1. To teach concepts of microbial risk assessment 2. To teach a systematic approach for estimating risk of microbial infection.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Pathogens, Occurrence and fate in environment, Human exposure pathways, Microbial exposure dose estimation, Infection and dose-response modeling, Risk of infection estimation, Uncertainty estimation	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Pathogens	1
2	Occurrence and fate in environment	2
3	Human exposure pathways	1
4	Microbial exposure dose estimation	1
5	Infection and dose-response effects	2
6	Dose-response modeling	2
7	Risk of infection estimation	2
8	First order uncertainty analysis	1
9	Monte Carlo uncertainty analysis	2
10		
11		
12		
COURSE TOTAL (14 times 'L')		14

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Text

Haas, C.N., Rose, J.B. and Gerba, C.P. Quantitative Microbial Risk Assessment, Latest edition, John Wiley & Sons, Inc.,

DeGroot, M.H. and Schervish, M.J. Probability and Statistics. Third edition. Addison-Wesley.

References

Kammen, D.M. and Hassenzahal, D.M. Should we risk it?: Exploring environmental, health, and technological problem solving. Latest Edition, Princeton University Press

Johnston, J. and DiNardo, J. Econometric methods. Latest edition. The McGraw-Hill Companies, Inc.

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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	Nil

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	Nil
20.2	Open-ended problems	20
20.3	Project-type activity	30
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	self study (50%)

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Civil Engineering
2.	Course Title (<i>< 45 characters</i>)	ENVIRONMENTAL QUALITY MODELING
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	CELXXX
6.	Status (<i>category for program</i>)	PROGRAMME ELECTIVE

7.	Pre-requisites (course no./title)	NA
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	CEL892

9.	Not allowed for (indicate program names)	N.A.
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. M. Khare, Prof. A. K. Nema, Dr. Gazala Habib, Dr. Arun Kumar	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To deliver various mathematical modeling approach/ techniques in ambient air/water environment.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Plume Rise Models; Introduction to Air Quality Modelling; Turbulence fundamentals; Basic diffusion equation; Fick's law; deterministic; numerical and statistical modeling approach; Fundamentals of Receptor modelling; Dispersion and receptor models; Fundamentals of Indoor air quality modelling techniques; Fundamentals of Water quality modeling: surface water and ground water models; Fate and transport of Conservative and non-conservative pollutants. Modelling as a tool for strategising pollution prevention and control.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to Environmental Quality Modelling- Approaches to model formulation; Systems and control volume	4
2	Model classification; criteria for model selection	2
3	Turbulence fundamentals	3
4	Basic diffusion equation, Fick's law, deterministic, numerical and statistical modeling approach.	6
5	Fundamentals of Receptor modelling	2
6	Plume Rise Models	6
7	Dispersion and receptor models- AERMOD; ADMS-Urban; CALINE4; CALPUFF; CMAQ; CMB; PMF	8
8	Fundamentals of Indoor air quality modelling techniques- Mass balance model	2
9	Fundamentals of Water quality Modeling- Basic water quality modeling equation; Dilution equation; Decay equations	4
10	Fate and transport of conservative and non-conservative water pollutants.	3
11	Modelling as a tool for strategising pollution prevention and control.	2
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Chapra, S.C. Surface Water Quality Modelling. McGraw-Hill, 1997.

2. Schnoor, Jerald L., Environmental Modelling: Fate and Transport of Pollutants in Water,

Air and Soil. John Wiley, NY, 1996.

- 3 Wainright, J., and Mulligan, M., Environmental Modelling, Wiley publication, 2004.
- 4 Hadlock, C.R. Mathematical Modelling in the Environment. The Mathematical Association of America, 1998.
- 5 Vallero, D.A. Environmental Contaminants Assessment and Control. Academic Press, Elsevier, 2004.
6. Lyons T. J., and Scott W. D. Principles of air-pollution meteorology, CBS Publishers & Distributors, 2001
7. Wadden, R.A., Scheff, P.A., Indoor Air Pollution: Characterization, Prediction, Control. Wiley, New York, 1983

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD Projector
19.7	Site visits	Nil

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	Nil
20.2	Open-ended problems	50%
20.3	Project-type activity	30%
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	20%

Date: 12.03.2015

(Signature of the Head of the Department)

MAJOR PROJECT TEMPLATE

1.	Department/Centre proposing the course	CIVIL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	MAJOR PROJECT I (CEV)
3.	L-T-P structure	0-0-12
4.	Credits	6
5.	Course number	CVXXX
6.	Status (<i>category for program</i>)	PROGRAMME CORE

7.	Pre-requisites (course no./title)	24 Course Credits
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8.	Supersedes any existing course	NIL
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9.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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10.	FACULTY WHO WILL SUPERVISE PROJECT STUDY ALL ENVIRONMENTAL Engineering FACULTY	
11.	Will the PROJECT SUPERVISION require any visiting faculty?	YES

12.	PROJECT objective (<i>about 50 words</i>): (1) TO INITIATE STUDENTS INTO RESEARCH ON WELL DEFINED OR OPEN ENDED PROBLEMS (2) TO FOSTER/PROMOTE UNDERSTANDING OF IDENTIFIED PROBLEM DOMAINS BASED ON LABORATORY AND/OR NUMERICAL MODELLING BASED APPROACHES (3) TO DEVELOP UNDERSTANDING OF SPECIFIC CONTEXTUAL ENVIRONMENTAL ENGINEERING AND MANAGEMENT PROCESSES	
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13. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	SPECIFIC TO THE PROBLEM TAKEN UP FOR THE STUDY	OPEN

14. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

RELEVANT, CONTEXTUAL RESEARCH ARTICLES, REPORTS AND BOOKS

15. Resources required for the STUDY *(itemized & student access requirements, if any)*

19.1	Software	YES
19.2	Hardware	YES
19.3	PRESENTATION aides (videos, etc.)	YES
19.4	Laboratory	YES
19.5	Equipment	YES
19.6	Classroom infrastructure	NO
19.7	Site visits	MAY BE REQUIRED AS PART OF THE STUDY

Date:

(Signature of the Head of the Department)

MAJOR PROJECT TEMPLATE

1.	Department/Centre proposing the course	CIVIL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	MAJOR PROJECT II (CEV)
3.	L-T-P structure	0-0-24
4.	Credits	12
5.	Course number	CVXXX
6.	Status (<i>category for program</i>)	PROGRAMME CORE

7.	Pre-requisites (course no./title)	MAJOR PROJECT PART 1
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8.	Supersedes any existing course	NIL
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9.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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10.	FACULTY WHO WILL SUPERVISE PROJECT STUDY ALL ENVIRONMENTAL ENGINEERING FACULTY	
11.	Will the PROJECT SUPERVISION require any visiting faculty?	YES

12.	PROJECT objective (<i>about 50 words</i>): (1) TO INITIATE STUDENTS INTO RESEARCH ON WELL DEFINED OR OPEN ENDED PROBLEMS (2) TO FOSTER/PROMOTE UNDERSTANDING OF IDENTIFIED PROBLEM DOMAINS BASED ON LABORATORY AND/OR NUMERICAL MODELLING BASED APPROACHES (3) TO DEVELOP UNDERSTANDING OF SPECIFIC CONTEXTUAL ENVIRONMENTAL ENGINEERING AND MANAGEMENT PROCESSES	
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13. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	SPECIFIC TO THE PROBLEM TAKEN UP FOR THE STUDY	OPEN

14. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

RELEVANT, CONTEXTUAL RESEARCH ARTICLES, REPORTS AND BOOKS

15. Resources required for the STUDY (*itemized & student access requirements, if any*)

19.1	Software	YES
19.2	Hardware	YES
19.3	PRESENTATION aides (videos, etc.)	YES
19.4	Laboratory	YES
19.5	Equipment	YES
19.6	Classroom infrastructure	NO
19.7	Site visits	MAY BE REQUIRED AS PART OF THE STUDY

Date:

(Signature of the Head of the Department)

MINOR PROJECT TEMPLATE

1.	Department/Centre proposing the course	CIVIL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	MINOR PROJECT
3.	L-T-P structure	0-0-6
4.	Credits	3
5.	Course number	CVXXX
6.	Status (<i>category for program</i>)	PROGRAMME ELECTIVE

7.	Pre-requisites (course no./title)	NONE
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8.	Supersedes any existing course	NONE
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9.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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10.	FACULTY WHO WILL SUPERVISE PROJECT STUDY ALL ENVIRONMENTAL ENGINEERING FACULTY	
11.	Will the PROJECT SUPERVISION require any visiting faculty?	NA

12.	PROJECT objective (<i>about 50 words</i>): (1) TO EXPLORE A PRESCRIBED PROBLEM BASED ON LABORATORY AND/OR NUMERICAL MODELLING BASED APPROACHES (2) TO EXPLORE DESIGN METHODOLOGIES IN THE AREA OF ENVIRONMENTAL ENGINEERING	
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13. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	SPECIFIC TO THE PROBLEM TAKEN UP FOR THE STUDY	OPEN

14. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

RELEVANT, CONTEXTUAL RESEARCH ARTICLES, REPORTS AND BOOKS

15. Resources required for the STUDY (*itemized & student access requirements, if any*)

19.1	Software	YES
19.2	Hardware	YES
19.3	PRESENTATION aides (videos, etc.)	YES
19.4	Laboratory	YES
19.5	Equipment	YES
19.6	Classroom infrastructure	NO
19.7	Site visits	MAY BE REQUIRED AS PART OF THE STUDY

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	CIVIL ENGINEERING	
2.	Course Title (<i>< 45 characters</i>)	INDEPENDENT STUDY	
3.	L-T-P structure	0-3-0	
4.	Credits	3	
5.	Course number		
6.	Status (<i>category for program</i>)	PC	
7.	Pre-requisites (course no./title)		
8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	NO	
9.	Not allowed for (indicate program names)	NIL	
10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
11.	Faculty who will teach the course ALL ENVIRONMENTAL ENGINEERING FACULTY		
12.	Will the course require any visiting faculty?	No	
13.	Course objective (<i>about 50 words</i>): TO STUDY AREAS THAT ARE NOT COVERED IN THE REGULAR COURSES OFFERED IN THE EXISTING CURRICULUM		
14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): SPECIFIC TO THE CONTEXT OF THE PROBLEM DECIDED BY THE SUPERVISOR		

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	SPECIFIC TO THE PROBLEM TAKEN UP FOR THE STUDY	OPEN
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

RELEVANT, CONTEXTUAL RESEARCH ARTICLES, REPORTS AND BOOKS

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	MAY BE REQUIRED
19.2	Hardware	MAY BE REQUIRED
19.3	Teaching aides (videos, etc.)	MAY BE REQUIRED
19.4	Laboratory	MAY BE REQUIRED
19.5	Equipment	MAY BE REQUIRED
19.6	Classroom infrastructure	NO
19.7	Site visits	MAY BE REQUIRED AS PART OF THE STUDY

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	90% self study & 10% of presentation

Date:

(Signature of the Head of the Department)