

Departmental UG Curriculum Implementation Committee
DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

Structure for BTech Degree in Civil Engineering

(i) Credits distribution **170** (155 + 15 non graded core)

1. Departmental credits	77
a. Core	63
b. Elective	14
2. Outside department credits	68
a. BS	22
b. EAS	18
c. HuSS	15
d. Programme linked	13
i. Civil Engg Materials	3 credits (3-0-0)
ii. Mechanics of Fluids	5 credits (3-1-2)
iii. Mechanics of Solids	5 credits (3-1-2)
3. Open category credits	10
4. Non-graded core requirement	15

(ii) Proposed slotting pattern for core + Elective + Programme Linked + Open Cat courses

III (25)	PLC1 (3-0-0)	DC1G (3-0-0)	DC5E (3-0-2)	PLC2 (3-1-2)	PLC3 (3-1-2)	HuSS1 (3-1-0)	Intro Dept, DCP1G
IV (23)	DC2S (3-0-0)	DC3G (3-0-0)	DC4W (3-1-0)	DC9T (3-0-0)	EnvSt (2-0-0)	HuSS2 (3-1-0)	DCP2S, DCP3G, DCP4W, DCP7T
V (22.5)	DC6S (2-0-0)	DC7G (3-1-0)	DC8W (3-0-2)	DC10S (3-0-0)	DC11S (3-0-0)	Biology (3-0-2)	DCP5S, DCP6G,
VI (21)	DC12S (3-0-0)	DC13S (2-0-0)	DC14W (3-0-2)	DC15E (3-0-2)	OC (3-0-0)	HuSS3 (3-1-0)	DCP8S (0-0-2)
VII (15.5)	DE1 (3-0-0/2-0-2)	DE2 (3-0-0/2-0-2)	DE3/OC (3-0-0/2-0-2)	DE4 (2-0-0)	DE5/OC (2-0-0)	HuSS4 (3-0-0)	DCP9S, DCP10 (0-0-8)
VIII (14)	DE6 (3-0-0/2-0-2)	DE7 (3-0-0/2-0-2)	DE8/OC (3-0-0/2-0-2)	DE9 (2-0-0)	DE10/OC (2-0-0)	OC (3-0-0/2)	DCP10, DCP11 (0-0-12)

(iii) List of core courses

SNo	Course type	Credits	Name of Course	Section
Lecture (with/without Lab) Courses				
1	PLC1	3 (3-0-0)	Civil Engg Materials	CED - Structural Engg
2	PLC2	5 (3-1-2)	Mechanics of Fluids	Outside Department (AM)
3	PLC3	5 (3-1-2)	Mechanics of Solids	Outside Department (AM)
4	DC1G	3 (3-0-0)	Engg Geology	Geotechnical Engg
5	DC2S	3 (3-0-0)	Structural Analysis I	Structural Engg
6	DC3G	3 (3-0-0)	Soil Mechanics	Geotechnical Engg
7	DC4W	4 (3-1-0)	Hydraulics	Water Resources Engg
8	DC5E	4 (3-0-2)	Elements of Surveying	Environmental Engg
9	DC6S	2 (2-0-0)	Construction Management	Structural Engg
10	DC7G	4 (3-1-0)	Geotechnical Engg	Geotechnical Engg
11	DC8W	4 (3-0-2)	Engineering Hydrology	Water Resources Engg
12	DC9T	3 (3-0-0)	Transportation Engg I	Transportation Engg
13	DC10S	3 (3-0-0)	Structural Analysis II	Structural Engg
14	DC11S	3 (3-0-0)	RC Design	Structural Engg
15	DC12S	3 (3-0-0)	Steel Design	Structural Engg
16	DC13S	2 (2-0-0)	Construction Practices	Structural Engg
17	DC14W	4 (3-0-2)	Design of Hydraulic Structures	Water Resources Engg
18	DC15E	4 (3-0-2)	Environmental Engg	Environmental Engg
Separate Lab/Project Courses				
1	DCP1G	1 (0-0-2)	Engineering Geology Lab	Geotechnical Engg
2	DCP2S	1 (0-0-2)	Structural Analysis Lab	Structural Engg
3	DCP3G	1 (0-0-2)	Soil Mechanics Lab	Geotechnical Engg
4	DCP4W	1 (0-0-2)	Hydraulics Lab	Water Resources Engg
5	DCP5S	1.5 (0-0-3)	Structures & Material (Concrete) Lab	Structural Engg
6	DCP6G	1 (0-0-2)	Geotechnical Engg Lab	Geotechnical Engg
7	DCP7T	1 (0-0-2)	Trans Engg Lab	Transportation Engg
8	DCP8S	1 (0-0-2)	Structures & Material (Steel) Lab	Structural Engg
9	DCP9S	1.5 (0-0-3)	Structural Design & Detailing	Structural Engg
10	DCP10	4 (0-0-8)	BTech Project Part 1	CED
11	DCP11	6 (0-0-12)	BTech Project Part 2	CED

Students opting for Specialisation only are allowed to register DCP10 (Project Part 1) in VII Semester as Core and rest students have to take DCP10 (Project Part1) in VIII Semester as core, also students doing Specialisation will register DCP11 (Project Part 2) in VIII Semester as Core.

(iv) Distribution of Core Credits among various Sections

SNo	Section	Core Credits
1	Structural Engineering	24 (21+3 PLC)
2	Geotechnical Engineering	13
3	Water Resources Engineering	13
4	Environmental Engineering	04
5	Transportation Engineering	04
6	Surveying	04
7	BTP (Project)	04
	Total Core Credits	66 (63+3 PLC)

Environmental Engg section has got 2 credits load as Institute Core (Environmental Studies) course.

(v) Proposed Slots for Electives – 14 credits

SNo	Course type	Credits	Slots in Semester
1	DE1, DE2, DE3	3 (3-0-0/2-0-2)	3 slots in VII Semester
2	DE4, DE5	2 (2-0-0)	2 slots in VII Semester
3	DE6, DE7, DE8	3 (3-0-0/2-0-2)	3 slots in VIII Semester
4	DE9, DE10	2 (2-0-0)	2 slots in VIII Semester

(vi) List of Elective courses

SNo	Name of Course	Credits	Section
DEE1	Industrial Waste Management	3-0-0	Environmental Engg
DEE2	Environmental Assessment Methodologies	3-0-0	Environmental Engg
DEE3	Air and Noise Pollution	3-0-0	Environmental Engg
DEE4	Solid & Hazardous Waste Management (PG)	3-0-0	Environmental Engg
DEE5	Environmental Risk Assessment (PG)	3-0-0	Environmental Engg
DEE6	Environmental Impact Assessment (PG)	3-0-0	Environmental Engg
DEE7	Life Cycle Analysis & Design for Environment (PG)	3-0-0	Environmental Engg
DEE8	Emerging Technologies for Environmental Management (PG)	3-0-0	Environmental Engg
DEE9	Thermal Technologies for Waste Management (PG)	3-0-0	Environmental Engg
DEE10	Design of Water & Waste Water Facilities (PG)	3-0-0	Environmental Engg
DEE11	Ecology & Eco-system Dynamics (PG)	3-0-0	Environmental Engg
DEE12	Environmental Systems Analysis (PG)	3-0-2	Environmental Engg
DEG1	Site Investigation & Ground Improvement	3-0-0	Geotechnical Engg
DEG2	Rock Engineering	3-0-0	Geotechnical Engg
DEG3	Design of Foundations & Retaining Structures	3-0-0	Geotechnical Engg
DEG4	Slopes and Earth Dams	2-0-0	Geotechnical Engg
DEG5	Geoenvironmental Engineering	3-0-0	Geotechnical Engg
DEG6	Underground Structures	2-0-0	Geotechnical Engg
DEG7	Geotechnical Design Studio	2-0-0	Geotechnical Engg
DEG8	Soil Dynamics	3-0-0	Geotechnical Engg
DEG9	FEM in Geotechnical Engineering	3-0-0	Geotechnical Engg
DES1	Structural Analysis III	3-0-0	Structural Engg
DES2	Prestressed Concrete & Industrial Structures	3-0-0	Structural Engg
DES3	Structural Design	3-0-0	Structural Engg
DES4	Construction Project Management	3-0-0	Structural Engg
DES5	Advanced Structural Analysis (PG)	3-0-0	Structural Engg
DES6	Design of Steel Structures (PG)	2-1-0	Structural Engg
DES7	Structural Dynamics (PG)	3-0-0	Structural Engg
DES8	Design of Concrete Structures (PG)	2-1-0	Structural Engg
DES9	Solid Mechanics in Structural Engineering (PG)	3-0-0	Structural Engg
DES10	Earthquake Analysis and Design (PG)	3-0-0	Structural Engg
DES11	Finite Element Method in Structural Engineering (PG)	2-1-0	Structural Engg
DES12	Design of Industrial Structures (PG)	2-1-0	Structural Engg
DES13	Advanced Design of Bridges (PG)	2-1-0	Structural Engg
DES14	Prestressed/Composite Structures (PG)	3-0-0	Structural Engg
DES15	Mathematical and Numerical Methods (PG)	2-1-0	Structural Engg
DES16	Civil Engineering Materials (PG)	3-0-0	Structural Engg
DES17	Structural Safety and Reliability (PG)	3-0-0	Structural Engg
DES18	Design of Plates and Shells (PG)	2-1-0	Structural Engg
DES19	Concrete Mechanics (PG)	3-0-0	Structural Engg

DES20	Stability Theory in Structural Engineering (PG)	3-0-0	Structural Engg
DES21	Design of Offshore Structures (PG)	2-1-0	Structural Engg
DES22	Advanced Finite Element Method and Programming (PG)	2-0-2	Structural Engg
DES23	Wind Resistant Design of Structures (PG)	3-0-0	Structural Engg
DES24	Design of Tall Buildings (PG)	2-1-0	Structural Engg
DES25	Structural Health Monitoring (PG)	2-0-2	Structural Engg
DES26	Construction and Contract Management (PG)	3-0-0	Structural Engg
DES27	Project Planning and Control (PG)	2-1-0	Structural Engg
DES28	Quantitative Methods in Construction Management (PG)	2-1-0	Structural Engg
DES29	Construction Engineering Practices (PG)	3-0-0	Structural Engg
DES30	Construction Methods and Equipment (PG)	3-0-0	Structural Engg
DES31	Construction Economics and Finance (PG)	3-0-0	Structural Engg
DES32	Systems Design and Value Analysis (PG)	3-0-0	Structural Engg
DES33	Recent Advances in Construction Materials (PG)	3-0-0	Structural Engg
DES34	Management of Quality and Safety in Construction (PG)	2-1-0	Structural Engg
DES35	Functional Planning, Building Services and Main. Man (PG)	3-0-0	Structural Engg
DES36	Building Science (PG)	3-0-0	Structural Engg
DES37	Infrastructure Development and Management (PG)	3-0-0	Structural Engg
DES38	Formwork for Concrete Structures (PG)	3-0-0	Structural Engg
DET1	Introduction to Intelligent Transportation Systems	3-0-0	Transportation Engg
DET2	Logistics and Freight Transport	3-0-0	Transportation Engg
DET3	Introduction to Railway Engineering	3-0-0	Transportation Engg
DET4	Urban and Regional Transportation Planning (PG)	2-0-2	Transportation Engg
DET5	Pavement Materials and Construction (PG)	2-0-2	Transportation Engg
DET6	Traffic Engineering (PG)	3-0-2	Transportation Engg
DET7	Design and Maintenance of Pavements (PG)	3-0-2	Transportation Engg
DET8	Advanced Transportation Modelling (PG)	2-0-2	Transportation Engg
DET9	Geometric Design of Streets and Highways (PG)	2-0-2	Transportation Engg
DET10	Public Transportation Systems (PG)	3-0-0	Transportation Engg
DET11	Transportation Economics and Finance (PG)	3-0-0	Transportation Engg
DET12	Transportation and Traffic Infrastructure Design (PG)	3-0-0	Transportation Engg
DET13	Airport Planning and Design (PG)	3-0-0	Transportation Engg
DET14	Transportation Infrastructure Management (PG)	3-0-0	Transportation Engg
DEW1	Water Resources Management	3-0-0	Water Resources Engg
DEW2	Groundwater	2-0-0	Water Resources Engg
DEW3	Water Power Engineering	2-0-2	Water Resources Engg
DEW4	Groundwater & Surface-water Pollution	2-0-0	Water Resources Engg
DEW5	Water Resources Systems	2-0-0	Water Resources Engg
DEW6	Computational Aspects in Water Resources	1-0-4	Water Resources Engg
DEW7	Urban Hydrology	2-0-0	Water Resources Engg
DEW8	River Mechanics	2-0-2	Water Resources Engg
DEW10	Geo-informatics	2-0-2	Water Resources Engg
DEW11	Fundamental to Geographic Information Systems	2-0-2	Water Resources Engg
DEW12	Fundamental to Remote Sensing	2-0-2	Water Resources Engg
DEW13	Frequency Analysis in Hydrology	2-0-0	Water Resources Engg
DEW9	Mechanics of Sediment Transport (PG)	3-0-0	Water Resources Engg

(vii) Specialisation – 20 Credits (10 in Lieu of OC + 6 Additional as Project + 4)

Total Credits **180** **(165 + 15 non graded core)**

1. Departmental credits **97**

- a. Departmental Core 63
 - b. Departmental Elective 10
 - c. Specialisation Core 10 in Lieu of OC
 - d. Specialisation Elective 8
 - e. Specialisation Project 6
2. Outside department credits (BS/EAS/HuSS/PLC) 68
 3. Open category credits 0

SNo	Course type	Credits	Remarks
1	DCP10 (Project Part 1)	4 (0-0-8)	VII Semester
2	DCP11 (Project Part 2)	6 (0-0-12)	VIII Semester
3	Specialisation Core courses in Lieu of OC	10	From Basket of Core Courses of Specialisation
4	Specialisation Elective Courses	8	From Basket of Elective Courses of Specialisation
5	Departmental Core Courses	59	All Core Courses of the Department
6	Departmental Elective Courses	10	From list of Elective Courses of Department

18 credits (excluding Project Part 2 of 6 credits) of Specialisation Core + Elective courses should be from the basket of courses of that Specialisation, out of which minimum 10 credits should be core courses.

List of Specialisations

1. Environmental Engineering
2. Geotechnical Engineering
3. Structural Engineering
4. Transportation Engineering
5. Water Resources Engineering

(viii) Basket of Courses for Specialisation – 18 Credits (Core + Elective)

SNo	Specialisation	Course Name	Credits	Course type
1	Environmental Engg	Core Courses		
		Solid & Hazardous Waste Management (PG)	3-0-0	SC-E
		Environmental Systems Analysis (PG)	3-0-2	SC-E
		Air and Noise Pollution	3-0-0	SC-E
		Elective Courses		
		Industrial Waste Management	3-0-0	SE-E
		Environmental Assessment Methodologies	3-0-0	SE-E
		Environmental Risk Assessment (PG)	3-0-0	SE-E
		Environmental Impact Assessment (PG)	3-0-0	SE-E
		Life Cycle Analysis & Design for Environment (PG)	3-0-0	SE-E
		Emerging Technologies for Environmental Management PG	3-0-0	SE-E
		Thermal Technologies for Waste Management (PG)	3-0-0	SE-E
		Design of Water & Waste Water Facilities (PG)	3-0-0	SE-E
		Ecology & Eco-system Dynamics (PG)	3-0-0	SE-E
		Core Courses		

2	Geotechnical Engineering	Geoenvironmental Engineering	3-0-0	SC-G
		Geotechnical Design Studio	2-0-0	SC-G
		Soil Dynamics	3-0-0	SC-G
		Underground Structures	2-0-0	SC-G
		Elective Courses		
		Site Investigation & Ground Improvement	3-0-0	SE-G
		Rock Engineering	3-0-0	SE-G
		Slopes and Earth Dams	2-0-0	SE-G
		Design of Foundations & Retaining Structures	3-0-0	SE-G
		FEM in Geotechnical Engineering	3-0-0	SE-G
3	Structural Engineering	Core Courses		
		Structural Analysis III	3-0-0	SC-S
		Prestressed Concrete & Industrial Structures	3-0-0	SC-S
		Structural Design	3-0-0	SC-S
		Solid Mechanics in Structural Engineering (PG)	3-0-0	SC-S
		Elective Courses		
		Construction Project Management	3-0-0	SE-S
		Advanced Structural Analysis (PG)	3-0-0	SE-S
		Design of Steel Structures (PG)	2-1-0	SE-S
		Structural Dynamics (PG)	3-0-0	SE-S
		Design of Concrete Structures (PG)	2-1-0	SE-S
		Solid Mechanics in Structural Engineering (PG)	3-0-0	SE-S
		Earthquake Analysis and Design (PG)	3-0-0	SE-S
		Finite Element Method in Structural Engineering (PG)	2-1-0	SE-S
		Design of Industrial Structures (PG)	2-1-0	SE-S
		Advanced Design of Bridges (PG)	2-1-0	SE-S
		Prestressed/Composite Structures (PG)	3-0-0	SE-S
		Mathematical and Numerical Methods (PG)	2-1-0	SE-S
		Civil Engineering Materials (PG)	3-0-0	SE-S
		Structural Safety and Reliability (PG)	3-0-0	SE-S
		Design of Plates and Shells (PG)	2-1-0	SE-S
		Concrete Mechanics (PG)	3-0-0	SE-S
		Stability Theory in Structural Engineering (PG)	3-0-0	SE-S
		Design of Offshore Structures (PG)	2-1-0	SE-S
		Advanced Finite Element Method and Programming (PG)	2-0-2	SE-S
		Wind Resistant Design of Structures (PG)	3-0-0	SE-S
		Design of Tall Buildings (PG)	2-1-0	SE-S
		Structural Health Monitoring (PG)	2-0-2	SE-S
		Construction and Contract Management (PG)	3-0-0	SE-S
		Project Planning and Control (PG)	2-1-0	SE-S
		Quantitative Methods in Construction Management (PG)	2-1-0	SE-S
		Construction Engineering Practices (PG)	3-0-0	SE-S
		Construction Methods and Equipment (PG)	3-0-0	SE-S
		Construction Economics and Finance (PG)	3-0-0	SE-S
		Systems Design and Value Analysis (PG)	3-0-0	SE-S
		Recent Advances in Construction Materials (PG)	3-0-0	SE-S
		Management of Quality and Safety in Construction (PG)	2-1-0	SE-S
		Functional Planning, Building Services and Main. (PG)	3-0-0	SE-S
		Building Science (PG)	3-0-0	SE-S
		Infrastructure Development and Management (PG)	3-0-0	SE-S
		Formwork for Concrete Structures (PG)	3-0-0	SE-S

4	Transportation Engineering	Core Courses		
		Urban and Regional Transportation Planning (PG)	2-0-2	SC-T
		Pavement Materials and Construction (PG)	2-0-2	SC-T
		Traffic Engineering (PG)	3-0-2	SC-T
		Elective Courses		
		Introduction to Intelligent Transportation Systems	3-0-0	SE-T
		Logistics and Freight Transport	3-0-0	SE-T
		Introduction to Railway Engineering	3-0-0	SE-T
		Traffic Engineering (PG)	3-0-2	SE-T
		Design and Maintenance of Pavements (PG)	3-0-2	SE-T
		Advanced Transportation Modelling (PG)	2-0-2	SE-T
		Geometric Design of Streets and Highways (PG)	2-0-2	SE-T
		Public Transportation Systems (PG)	3-0-0	SE-T
		Transportation Economics and Finance (PG)	3-0-0	SE-T
		Transportation and Traffic Infrastructure Design (PG)	3-0-0	SE-T
		Airport Planning and Design (PG)	3-0-0	SE-T
5	Water Resources Engineering	Core Courses		
		Water Resources Management	3-0-0	SC-W
		Groundwater	2-0-0	SC-W
		Water Power Engineering	2-0-2	SC-W
		Groundwater & Surface-water Pollution	2-0-0	SC-W
		Elective Courses		
		Water Resources Systems	2-0-0	SE-W
		Computational Aspects in Water Resources	1-0-4	SE-W
		Urban Hydrology	2-0-0	SE-W
		River Mechanics	2-0-2	SE-W
		Mechanics of Sediment Transport (PG)	3-0-0	SE-W
		Geo-informatics	2-0-2	SE-W
		Fundamental to Geographic Information Systems	2-0-2	SE-W
		Fundamental to Remote Sensing	2-0-2	SE-W
		Frequency Analysis in Hydrology	2-0-0	SE-W
		Design of Water & Waste Water Facilities (PG)	3-0-0	SE-W
		Environmental Impact Assessment (PG)	3-0-0	SE-W

(Prof B Bhattacharjee)
(Chairman)

(Prof B R Chahar)
(Convener & SI, WRE)

(Prof KS Rao)
(Member & SI, GE)

(Prof BJ Alappat)
(Member & SI, EE & Sur)

(Dr K N Jha)
(Member & SI, StE)

Dr A K Swamy
(Member & SI, TE)

Chairman DFB (Head), Civil Engineering

COURSE TEMPLATE

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

7.	Pre-requisites (course no./title)	Structural Analysis-I
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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)	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	
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12.	Will the course require any visiting faculty?	NO
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13.	Course objective (<i>about 50 words</i>): To develop knowledge on the analysis of indeterminate structures	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Determinacy and stability; Method of consistent deformations-Matrix formulation, Application to beams, trusses and frames; Slope-deflection method and Moment-distribution method- Beams and frames with uneven loading, support settlements, dealing with symmetry and anti-symmetry, Non-sway and sway frames; Matrix stiffness method; Matrix flexibility method; Energy methods; Approximate methods of analysis; Direct stiffness method for computer applications including computational aspects and MATLAB Assignments	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Stability and determinacy-Static and Kinematic	3
2	Method of consistent deformations-Development and application to beams, trusses and frames	4
3	Slope-deflection method-Development and application to beams and frames	8
4	Moment-distribution method	6
5	Matrix stiffness method	6
6	Matrix flexibility method	6
7	Energy methods	3
8	Approximate methods of analysis;	2
9	Direct stiffness method for computer applications	4
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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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.

- Wang, C. K., (1952), Indeterminate Structural Analysis, Tata McGraw Hill Publishing.
- Yuan Yu Hsieh, (1987), Elementary Theory of Structures, 3rd edition, Prentice Hall.
- Hibbeler, R. C., (2002), Structural Analysis, 6th Edition, Pearson Education.
- Kinney, J.S., Indeterminate Structural Analysis, Oxford IBH Publishing Company.
- Reddy, C. S., Basic Structural Analysis, Tata McGraw Hill Publishing.
- Ghali, A. and Neville, A. M., (2003), Structural Analysis (Unified Classical and Matrix Approach), 5th Edition, Chapman and Hall, Ltd.

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

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

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)	

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>)	REINFORCED CONCRETE DESIGN
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	
6.	Status (<i>category for program</i>)	Core

7.	Pre-requisites (course no./title)	None
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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)	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	
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12.	Will the course require any visiting faculty?	
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13.	Course objective (<i>about 50 words</i>): To develop knowledge on the basic design principles of concrete structures based on design standards	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Design Philosophy: Working stress and limit state design concepts; Design of and detailing of RC beam sections in flexure, shear, torsion and bond; Design for serviceability; Design of RC beams, One way and two way RC slabs, RC short and long columns, RC footings.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Design philosophy - Working stress and limit state methods	2
2	Design of RC beam sections for flexure using working stress method	3
3	Design of RC beam sections for flexure, shear and torsion using limit state methods	9
4	Design of RC beam elements - detailing, curtailment and serviceability	4
5	Design of one way slabs, design of two-way slabs, design of slabs for serviceability, design of continuous slab systems	6
6	Design of short columns under pure compression, design of short columns under compression, and uniaxial and biaxial bending	8
7	Design of long columns	5
8	Principles of structural design of footings, design of isolated RC footings	5
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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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.

1. S.N. Sinha, Reinforced Concrete Design, Tata McGraw Hill
2. P. Dayaratnam, Design of Reinforced Concrete Structures, Oxford and IBH Publishing
3. Wight and MacGregor, Reinforced Concrete: Mechanism and Design, Pearson

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

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

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)	

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>)	DESIGN OF STEEL STRUCTURES	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number		
6.	Status (<i>category for program</i>)	CORE	

7.	Pre-requisites (course no./title)	Structural Analysis-I	
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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)	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		
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12.	Will the course require any visiting faculty?	No	
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13.	Course objective (<i>about 50 words</i>): To develop knowledge on the design principles of steel structures based on design standards		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Structural steel and properties, Design philosophy-Working stress and limit state; Connection types- Riveted, bolted and welded; Design of tension, compression and flexural members; Design of members subjected to combined loadings-Axial and bending, Torsion, Biaxial bending; Column bases, Gantry and plate girders; Roof trusses; Plastic design; Introduction to stability concepts, Design of shed-type structures		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Properties of structural steel	2
2	Design philosophy-Working stress and limit state	2
3	Connection types- Riveted, bolted and welded	6
4	Design of tension, compression and flexural members	9
5	Design of members subjected to combined loadings-Axial and bending, Torsion, Biaxial bending	3
6	Design of column bases	3
7	Design of gantry and plate girders	6
8	Design of roof trusses	2
9	Plastic design approach	5
10	Introduction to stability concepts	2
11	Design of shed-type structures	2
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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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.

- Subramanian, N. (2008). Design of Steel Structures, Oxford University Press.
- Segui, W.T. (2007). Design of Steel Structures, Cengage Learning.
- Salmon, C.G. and Johnson, J.E. (1996). Steel Structures: Design and Behaviour, Prentice Hall.
- McCormac, J.C. (1995). Structural Steel Design: LRFD Method, Harper Collins Publishers.
- IS: 800-2007. General Constructions in Steel-Code of Practice, Bureau of Indian Standards, New Delhi.
- IS:808-1989 & SP:6 (1)-1964. Handbook for structural steel sections. Bureau of Indian Standards, New Delhi.
- SP:6 (6)-1972. Handbook for structural engineers-Application of plastic theory in design of steel structures, Bureau of Indian Standards, New Delhi.

- AISC Manual of Steel Construction, LRFD, Third Edition, American Institute for Steel Construction, 2001.

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

19.1	Software	
19.2	Hardware	Steel sculpture
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	Audio-Visuals
19.7	Site visits	

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)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department proposing the course	Civil Engineering
2.	Course Title	Construction Practices
3.	L-T-P Structures	2-0-0
4.	Credits	2
5.	Course Number	CEL
6.	Status (Category for program)	Core
7.	Pre-requisites	
8.	Status vis-à-vis other courses (give course number/title)	
8.1	Overlap with any UG/PG course of the department/centre	
8.2	Overlap with any UG/PG course of other department/centre	No
8.3	Supersedes any existing course	No
9.0	Not allowed for (indicate program name)	
10	Frequency of offering	2 nd semester
11	Faculty who will teach this course	
12	Will the course require any visiting faculty	No
13	Course objective (about 50 words)	
	To familiarize students with the latest technologies in the Civil Engineering field namely- High rise construction, Underground construction, Bridge construction, and Mass housing.	
14	Course contents (about 100 words) (Include laboratory/design activities)	
	Introduction and role of technologies, Construction technologies in RC Buildings for Reinforcement, Formwork , and concreting activities, Excavation and Concreting equipment, Formwork material and Design Concepts, Formwork system for Foundations, walls, columns, slab and beams and their design, Flying Formwork such as Table form, tunnel form. Slipform, temporary structures failure, Determining construction loads and ensuring safety of slabs during construction of high rise buildings- shoring, reshoring, preshoring and backshoring technology, Top down construction technology for high rise and underground construction, Bridge construction including segmental construction, incremental construction and push launching techniques, Prefab construction.	
15	Lecture outline (with topics and number of lectures)	
Module No.	Topic	No. of hours
1	Introduction and role of construction equipment and construction technologies, Requirements, Selection, and Classification (Types) of equipment	02
2.	Reinforcement cutting , bending and tying technologies	01
3.	Concrete production and placement Technologies	02
4.	Formwork technologies for Foundations, walls, columns, slab and beams	03

5.	Formwork Design Concepts	03
6.	Flying Formwork such as Table form, tunnel form	01
7.	Slipform	01
8.	Determining construction loads and ensuring safety of slabs during construction of high rise buildings- shoring, reshoring, preshoring and backshoring technology	04
9.	Temporary structures failure	02
10.	Temporary structures for deep excavation for underground structures	02
11.	Bridge construction including segmental construction, incremental construction and push launching techniques.	03
12.	Top down construction technology for high rise and underground construction	02
13.	Prefab construction.	02
	Course total (14 times 'L')	28
16.	Brief description of tutorial activities	Nil
17.	Brief description of laboratory activities	Nil
Module No.	Experiment description	No. of hours
18.	Suggested texts and reference materials	
	STYLE: Author name and initials, Title, Edition, Publisher, Year	
1	Jha, K.N., Formwork for Concrete Structures, First Edition, McGraw Hill. 2012.	
2	Peurifoy, R.L. and Oberlender, G.D. , Formwork for concrete structures, McGraw Hill. 2011.	
3	Robinson, J.R., Piers, abutments, and formwork for bridges.	Library Accn No. 29797
4	Austin, C.K., Formwork to concrete	Library Accn No. 87018
5	Moore, C.E., Concrete Form Construction	Library Accn No. 79825
19.	Resources required for the course (itemized and student access requirements, if any)	
19.1	Software	Optional
19.2	Hardware	
19.3	Teaching aides (videos etc.)	Available
19.4	Laboratory	Not required
19.5	Equipment	Not required
19.6	Classroom infrastructure	LCD Projector and video playing facilities
19.7	Site visits	One site visit
20.	Design content of the course (Percent of student time with examples, if possible)	

20.1	Design-type problems	
1.		
20.2	Open –ended problems	No
20.3	Project-type activity	No
20.4	Open-ended laboratory work	No
20.5	Others (please specify)	

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>)	DESIGN OF HYDRAULIC STRUCTURES
3.	L-T-P structure	3 - 0 - 2
4.	Credits	4
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DC

7.	Pre-requisites (<i>course no./title</i>)	CEL (Hydraulics) CEL (Engineering Hydrology)
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	Nil

9.	Not allowed for (<i>indicate program names</i>)	Nil
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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 All Water Resources Engineering faculty	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): Hydraulic design of irrigation structures, such as headworks (wiers, barrages), canals, falls, cross drainage works and gravity & embankment dams	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Input studies. Storage structures: Dams and reservoirs, Different types of dams and selection of suitable type and dam site, Gravity dam, Embankment dams. Diversion works: Design concepts for irrigation structures on permeable foundations, Design of Weirs and barrages. Design of energy dissipation devices. Canals: canal layout, Regime canal design, Rigid boundary canal design. Design of canal falls. Design of cross drainage works. Design of head regulator, cross regulator and canal outlet structures.	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Input Studies, Role of Flood plain morphology	3
2	Canal layout	1
3	Regime & rigid boundary canal design	4
4	Design concepts for irrigation structures on permeable foundations	3
5	Energy dissipation devices	4
6	Diversion works- Design of weirs & barrages	6
7	Storage structures- Dams & reservoirs, Different types of dams & selection suitable type & dam site, Gravity Dam, Embankment dam	9
8	Design of Cross drainage works	5
9	Design of Canal Falls	3
10	Design of head & cross regulators, Canal outlet structures	4
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Design problems on canals, weirs, barrages, spillways, energy dissipation devices, gravity dams, embankment dams, aqueducts, syphons, superpassages, falls (Sarda type, glacis type) etc	28
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

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|---|
| (1) Fundamental of Irrigation engineering by Bharat Singh, Nem Chand and Bros., Roorkee
(2) Theory and Design of Irrigation Structures, Vol 1 & 2, by R.S. Varshney, S.C. Gupta and R.L. Gupta, Nem Chand and Bros
(3) Handbook of Applied Hydraulics, by C.V. Davis and K.E. Sorensen, McGraw Hill
(4) USBR, Design of Gravity Dams, Water resources Technical publications, Denver, Colorado
(5) All relevant I S codes |
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19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	No
19.2	Hardware	No
19.3	Teaching aides (videos, etc.)	Yes
19.4	Laboratory	Yes
19.5	Equipment	No
19.6	Classroom infrastructure	Yes
19.7	Site visits	Preferred (If funds available)

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

20.1	Design-type problems	95
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	5 (Field Trip)

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 ENGINEERING
3.	L-T-P structure	3 - 0 - 2
4.	Credits	4
5.	Course number	CEL XXX
6.	Status (<i>category for program</i>)	DC

7.	Pre-requisites (<i>course no./title</i>)	CEL100
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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	
8.2	Overlap with any UG/PG course of other Dept./Centre	
8.3	Supercedes any existing course	

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, 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>): The main objective is to introduce fundamentals of Environmental unit processes and design aspects. Topics include water and wastewater treatment unit processes; air pollution systems; solid waste management and noise pollution. The idea is to motivate and train them to understand role of unit processes in water and wastewater treatment systems and in air and noise pollution systems.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Water and wastewater treatment overview; Unit processes: systems of water purification, processes (sedimentation, coagulation-flocculation, softening, disinfection, adsorption, ion exchange, filtration) and kinetics in unit operation of water purification-theory and design aspects; distribution of water layout systems: design aspects; Wastewater engineering: systems of sanitation, wastewater collection systems design and flows,; Characteristics and	
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	microbiology of wastewater, BOD kinetics; Unit processes for wastewater treatment (screening, sedimentation;biological aerobic and anaerobic process)-theory and design aspects; Biological processes (Nutrient and phosphorous removal); advanced wastewater treatment-theory and design aspects; Air pollution (health effects, regulatory standards, dispersion; stacks, control systems); Municipal solid waste management; Noise pollution
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Water and wastewater treatment overview	1
2	Unit processes: systems of water purification (2h)+Unit processes (sedimentation, coagulation-flocculation, softening, disinfection)(6h)-theory and design aspects	2+6
3	Unit processes: adsorption, ion exchange, filtration-theory and design aspects	3
4	Distribution of water layout systems: design aspects	3
5	Wastewater engineering: systems of sanitation, wastewater collection systems design and flows,	4
6	Characteristics and microbiology of wastewater, BOD kinetics	2
7	Unit processes for wastewater treatment (screening, sedimentation)-theory and design aspects	2
8	Unit processes for wastewater treatment (biological aerobic and anaerobic process)-theory and design aspects (5h)	5
9	Biological processes (Nutrient and phosphorous removal)(3h)+ advanced wastewater treatment-theory and design aspects (3h)	3+3
10	Air pollution (health effects, regulatory standards, dispersion)(3 h)+Air pollution (stacks, control systems) (2h)	3+2
11	Municipal solid waste management	2
12	Noise pollution	1
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	introduction; Solids, pH and conductivity	3
2	Hardness	2
3	Alkalinity and acidity	2
4	Sulfate and standard curve preparation	2
5	Total coliforms	2
6	DO, BOD	5
7	Chloride	2
8	COD	2
9	Jar test	4
10	Air pollution indoor and outdoor CO and CO ₂ monitoring	4
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

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

H.S. Peavy, D.R. Rowe and G. Tchobanoglous, Environmental Engineering, McGraw Hill International.

J. G. Henry and G.H. Heinke, Environmental Science and Engineering, Prentice Hall International.

G.M. Masters, Introduction to Environmental Engineering and Science, Pearson Education.

P.A. Vesilind and S.M. Morgan, Introduction to Environmental Engineering, Thomson Books.

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.)	Yes
19.4	Laboratory	yes
19.5	Equipment	yes
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	0
20.4	Open-ended laboratory work	30
20.5	Others (please specify)	40 (theory)

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>)	ENGINEERING GEOLOGY
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL XXX
6.	Status (<i>category for program</i>)	DC

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	nil
8.2	Overlap with any UG/PG course of other Dept./Centre	nil
8.3	Supercedes any existing course	nil

9.	Not allowed for (indicate program names)	nil
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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. K.S.RAO, Prof G.V.Ramana	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): To teach fundamental Geological principles and processes which are applied to design of Civil Engineering structures such as foundations, Underground structures, natural and cut slopes.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Engineering Geology: Introduction; Dynamic Earth; Origin, Age, Interior, Materials of Earth; Silicate Structures and Symmetry Elements; Physical properties, Formation of Rocks ;Igneous, Sedimentary and Metamorphic processes and structures, Characterisation; Weathering Processes; Geological Work of Rivers, Glaciers, Wind and Sea/Oceans, Deposits and Landforms; Formation of Soils; Geological Time Scale; Structural Features ,Attitude of beds, Folds, Joints, Faults, Plate tectonics; Stress Distribution; Geophysical methods, Earthquakes. Engineering Properties of Rocks; Rock as Construction Material; Geological Site Criteria for Tunnels and Underground Structures, Foundations, Dams, Rock Slopes and Landslides.	
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Introduction,Earth and Earth processes	2
2	Origin,Interior and age determination of Earth	4
3	Silicate structures,Symmetry elements,Mineral characteristics and Families of minerals	3
4	Igneous processes,Bowens reaction principle,textures and structures of plutonic and volcanic rocks	2
5	Weathering processes,sedinentary processes,structures of sedimentary rocks	2
6	Effects of pressure and temparature,Metamorphic rocks and structures	2
7	Geological work of Rivers,Sea/Oceans,Glaciers,Wind and Deposits	4
8	Structural features,Beds,Folds,Joints,Faults and their Influence on Civil structures,Rockmass description.	6
9	Plate tectonics and Sea Floor spreading,Continental Drift,Mechanical behaviour of soils and rocks	6
10	Geophysical Methods:Resistivity and Seismic Refraction methods	2
11	Earthquakes,Landslides,Subsidence,Erosion,Karst Formations	4
12	Enineering properties of Rocks,Site selection for Slopes,Tunnels and Foundations,Rock as a construction material	5
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

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: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

- 1.de Vallejo,L.G and Ferrer,M., Geological Engineering, CRC Press,Balkema,2011.
- 2.Billings,M.P.,Structural Geology,4th Edition, PHI Pub.,2010
- 3 Read,H.H.,Elememts of Mineralogy
- 4.Gangopadhyay,S., Engineering Geology,Oxford Pub.,2013.
- 5.Mclean,A.C.and Gribble,C.D.,Geology for Civil Engineers,2nd Edition,E&FN Spon,1995.

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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.)	Physical models, Maps, Videos
19.4	Laboratory	Well equipped Engineering Geology lab.
19.5	Equipment	Fully Equiped
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	A compulsory 5 day field visit to suitable sites for Geological Mapping and Outcrop Study, to major construction sites.

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

20.1	Design-type problems	NA
20.2	Open-ended problems	NA
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	AS per the Syllabus

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>)	STRUCTURAL ANALYSIS I
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL231
6.	Status (<i>category for program</i>)	CORE

7.	Pre-requisites (course no./title)	AML 110
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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	NA
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supercedes any existing course	NA

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	
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12.	Will the course require any visiting faculty?	NA
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13.	Course objective (<i>about 50 words</i>): To impart basic concepts of structural analysis and to provide an introduction to the very first level concepts of structural analysis for second year undergraduate students.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): General Concept of Static Equilibrium of Structures, Concept of Free Body Diagram, Analysis of Statically Determinate Trusses, Energy Methods for Determination of Joint Displacements - Castigliano Theorem, Unit Load Method etc., Introduction to Analysis of Statically Indeterminate Trusses using Energy Methods, Analysis Statically Determinate Beams - Moment Area Theorem, Conjugate Beam Method, Maxwell Betti Theorem, Method of Superposition, Application of Energy Methods to Statically Determinate Beams and Rigid Frames, Solving Simple Indeterminate Beams Structures using Energy Methods, Analysis of Rolling Loads and Influence Line Diagram, Analysis of Arches and cable structures	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	General Concept of Static Equilibrium of Structures, Concept of Free Body Diagram	1.0
2	Analysis of Statically Determinate Trusses	2.0
3	Space Trusses	2.0
4	Energy Methods for Determination of Joint Displacements - Castigliano Theorem, Unit Load Method etc.	6.0
5	Introduction to Analysis of Statically Indeterminate Trusses using Energy Methods	3.0
6	Analysis Statically Determinate Beams - Moment Area Theorem, Conjugate Beam Method, Maxwell Betti Theorem	6.0
7	Method of Superposition, Application of Energy Methods to Statically Determinate Beams and Rigid Frames	6.0
8	Solving Simple Indeterminate Beams Structures using Energy Methods	3.0
9	Analysis of Rolling Loads and Influence Line Diagram	6.0
10	Analysis of Arches	4.0
11	Analysis of Cable Structures	3.0
12		
COURSE TOTAL (14 times 'L')		42 hours

16. Brief description of tutorial activities

NA

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.

S. P. Timoshenko and D. H. Young, Engineering Mechanics, 5th Edition, Mc-Graw Hill 2013
 R.C. Hibbeler, Structural Analysis, 5th Edition, Pearson Education, 6th Edition
 C. K Wang, Intermediate Structural Analysis, Tata Mc-Graw Hill, 2010 Edition

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

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

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)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	CIVIL ENGINEERING
2.	Course Title (< 45 characters)	SOIL MECHANICS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL XXX
6.	Status (category for program)	DC

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

9.	Not allowed for (indicate program names)	nil
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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. Manoj Datta, Prof. G.V. Ramana, Prof. J. T. Shahu, Dr. R. Ayothiraman, Dr. B. Manna, Dr. Tanusree Chakraborty	
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12.	Will the course require any visiting faculty?	NO
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13.	Course objective (about 50 words): To teach the overview of engineering soil properties and mechanics together with covrage of field pratices and basic engineering procedures.	
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14.	Course contents (about 100 words) (Include laboratory/design activities): Origin and Classification of Soils; Phase Relationships; Effective Stress Principle; Effective Stress Under Hydrostatic and 1D flow; Permeability; Flow Through Soils–Laplace equation, flownets, seepage; Contaminant Transport; Compressibility; Consolidation; Terzaghi's 1D Consolidation Theory; Shear Strength; Drainage Conditions; Pore Water Pressure; Mohr's Circle; Failure	
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	Envelope and Strength Parameters; Factors Affecting Shear Strength; Critical State frame work; Behaviour of soils under cyclic loading, Liquefaction,; Compaction; Engineering properties of Natural soils, Compacted Soils and modified soils; Site Investigations; Soil deposits of India
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15.	Lecture Outline <i>(with topics and number of lectures)</i>	
Module no.	Topic	No. of hours
1	Origin and Classification of Soils	2
2	Phase Relationships	3
3	Effective Stress Principle, Effective Stress Under Hydrostatic and 1D flow	4
4	Permeability, Flow through soils, Laplace equation, flow nets, Contaminant Transport	5
5	Compressibility and Consolidation and Terzaghi's 1D Consolidation Theory	8
6	Shear Strength, Drainage conditions, Pore Water Pressure, Mohr's circle, Failure envelope and strength parameters, Factors affecting shear strength, Critical state framework	8
7	Behaviour of soils under cyclic loading, Liquefaction	2
8	Compaction, Engineering Properties of Natural, Compacted and Modified Soils	5
9	Site Investigations	3
10	Soil Deposits of India	2
11		
12		
COURSE TOTAL (14 times 'L')		42

16.	Brief description of tutorial activities
NIL	

17.	Brief description of laboratory activities	
Moduleno.	Experiment description	No. of hours
1	NIL	
2		
3		
4		
5		
6		
7		
8		
9		
10		

COURSE TOTAL (14 times 'P')	
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18.	Suggested texts and reference materials STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., <i>Fundamentals of Thermodynamics</i> , 5 th Ed., John Wiley, 2000.
1. Gulhati, S. K., and Datta Manoj, Geotechnical Engineering, 1st edition, Tata Mcgraw Hill 2005. 2. Graham Barnes, Soil Mechanics Principles and Practice, 3 rd edition, Palgrave Macmillan, 2005 3. Braja M Das, Principles of Geotechnical Engineering, 7 th edition, Cengage publishers 2010.	

19.	Resources required for the course (<i>itemized & student access requirements, if any</i>)	
19.1	Software	Available
19.2	Hardware	Available
19.3	Teaching aides (videos, etc.)	NONE
19.4	Laboratory	Well equipped Soil mechanics laboratory
19.5	Equipment	Fully Equiped
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	

20.	Design content of the course (<i>Percent of student time with examples, if possible</i>)	
20.1	Design-type problems	30
20.2	Open-ended problems	20
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	50 (explanation of basic theories)

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>)	HYDRAULICS
3.	L-T-P structure	3 - 1 - 0
4.	Credits	4
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DC

7.	Pre-requisites (course no./title)	AML (Mechanics of Fluids)
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	Nil
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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 All Water Resources Engineering Faculty	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To impart knowledge of hydraulics of open channel flow, pipe flow and sediments transport and field applications in the domain of hydraulics.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Open Channel Flow: Channel Characteristics and parameters, Uniform flow, Critical flow, Specific Energy concepts, Gradually Varied Flows, Rapidly Varied flow with special reference to hydraulic jump, Unsteady flow in open channels. Boundary Layer Theory :Navier Stokes Equation, Boundary Layer Equation in 2- dimension, Boundary layer characteristics, Integral Momentum equation, onset of turbulence, properties of turbulent flow, skin friction,application of drag, lift and circulation to hydraulic problems. Pipe Flow: Laminar and Turbulent flow in Smooth and Rough pipes, pipe network analysis, Losses in pipes Fluvial Hydraulics: Settling velocity, Incipient motion, Resistance to flow and	
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	bed forms, Sediment load and transport.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Open Channel Flow: Channel characteristics and parameters, Uniform flow, Critical flow, Specific Energy concepts.	6
2	Gradually Varied Flows, Rapidly Varied flow and hydraulic jump in open channels.	5
3	Unsteady flow in open channels.	5
4	Navier Stokes Equation, Boundary Layer Equation in 2- dimension, Boundary layer characteristics.	3
5	Integral Momentum equation, Onset of turbulence, properties of turbulent flow.	2
6	Application of Skin friction, drag, lift and circulation to hydraulic problems.	2
7	Laminar and Turbulent flow in Smooth and Rough pipes,	4
8	Pipe network analysis, Losses in pipes, unsteady flow in pipes	6
9	Fluvial Hydraulics: Settling velocity, Incipient motion, Resistance to flow and bed forms.	4
10	Sediment load and transport, Bridge Hydraulics	5
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

First set of core courses for Civil Engineering students. Tutorials will cover all the course contents - 1 hour per week.

The tutorials are numerical based problems on the application of the theory covered in class. The students are handed out tutorial sheets one week prior to the actual turn so that they get sufficient time to work on them before they come to class. About 12 tutorial sheets are given, each having about 10 problems.

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: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

- 1) Fox, R. W., and Alan T. McDonald, A. T., Introduction to Fluid Mechanics, John Wiley, 3rd Ed., John Wiley, 1985.
- 2) Subramanya, K., Flow in Open Channel, Tata McGraw Hill, 1991
- 3) Richard H. F. Pao, Fluid Dynamics, Charles E Merrill Books Inc, Ohio
- 4) Chow, V. T., Open-channel Hydraulics, McGraw Hill, 1985.
- 5) French, R. F., Open-channel Hydraulics, McGraw Hill, 1994.
- 6) Yang, C. T., Sediment Transport - Theory & Practice, McGraw Hill, 1996.
- 7) Graf, W.H., Hydraulics of sediment transport, by Graf, McGraw Hill, 1971
- 8) Watters, G.Z., Modern analysis and control of unsteady flow in pipelines, Ann Arbor Science Publishers, 1979

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.)	Yes
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	Existing
19.7	Site visits	No

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	10
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

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>)	ELEMENTS OF SURVEYING
3.	L-T-P structure	3 - 0 - 2
4.	Credits	3
5.	Course number	CEL XXX
6.	Status (<i>category for program</i>)	DC

7.	Pre-requisites (course no./title)	-
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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)	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. M. Khare/Dr. A. K. Nema/Dr. Mittal/ Dr. Alappat/Dr. Arun Kumar	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): This course is aimed at providing integrated group work experience, resulting in the development of: Practical instrument skills and organisational and inter-personal skills. Students will learn about surveying project fundamentals, referencing systems, horizontal and vertical control, and topographic mapping, methods of data recording, display, and storage and the need for error control.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Introduction to Surveying, Levels, Theodolites, total station. Measurement of distances, directions and elevations. Traversing. Trigonometric levelling. Mapping and contouring. Measurement of areas, volumes. Quantity computations. Errors of measurements and their adjustments. Curve setting: simple, compound and reverse curves. Introduction to GPS, Differential GPS, Remote sensing techniques and application in land use change and mapping, arial surveying, photogrametry	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to Surveying: Primary division of surveying	2.0
2	Levelling: Precise levelling, Trigonometric levelling, Contouring.	6.0
3	Measurement of Distances, directions and elevations by different methods.	4.0
4	Traversing	4.0
5	Errors of measurements and their adjustments.	3.0
6	Measurement of areas, volumes. Application of above measurements in quantity computations.	4.0
7	Curve setting: simple circular curves, compound and reverse curves	4.0
8	EDM, Total station, Photogrammetric cameras, scanner	3.0
9	Introduction to GPS, Differential GPS.	2.0
10	Recent practices in large survey projects: Planning and implementation	3.0
11	Remote sensing techniques	3.0
12	Remote sensing data analysis and interpretation and application in land use change and mapping	4.0
COURSE TOTAL (14 times 'L')		42.0

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Levelling with tilting level, autolevel, digital level	6.0
2	Techimetry	2.0
3	Curve setting	4.0
4	Theodolite for angle measurement and height calculation	6.0
5	Total station	4.0
6	Differential GPS	4.0
7	Setting out building plan	2.0
8		
9		
10		
COURSE TOTAL (14 times 'P')		28 hrs

18. Suggested texts and reference materials

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

Chandra, A. M. (2006) Plane surveying, New Age Publishers, New Delhi
 Wolf P., R. and Ghilani, C. G. (2002) Elementary Surveying: An Introduction to Geomatics, Prentice Hall, New Jersey.
 Punmia, B. C. (2002) Text book of Surveying, Vol I, II and III, Laxmi Publications Ltd
 Duggal, S. K. (2009) Surveying vol 1 and 2, The McGraw Hill Companies

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.)	required
19.4	Laboratory	Available
19.5	Equipment	Available
19.6	Classroom infrastructure	Available
19.7	Site visits	Required

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

20.1	Design-type problems	-
20.2	Open-ended problems	25%
20.3	Project-type activity	-
20.4	Open-ended laboratory work	35%
20.5	Others (please specify)	40% Theory

Date: 03.01.2014

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department proposing the course	Civil Engineering
2.	Course Title	Construction Management
3.	L-T-P Structures	2-0-0
4.	Credits	2
5.	Course Number	CEL_____
6.	Status (Category for program)	Core
7.	Pre-requisites	No
8	Status vis-à-vis other courses (give course number/title)	
8.1	Overlap with any UG/PG course of the department/centre	
8.2	Overlap with any UG/PG course of other department/centre	No
8.3	Supersedes any existing course	No
9.0	Not allowed for (indicate program name)	
10	Frequency of offering	1 st Semester
11	Faculty who will teach this course	
12	Will the course require any visiting faculty	No
13	Course objective (about 50 words)	
	This course is intended to provide a brief background about construction projects. After studying the course the students would learn- (a) how to select a project (b) how to plan and prepare cost estimates (c) how to procure a construction project (d) how to implement and (e) how to monitor a project	
14	Course contents (about 100 words) (Include laboratory/design activities)	
	Introduction to construction projects, stakeholders, phases in a project, Cost estimation from clients perspective, Project selection using time value of money concept, construction contract, cost estimate –contractors perspective, Project planning and network analysis-PERT, CPM, and Precedence Network, Resource scheduling, Time Cost trade off, Time -cost monitoring and control using S-curve and earned value analysis, Construction claims and disputes , and introduction to construction quality and safety.	
15	Lecture outline (with topics and number of lectures)	
Module No.	Topic	No. of hours
1	Introduction to construction projects, stakeholders, phases in a project	01
2	Cost estimation from clients perspective, Rate analysis and specifications.	02

3	Project selection using time value of money concept	05
4	Tendering process and construction contract	02
5	Cost estimate –contractors perspective	02
6	Project planning and network analysis-PERT, CPM, and Precedence Network,	05
7	Resource scheduling	02
8	Time Cost trade off	01
9	Time -cost monitoring and control using S-curve and earned value analysis	02
10	Construction claims and disputes	02
11	introduction to construction quality	02
12	introduction to construction safety	02
	Course total (14 times 'L')	28
16.	Brief description of tutorial activities	Nil
17.	Brief description of laboratory activities	Nil
Module No.	Experiment description	No. of hours
18.	Suggested texts and reference materials	
	STYLE: Author name and initials, Title, Edition, Publisher, Year	
1	Jha, K.N., Construction Project Management, First Edition, Pearson Publishers, 2011.	
2	Harris, F. and McCaffer, R. (1989). Modern Construction Management. BSP Professional Books (Third Ed.)	
3	Pilcher R. (1966). Principles of Construction Management. McGraw Hill Publishing Co Ltd (First Ed.)	
4	Riggs, J.L., Bedworth, D.D., and Randhawa, S.U. (2005). Engineering Economics Tata-McGraw Hill Publishing Co Ltd (Fourth Ed.)	
5	Tarquin, A.J. and Blank, L.T. (1976) Engineering Economy, A Behavioural Approach McGraw Hill Book Company (Cat No 658.15 TAR-E, Accn No 76211)	
19.	Resources required for the course (itemized and student access requirements, if any)	
19.1	Software	Optional
19.2	Hardware	
19.3	Teaching aides (videos etc.)	Available
19.4	Laboratory	Not required
19.5	Equipment	Not required
19.6	Classroom infrastructure	LCD Projector and video playing facilities

19.7	Site visits	
20.	Design content of the course (Percent of student time with examples, if possible)	
20.1	Design-type problems	
1.		
20.2	Open –ended problems	No
20.3	Project-type activity	No
20.4	Open-ended laboratory work	No
20.5	Others (please specify)	

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>)	GEOTECHNICAL ENGINEERING
3.	L-T-P structure	3 - 1 - 0
4.	Credits	4
5.	Course number	CEL XXX
6.	Status (<i>category for program</i>)	DC

7.	Pre-requisites (course no./title)	CEL XXX / SOIL MECHANICS
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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	nil
8.2	Overlap with any UG/PG course of other Dept./Centre	nil
8.3	Supercedes any existing course	nil

9.	Not allowed for (indicate program names)	nil
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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. J. T. Shahu, Prof. Manoj Datta, Prof. G.V. Ramana, Dr. R. Ayothiraman, Dr. Tanusree Chakraborty, Dr. B. Manna	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): To teach geotechnical design of civil engineering structures, namely, building foundations, slopes, earth dams, earth retaining structures, machine foundations, landfills and ash ponds. Eathquake resistant design, reinforced soil structure design and ground improvement techniques will also be introduced.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Foundations: types, selection and design considerations; Bearing capacity of shallow foundations: Terzaghi theory, factors affecting; Bearing capacity of deep foundations: single pile analysis, pile tests, pile driving formula, group capacity, introduction to laterally loaded piles; Settlement of shallow and deep foundations: stress distribution, immediate and consolidation settlements; Slope stability analysis: infinite slopes, method of slices, Swedish circle method; Earth dams: types and design aspects; Earth pressure analysis:	
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	Rankine and Coulomb methods; Earth retaining structures: types, design aspects, underground structures; Earthquake geotechnics: evaluation of liquefaction potential, seismic slope stability, seismic bearing capacity; Machine foundations: types, analysis, design procedure; Ground improvement techniques: types, deep stabilization, anchorage, grouting; Geosynthetics: types, functions, properties; reinforced soil walls; Geoenvironment: Landfills - types, liner, cover, stability; Ash ponds - stage raising, design aspects.
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Foundations: types, selection, design considerations	2
2	Bearing capacity of shallow and deep foundations	6
3	Settlement of shallow and deep foundations	4
4	Slope stability analysis and earth dams	6
5	Earth pressure analysis and earth retaining structures	6
6	Earthquake geotechnics	4
7	Machine foundations	3
8	Ground improvement techniques	3
9	Geosynthetics	3
10	Geoenvironment	5
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Effective stress, Flow analysis, Consolidation, Shear strength, Standard penetration test, Compaction, Shallow foundation, Pile foundation, Settlement, Slope stability, Earth pressure analysis, Earth retaining structure, Earthquake geotechnics, Reinforced earth wall

17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Gulhati, S. K., and Datta Manoj, *Geotechnical Engineering*, 1st edition, Tata Mcgraw Hill 2005.
2. Ranjan Gopal, and ASR Rao, *Basic and applied soil mechanics*, 2nd edition, New age International publishers 2004.
3. Arora, K. R., *Soil Mechanics and Foundation Engineering*, 5th edition, Standard publishers 2000.

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.)	NONE
19.4	Laboratory	Well equipped Soil mechanics laboratory
19.5	Equipment	Fully Equiped
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	

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

20.1	Design-type problems	50
20.2	Open-ended problems	20
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	30 (explanation of theories)

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>)	ENGINEERING HYDROLOGY
3.	L-T-P structure	3 - 0 - 2
4.	Credits	4
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DC

7.	Pre-requisites (course no./title)	AML (Mechanics of Fluids)
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	Nil
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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 All Water Resources Engineering Faculty	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To impart knowledge of, and to mathematically model, basic processes in the domain of hydrology.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Hydrologic Cycle, Processes and Applied Methodologies. Rainfall; Evapotranspiration; Infiltration; Groundwater: Occurrence, Movement, Governing equations, Well hydraulics. Runoff: Hydrograph, Unit Hydrographs; Streamflow measurement Flood Routing: Hydrological routing for reservoirs and channels. Frequency Analysis	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Hydrological Cycle	1
2	Atmospheric water, Evaporation	4
3	Rainfall: Measurements, Pre and Post Processing	2
4	Sub-surface water, Infiltration	6
5	Runoff	1
6	Streamflow Measurement;	4
7	Hydrograph Analysis	6
8	Floods & Flood Routing	6
9	Statistics & Frequency Analysis	6
10	Groundwater	6
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Demonstration of various types of Raingauges; Elements of a WeatherStation	2
2	Demonstration of Work on a Basic Hydrologic System	2
3	Rainfall-Runoff relationships	2
4	Infiltration Experiment	2
5	Well Hydraulics	4
6	Design Problems: Unit Hydrograph Estimation; Flood Routing problems; Frequency Analysis; Basic Regional Hydrologic Estimation methods	16
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

- 1) Viessmann Jr., W., and Lewis, G.L., *Introduction to Hydrology*, 5th Ed., Pearson Prentice Hall
- 2) Ward, R.C., and Robinson, M., *Principles of Hydrology*, Tata Mcgraw-Hill, 2011
- 3) Subramanya, K., *Engineering Hydrology*, 3rd Ed., Tata McGraw Hill.
- 4) Singh, V.P., *Elementary Hydrology*
- 5) Chow, V.T., Maidment, D.R., and Mays, L.W., *Applied Hydrology*, Tata McGraw Hill

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.)	Laptop, Multimedia projector
19.4	Laboratory	Yes - Existing
19.5	Equipment	Yes
19.6	Classroom infrastructure	Yes
19.7	Site visits	No

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	10
20.3	Project-type activity	0
20.4	Open-ended laboratory work	0
20.5	Others (please specify)	0

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>)	TRANSPORTATION ENGINEERING I
3.	L-T-P structure	3 - 0 - 0
4.	Credits	4
5.	Course number	CEL 2XX
6.	Status (<i>category for program</i>)	UG Core

7.	Pre-requisites (course no./title)	Surveying
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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	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	Nil
8.3	Supercedes any existing course	Nil

9.	Not allowed for (indicate program names)	Non-Civil Engineering Majors
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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. Geetam Tiwari, Dr. S.K. Deb, Dr. Kalaga Ramachandra Rao, Dr. Aravind Krishna Swamy	
12.	Will the course require any visiting faculty?	Nil

13.	Course objective (<i>about 50 words</i>): This course is designed to introduce student to various aspects of transportation engineering with special emphasis on land based transportation modes. The learning objectives are: Understand the fundamentals principles of Transportation Engineering • Acquaint with the necessary knowledge on road based transportation systems • Design the road pavements and related appurtenances The topics that shall be covered can be broadly classified into	
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	1) Transportation planning process, 2) Pavement design, construction and maintenance, 3) Traffic engineering, 4) Design of highways and traffic facilities.
14.	Course contents <i>(about 100 words) (Include laboratory/design activities):</i> Transportation systems and their classification; Role of transportation with respect to socio-economic conditions; Transportation planning process; Road user and the vehicle; Geometric design of roads: horizontal alignment, vertical alignment, cross-section elements; Relevant geometric design standards; Traffic surveys; Pavements: flexible and rigid; Characterization of pavement materials; Analysis and design of pavement systems; Pavement design specifications; Pavement construction process; Pavement performance; Traffic engineering: Traffic characteristics; Fundamental relationships; Theories of traffic flow; Intersection design; Design of traffic signs and signals; Highway capacity.

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

Module no.	Topic	No. of hours
1	Transportation systems and their classification	2
2	Transportation planning process	4
3	Transportation network Planning	3
4	Introduction to pavement systems	2
5	Characterization of pavement materials	2
6	Analysis and design of pavement systems	5
7	Pavement construction process; Pavement performance; Highway maintenance	6
8	Geometric Design of Highways	4
9	Introduction to traffic engineering	4
10	Traffic engineering and Traffic flow theories	3
11	Design of intersection, traffic signs and signals	5
12	Highway capacity issues	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

Khanna, S.K. and Justo, C.E.G., Highway Engineering, Nem Chand Bros., 1998
 Kadiyali, L.R., Principles and Practice of Highway Engineering, Khanna Publishers, 2000
 Mannering, F.L. and Kilarseki, W.P., Washburn, S.C., Principles of Highway Engineering and Traffic Analysis, 4th Edition, John Wiley, 2009
 Papacostas, C.S. and Prevedourous, P.D., Transportation Engineering and Planning, 3rd Edition, Prentice-Hall India, New Delhi, 2002
 Meyer, M.D., Miller, E.J. Urban Transportation Planning, 2nd Edition, MCGraw Hill, New York 2001
 Chakroborty, P., Das, A. Principles of Transportation Engineering, Prentice Hall, India, 2003
 Roess, R.P., Prassas, E.S., W.R. McShane Traffic Engineering, 3rd Edition, Pearson, 2004
 Sheffi, Y, Urban Transportation Networks, Prentice Hall, 1985

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

19.1	Software	MS Excel
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Laptop, Multimedia projector
19.4	Laboratory	Yes
19.5	Equipment	Yes
19.6	Classroom infrastructure	Yes (Approximately 120 students every year)
19.7	Site visits	One time during semester

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

20.1	Design-type problems	70
20.2	Open-ended problems	10
20.3	Project-type activity	20
20.4	Open-ended laboratory work	0
20.5	Others (please specify)	0

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>)	ENGINEERING GEOLOGY LABORATORY
3.	L-T-P structure	0 - 0 - 2
4.	Credits	1
5.	Course number	CEP XXX
6.	Status (<i>category for program</i>)	UG

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	nil
8.2	Overlap with any UG/PG course of other Dept./Centre	nil
8.3	Supercedes any existing course	nil

9.	Not allowed for (indicate program names)	nil
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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. K.S.RAO, Dr R.Ayothiraman, Dr.B.Manna and Dr T.Chakravarty	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): To learn geological mapping, interpretation of Geological data and Physical and Mechanical characterisation of Minerals and Rocks.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Geological Maps, Geological Mapping – contouring, topo sheets, outcrops, apparent and true dips, three point problems, depth and thickness problems, joints, faults; Megascopic and Microscopic identification of Minerals and Rocks, Engineering properties of rocks, refraction and resistivity methods, Guided tour through representative geological formations and structures.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
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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	Introduction, Geological Maps, Contouring, Topographic Maps	2
2	Attitude of Horizontal, Vertical and Inclined Formations	4
3	Out crop relations, mapping, Section making, Thickness problems	4
4	Three point problems, Mapping series of outcrops	4
5	Symmetry elements, Crystal systems, Study of Minerals	2
6	Characterisation of Igneous rocks, Textures and structures	2
7	Characterisation of Sedimentary rocks, Textures and structures,	2
8	Characterisation of Metamorphic rocks, Textures and structures	2
9	Geomorphological model study, Indian Stratigraphy	2
10	Rock specimen preparation, Physical and Mechanical testing	4
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Billings, M.P., Structural Geology, 4th Edition, PHI Learning Private Ltd., 2010.
2. Read, H.H., Elements of Mineralogy,
3. Krishnan, M.S., Geology of India and Burma, 6th Edition, CBS Pub., 1999..

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.)	Physical models, Maps, Videos
19.4	Laboratory	Well equipped Engineering Geology lab.
19.5	Equipment	Fully Equiped
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	A compulsory 5 day field visit to suitable sites for Geological Mapping and Outcrop Study, to major construction sites.

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

20.1	Design-type problems	NA
20.2	Open-ended problems	NA
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	As per the syllabus

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>)	STRUCTURAL ANALYSIS LABORATORY
3.	L-T-P structure	0 - 0 - 2
4.	Credits	1
5.	Course number	
6.	Status (<i>category for program</i>)	CORE

7.	Pre-requisites (course no./title)	
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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	NA
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supercedes any existing course	NA

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	
12.	Will the course require any visiting faculty?	NA

13.	Course objective (<i>about 50 words</i>): To impart basic concepts of structural analysis to second year UG students through practical experimental setups	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Determination of forces and displacements in statically determinate and indeterminate trusses, Influence Line Diagram for Trusses, Measurement of bending moment and shear forces in beams, Determination of Elastic Properties of Beams, Verification of the Moment Area Theorem, Maxwell Betti Theorem, Influence Line Diagram for Displacement, Support Reaction, Shear Force at an Intermediate Section and Bending Moment, Determination of Carry over Factor, Verification of Carry Over Factor, Determination of displacements in curved members, Analysis of Elastically Coupled Beams, Determination of horizontal reactions in two and three hinged arches, experiment on cable structures	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
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COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Determination of forces and displacements in determinate trusses, Influence Line Diagram for Member Force	2
2	Determination of forces and displacements in an indeterminate truss	2
3	Measurement of bending moment and shear forces in beams	2
4	Determination of Elastic Properties of Beams	2
5	Verification of the Moment Area Theorem,	2
6	Influence Line Diagram for Support Reaction, Shear Force for a Statically Determinate Beam	2
7	Demonstration of the Maxwell-Betti theorem, Influence Line Diagram for Displacement	2
8	Influence Line Diagram for Bending Moment	2
9	Determination and verification of Carry Over Factor	4
10	Determination of Horizontal Reaction in a two hinged arch and Generation of the Influence Line Diagram for the Horizontal Reaction; Analysis of cable structures Analysis of a Elastically Couple Continuous Beam Determination of horizontal reactions for three hinged arch and influence line diagram for horizontal reactions	8
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

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

S. P. Timoshenko and D. H. Young, Engineering Mechanics, 5th Edition, Mc-Graw Hill 2013
 R.C. Hibbeler, Structural Analysis, 5th Edition, Pearson Education, 6th Edition
 C. K Wang, Intermediate Structural Analysis, Tata Mc-Graw Hill, 2010 Edition
 Devdas Menon, Structural Analysis, Narosa Publications, 2009

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

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

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)	

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>)	SOIL MECHANICS LABORATORY
3.	L-T-P structure	0 - 0 - 2
4.	Credits	1
5.	Course number	CEP XXX
6.	Status (<i>category for program</i>)	DC

7.	Pre-requisites (course no./title)	
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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	nil
8.2	Overlap with any UG/PG course of other Dept./Centre	nil
8.3	Supercedes any existing course	nil

9.	Not allowed for (indicate program names)	nil
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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. Manoj Datta, Prof. G.V. Ramana, Prof. J. T. Shahu, Dr. R. Ayothiraman, Dr. B. Manna, Dr. Tanusree Chakraborty	
12.	Will the course require any visiting faculty?	NO

13.	Course objective (<i>about 50 words</i>): To acquire hands on experinece of measuring and interpreting soil properties.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Visual Soil Classification; Water Content; Atterberg Limits; Grain Size Analysis; Specific Gravity; Permeability; standard proctor compaction test, consolidation test, site investigations and introduction to triaxial testing	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	NIL	
2		
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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	Introduction, Visual Classification, water content	2
2	Atterberg's Limits	2
3	Sieve Analysis and specific gravity	2
4	Hydrometer Analysis	4
5	Permeability Test: Constant Head and Fallig Head	4
6	Proctor Compaction test	4
7	Consolidation test	8
8	Site investigations	2
9	Introduction to Direct shear and Triaxial testing	2
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Relevant Indian Codes of practice
2. Head, K. H., Manual of soil laboratory testing, Volume 1, 2 and 3, Pentech press, 1980.
3. Lambe, T. W., Soil testing for engineers, John Wiley 1969.

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.)	
19.4	Laboratory	Well equipped soil mechanics lab.
19.5	Equipment	Fully Equiped
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	NIL.

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

20.1	Design-type problems	NA
20.2	Open-ended problems	NA
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	As per the syllabus

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>)	HYDRAULICS LABORATORY
3.	L-T-P structure	0 - 0 - 2
4.	Credits	1
5.	Course number	CEP
6.	Status (<i>category for program</i>)	DC

7.	Pre-requisites (course no./title)	CEL (Hydraulics or Concurrent with Hydraulics)
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	Nil
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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 All Water Resources Engineering Faculty	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To impart hands on experience on hydraulics of open channel flow, pipe flow and sediments transport.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Experiments on Open Channel Flow Hydraulics, Boundary Layer Theory, Pipe flow, Sediment transport.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
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2		
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12		
COURSE TOTAL (14 times 'L')		Nil

16. Brief description of tutorial activities

Nil

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Introduction to Lab and experiments Ten laboratory sessions will be held. (a) Velocity distribution in open channel flow	2
2	(b) Energy and momentum correction factors.	4
3	(c) Flow over a hump	2
4	(d) Hydraulic Jump	2
5	(e) Flow over a sharp crested weir	2
6	(f) Head losses through pipe bends and valves	4
7	(g) Study of Pipe fittings and Valves of the laboratory equipment	2
8	(h) Determination of sediment properties	4
9	(i) Uniform Flow in Open Channel	2
10	(h) Boundary Layer over Flat Plate	2
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

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|---|
| <ol style="list-style-type: none"> 1) Fox, R. W., and Alan T. McDonald, A. T., <i>Introduction to Fluid Mechanics</i>, John Wiley, 3rd Ed., John Wiley, 1985. 2) Subramanya, K., <i>Flow in Open Channel</i>, Tata McGraw Hill, 1991 3) Richard H. F. Pao, <i>Fluid Dynamics</i>, Charles E Merrill Books Inc, Ohio 4) Chow, V. T., <i>Open-channel Hydraulics</i>, McGraw Hill, 1985. 5) French, R. F., <i>Open-channel Hydraulics</i>, McGraw Hill, 1994. 6) Yang, C. T., <i>Sediment Transport - Theory & Practice</i>, McGraw Hill, 1996. |
|---|

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

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

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	10
20.5	Others (please specify)	

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>)	MATERIALS AND STRUCTURES LABORATORY - CONCRETE
3.	L-T-P structure	0 - 0 - 3
4.	Credits	1.5
5.	Course number	
6.	Status (<i>category for program</i>)	

7.	Pre-requisites (course no./title)	None
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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	NA

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	
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12.	Will the course require any visiting faculty?	No
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13.	Course objective (<i>about 50 words</i>): To provide hands-on knowledge about the production of concrete, its constituents, their properties, the behaviour of reinforced concrete elements	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Testing of cement, testing of aggregates, mixture design and testing, non-destructive tests, testing of reinforcement, behaviour of reinforced concrete beams under flexure and torsion, behaviour of reinforced concrete slabs under uniform and point loads, behaviour of reinforced concrete columns under concentric and eccentric loads	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	None	
2		
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12		
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

None

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Testing of aggregates - Sieve analysis, specific gravity, moisture content, crushing value; Test on bricks, masonry, Plastic, Timber	6
2	Testing of cements - Specific gravity, normal consistency, setting time	2
3	Mixture design - Effect of water content, effect of water-cement ratio, effect of chemical admixtures and supplementary cementitious materials	4
4	Testing of concrete - Compressive strength, Flexural strength, tensile strength	3
5	Behaviour of under-reinforced and over-reinforced concrete beams under flexure, effect of shear reinforcement,, behaviour of beams under torsion	9
6	Behaviour of reinforced concrete slabs under point loads and uniform loads	3
7	Behaviour of reinforced concrete columns under concentric and eccentric loading	3
8	One way ad two-way shear failure	3
9	Rebar test	3
10	Non destructive testing	3
COURSE TOTAL (14 times 'P')		42

18. Suggested texts and reference materials

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

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

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

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)	

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>)	GEOTECHNICAL ENGINEERING LABORATORY
3.	L-T-P structure	0 - 0 - 2
4.	Credits	1 . 0
5.	Course number	CEP XXX
6.	Status (<i>category for program</i>)	DC

7.	Pre-requisites (course no./title)	CEL XXX / Soil Mechanics
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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	nil
8.2	Overlap with any UG/PG course of other Dept./Centre	nil
8.3	Supercedes any existing course	nil

9.	Not allowed for (indicate program names)	nil
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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. J.T. Shahu, Prof. Manoj Datta, Prof. G.V. Ramana, Dr. B. Manna, Dr. T. Chakraborty, Dr. R. Ayothiraman	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): To evaluate important soil parameters required for geotechnical analysis and design	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Vane shear test, Direct shear test, Specimen preparation, Unconfined compression test, Unconsolidated undrained test, Consolidated drained test, Consolidated undrained test with pore water pressure measurement.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
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2		
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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	Vane shear test	2
2	Direct shear test	4
3	Specimen preparation	2
4	Unconfined compression test	2
5	Unconsolidated undrained test	4
6	Consolidated drained test	4
7	Consolidated undrained test with pore pressure measurement	10
8		
9		
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Head, K. H., Manual of soil laboratory testing, Volume 1, 2 and 3, Pentech press, 1980.
2. Lambe, T. W., Soil testing for engineers, John Wiley 1969.

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.)	Physical models, Videos

19.4	Laboratory	Well equipped Soil Mechanics lab.
19.5	Equipment	Fully Equiped
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	Nil

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

20.1	Design-type problems	NA
20.2	Open-ended problems	NA
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	As per the syllabus

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>)	TRANSPORTATION ENGINEERING I LAB
3.	L-T-P structure	0 - 0 - 2
4.	Credits	1
5.	Course number	CEP 2XX
6.	Status (<i>category for program</i>)	UG Core

7.	Pre-requisites (course no./title)	Surveying Course
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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	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	Nil
8.3	Supercedes any existing course	Nil

9.	Not allowed for (indicate program names)	Non-Civil Engineering Majors
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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. Geetam Tiwari, Dr. S.K. Deb, Dr. Kalaga Ramachandra Rao, Dr. Aravind Krishna Swamy	
12.	Will the course require any visiting faculty?	Nil

13.	Course objective (<i>about 50 words</i>): This course is designed to introduce student to various tests and surveys that are used in land based transportation mode. This course will run concurrently with CEL241. The experiments that shall be covered can be covered in this part shall be classified into 1) Material characterization, (2) Traffic surveys	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>):	
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	Introduction to material behavior; Characterization of materials used in pavement construction: soil, aggregate, asphalt, asphalt concrete; Introduction to traffic survey methodologies; Traffic surveys: speed studies, intersection study.
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
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2		
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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	Test on Subgrade: CBR test	2
2	Tests on Aggregates to determine its suitability for pavement applications like specific gravity measurement, durability tests, Abrasion test, Aggregate impact test, Aggregate crushing value test, and Shape tests	8
3	Tests on bitumen: Solubility test, Softening point test, Viscosity test, Brookfield viscometer (demo) and Flash & Fire point test	8
4	Test on Bituminous Mixes: Marshall stability test	6
5	Spot speed study (with speed gun)	2
6	Intersection study	2
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

Khanna, S.K. and Justo, C.E.G., Highway Engineering, Nem Chand Bros., 1998
 Kadiyali, L.R., Principles and Practice of Highway Engineering, Khanna Publishers, 2000
 Mannering, F.L. and Kilarseki, W.P., Washburn, S.C., Principles of Highway Engineering and Traffic Analysis, 4th Edition, John Wiley, 2009
 Papacostas, C.S. and Prevedourous, P.D., Transportation Engineering and Planning, 3rd Edition, Prentice-Hall India, New Delhi, 2002
 Meyer, M.D., Miller, E.J. Urban Transportation Planning, 2nd Edition, MCGraw Hill, New York 2001

Chakroborty, P., Das, A. Principles of Transportation Engineering, Prentice Hall, India, 2003
 Roess, R.P., Prassas, E.S. , W.R. McShane Traffic Engineering, 3rd Edition, Pearson, 2004
 Sheffi, Y, Urban Transportation Networks, Prentice Hall, 1985

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

19.1	Software	MS Excel
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Laptop, Multimedia projector
19.4	Laboratory	Yes
19.5	Equipment	Yes
19.6	Classroom infrastructure	Yes (Approximately 120 students every year)
19.7	Site visits	One time during semester

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

20.1	Design-type problems	70
20.2	Open-ended problems	10
20.3	Project-type activity	20
20.4	Open-ended laboratory work	0
20.5	Others (please specify)	0

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>)	MATERIALS AND STRUCTURES LABORATORY - STEEL	
3.	L-T-P structure	0 - 0 - 2	
4.	Credits	1	
5.	Course number		
6.	Status (<i>category for program</i>)	CORE	
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)	NA	
10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem	
11.	Faculty who will teach the course		
12.	Will the course require any visiting faculty?	No	
13.	Course objective (<i>about 50 words</i>): To understand and develop the material, component and assemblage behaviour of steel structures		
14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Basic properties of structural steel; Tensile stress-strain behaviour; Buckling of slender columns, Flexural testing of beams; Torsional behaviour of beams, Unsymmetrical bending; Lateral-torsional buckling; Flexural-torsional buckling; Connection behaviour; Tension-field action in plate girders.		

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

Module no.	Topic	No. of hours
1		
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10		
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12		
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Tension test on a structural steel and reinforcement bars	4
2	Buckling test on steel columns	2
3	Bending test on steel beams	4
4	Unsymmetrical bending test on beams	4
5	Torsion test on beams	2
6	Flexural-torsional elastic buckling of beams	2
7	Lateral torsional buckling of thin-walled columns	4
8	Tension-field action in plate girder	2
9	Test on bolted connections	4
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

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

- Subramanian, N. (2008). Design of Steel Structures, Oxford University Press.
- Bhavikatti, S. S. (2010). Design of Steel Structures (as Per IS: 800—2007), Second Edition, IK International Publishing, New Delhi.
- Segui, W.T. (2007). Design of Steel Structures, Cengage Learning.
- Salmon, C.G. and Johnson, J.E. (1996). Steel Structures: Design and Behaviour, Prentice Hall.
- McCormac, J.C. (1995). Structural Steel Design: LRFD Method, Harper Collins Publishers.
- IS: 800-2007 General Constructions in Steel-Code of Practice, Bureau of Indian Standards, New Delhi.
- IS:808-1989 & SP:6 (1)-1964: Handbook for structural steel sections. Bureau of Indian Standards, New Delhi.
- SP:6 (6)-1972: Handbook for structural engineers-Application of plastic theory in

design of steel structures, Bureau of Indian Standards, New Delhi.

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

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

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)	

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>)	STRUCTURAL DESIGN AND DETAILING
3.	L-T-P structure	0 - 0 - 3
4.	Credits	1 . 5
5.	Course number	
6.	Status (<i>category for program</i>)	Core

7.	Pre-requisites (<i>course no./title</i>)	Reinforced Concrete Design Steel Design
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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	Supercedes any existing course	No

9.	Not allowed for (<i>indicate program names</i>)	NIL
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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 -	
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12.	Will the course require any visiting faculty?	No
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13.	Course objective (<i>about 50 words</i>): To teach structural design of real-life structure made of reinforced concrete (RC) and steel; To teach member and joint detailing required for RC and steel elements; To make the students aware of ductile detailing requirements, Indian standard (IS) code recommendations and practical intricacies involved in casting/ fabrication of members, its sequence and constructability.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Part-I Concrete Structures Computer-aided analysis and design of real-life reinforced concrete (RC) structure. Dimensioning of concrete elements based on modular formworks available in construction industry. Detailing of concrete elements in terms of reinforcement, curtailment, lapping, splicing of reinforcements and connection with adjoining elements in the structure; member drawings. Joint detailing from	
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	ductility view point, Indian standard (IS) code recommendations and practical intricacies involved in casting and handling of the RC members, its sequence of construction and constructability. Part-II Steel Structures Computer-aided analysis and design of real-life steel structure. Steel member details as per shop/ field activities for welding/ bolting; i.e. fabrication (shop) drawings. Connection details, gusset plate design and detailing from ductility view point, Indian standard (IS) code recommendations and practical intricacies involved in fabrication and handling of the steel members, its sequence of erection and constructability.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
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12		
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Developing a computer model of reinforced concrete (RC) real-life structure; Loads, combinations and analysis types for the RC structure; Concrete member design	3
2	RC member and connection detailing	3
3	Bar bending; Reinforcement bar splicing	3
4	RC members detailing for ductility and drawings	9
5	Bar bending schedule	3
6	Developing a computer model of real-life steel structure; Loads, combinations and analysis types of the steel structure; Steel member design	3
7	Steel member and connection detailing	3
8	Welding and bolting details, finishing	3
9	Steel members detailing for ductility and drawings	9
10	Gusset plate design and sizing	3
COURSE TOTAL (14 times 'P')		42

18. Suggested texts and reference materials

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

IS 875 : Code of practice for design loads (other than earthquake) for buildings and structures, All Parts
Concrete:: Year - Latest Edition
IS 456 : General Construction in Concrete - Code of Practice
SP 16 : Design Aids for Reinforced Concrete to IS 456
SP 24 : Explanatory Handbook on Indian Standard Code of Practice for Plain and Reinforced Concrete
SP 34 : Handbook on Concrete Reinforcement and Detailing
SP 43 : 1987 Handbook on Structures with Reinforced Concrete Portal Frames (Without Cranes)

IS 2502 : Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
 IS 5525 : Recommendations for Detailing of Reinforcement in Reinforced Concrete Works
 IS 13920 : Ductile detailing of reinforced concrete structures subjected to seismic forces - Code of practice
 Steel:: Year - Latest Edition
 IS 800 : General Construction in Steel - Code of Practice
 SP 6 : Handbook for structural engineers, All Parts
 SP 38 : Handbook of Typified Designs for Structures with Steel Roof Trusses (with and without Cranes)
 SP 40 : Handbook on Structures with Steel Portal Frames
 SP 47 : Handbook on Structures with Steel Lattice Portal Frames (Without Cranes)

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

19.1	Software	AutoCAD, STAAD Pro, SAP2000, ETABS etc.
19.2	Hardware	Computers
19.3	Teaching aides (videos, etc.)	Videos
19.4	Laboratory	Computational Laboratory
19.5	Equipment	-
19.6	Classroom infrastructure	-
19.7	Site visits	Two site visits

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

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

Date: 10th September 2013

(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
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL XXX
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	DC15E
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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	CEL879 (< 15% overlap)
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)	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 Prof. Mukesh Khare, Prof. Atul K.Mittal, Prof.A.K. Nema; Prof. B.J. Alappat, Dr. Gazala Habib, and Dr. Arun Kumar	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To provide students understanding about industrial wastes and their treatment and management alternatives	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): industrial waste types and characteristics; levels of environmental pollution due to industrial wastes; health issues due to industrial wastes; ecological and human health risk assessment due to industrial wastes; waste characterization methods; treatment methods-conventional and recent trends (for air, water, soil media); Prevention versus control of industrial pollution; hierarchy of priorities for industrial waste management; comparison of real-life industrial waste management practices (ex: superfund remedial sites, etc.); economics of industrial waste management and sustainability issues; environmental rules	
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	and regulations; clean up goals;disposal/reuse of treated wastes; Source reduction and control of industrial water and air pollution; Minimization of industrial solid and hazardous waste; Waste management case studies from various industries.
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Industrial waste types and characteristics; levels of environmental pollution	2
2	Health issues due to industrial wastes; ecological and human health risk assessment due to industrial wastes;	4
3	Waste characterization methods; treatment methods-conventional and recent trends (for air, water, soil media);	6
4	Prevention versus control of industrial pollution; hierarchy of priorities for industrial waste management;	2
5	Economics of industrial waste management and sustainability issues;	2
6	Environmental rules and regulations; clean up goals	4
7	Source reduction and control of industrial water pollution; disposal/reuse of treated wastes	4
8	Source reduction and control of industrial air pollution;	4
9	Minimization of industrial solid and hazardous waste;	4
10	Comparison of real-life industrial waste management practices (ex: superfund remedial sites, etc.);	4
11	Waste management case studies from various industries.	6
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

- Peavy, H.S., Rowe D.R., and Tchobanoglous G., "Environmental Engineering", McGraw Hill Int. 2000.
- Woodard, Curran. *Industrial Waste Management Handbook* Elsevier,,2nd Ed. 2006.
- Allegri, T.H. *Handbook and management of hazardour materials and waste*,Chapman and Hall,1986.

Wentz, C.A. 1989. Hazardous Waste Management, McGraw Hill, New York.
 Hass, C.N. and Vamos, R.J., Hazardous and Industrial Waste Treatment, Englewood Cliffs, NJ.

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

19.1	Software	no
19.2	Hardware	no
19.3	Teaching aides (videos, etc.)	no
19.4	Laboratory	no
19.5	Equipment	no
19.6	Classroom infrastructure	projector, laptop
19.7	Site visits	no

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	25%
20.3	Project-type activity	25%
20.4	Open-ended laboratory work	0%
20.5	Others (please specify)	40% Thoery

Date: 15.01.2014

(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 ASSESSMENT METHODOLOGIES
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL XXX
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	DC15E
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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)	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. G. Habib/ Prof. M. Khare/Prof. A. K. Nema/ Prof. B. J. Alappat/ Prof. A. K. Mittal/ Dr. A. Kumar	
12.	Will the course require any visiting faculty?	NO

13.	Course objective (<i>about 50 words</i>): This course is aimed at providing an overall understanding of methodologies, which can be used for environmental assessment of developmental activities and their role in sustainable development.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Environmental issues related to developmental activities: Nature and characteristics of environmental impacts of urban and industrial developments. Linkages between technology, environmental quality, economic gain, and societal goals. Environmental indices and indicators for describing affected environment. Methodologies and environmental systems modeling tools for prediction and assessment of impacts on environmental quality (surface water, ground water, air, soil).	
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	Monitoring and control of undesirable environmental implications. Environmental cost benefit analysis. Decision methods for evaluation of environmentally sound alternatives. Environmental health and safety: Basic concepts of environmental risk and definitions; Hazard identification procedures; Consequence analysis and modeling (discharge models, dispersion models, fire and explosion models, effect models etc.). Emerging tools for environmental management: Environmental Management Systems, Environmentally sound technology transfer, emission trading, international resource sharing issues, climate change, international environmental treaties and protocols. Case studies.
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Nature and characteristics of environmental impacts of urban and industrial developments	3
2	Linkages between technology, environmental quality, economic gain, and societal goals	2
3	Environmental indices and indicators for describing affected environment	3
4	Methodologies and environmental systems modeling tools for prediction and assessment of impacts on environmental quality	6
5	Monitoring and control of undesirable environmental implications	3
6	Environmental cost benefit analysis. Decision methods for evaluation of environmentally sound alternatives	5
7	Basic concepts of environmental risk and definitions; Hazard identification procedures	5
8	Consequence analysis and modeling (discharge models, dispersion models, fire and explosion models, effect models etc.).	4
9	Environmental Management Systems	3
10	Environmentally sound technology transfer	2
11	Emission trading, international resource sharing issues	2
12	Climate change, international environmental treaties and protocols	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

- Dupont, R., Joseph P. Reynolds, L. Theodore, Accident and Emergency Management: Problems and Solutions, John Wiley & Sons, 1991
- Schnoor Jerald L., "Environmental Modelling - Fate and Transport of pollutant in Water, Air and Soil", A Wiley Interscience Publication John Wiley & Sons, 1996
- Hadlock Charles R, "Mathematical Modelling in the Environment", The Mathematical

Association of America, 1998.

- Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York, 1996
- Willing J.T., "Strategic Environmental Management: Using TQEM and ISO 14000 for Competitive Advantage", John Wiley & Sons. Inc, 1998

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

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

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

20.1	Design-type problems	0
20.2	Open-ended problems	30
20.3	Project-type activity	30
20.4	Open-ended laboratory work	0
20.5	Others (please specify)	40 (Theory)

Date: 15.01.2014

(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 AND NOISE POLLUTION
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CELXXX
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (<i>course no./title</i>)	DC15E
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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	CEL793 (< 15% overlap)
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>)	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. G. Habib/ Prof. M. Khare/Prof. A. K. Nema/ Prof. B. J. Alappat/ Prof. A. K. Mittal/ Dr. A. Kumar	
12.	Will the course require any visiting faculty?	

13.	Course objective (<i>about 50 words</i>): 1. To understand the natural and anthropogenic sources of air pollutants 2. To understand the impact of air pollutants on society 4. To understand principle of air quality monitoring. 5. To understand the sources and impact of noise pollution 6. To learn the analysis and interpretation of air and noise pollution data	
14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Definitions, source and types of air and noise pollution, physical and chemical properties of air pollutants, secondary pollutants formation, instrument design and industrial application, gas phase adsorption and biofiltration, carbon credit, global warming potential, case studies, data analysis, interpretation	

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

Module no.	Topic	No. of hours
1	Introduction and definitions: Air pollution, noise pollution, pollutants	2
2	Types of pollutants, sources, measurement units: primary pollutants, secondary pollutants, green house gases, short term and long term pollutants, Natural sources, anthropogenic sources, Energy use pattern, technological drawbacks and advances responsible for pollution	4
3	Design of air and noise pollution instruments	6
4	Indoor and outdoor air and noise pollution: Causes, Current status in various parts of the world and impact, impact on human, local and regional air quality and climate, global climate	4
5	Physical, optical and chemical properties of air pollutants and relation to anthropogenic activities	4
6	Fate of pollutants in the atmosphere: secondary pollutant formation, life time, transportation at regional and global scale	4
7	Gas phase adsorption and biofiltration	4
8	Principal and experimental design of air and noise pollution monitoring and limitations	3
9	Global warming potential estimation and implication	2
10	Carbon credits and clean development mechanism: Implications in various parts of the world	3
11	Industrial application of various instruments	4
12	Case studies, data analysis and interpretation	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

Sportisse, B. Fundamentals of Air Pollution: From Processes to modelling, Springer, New York, USA, 2008.

Rao M. N. and Rao, H. V. N., Air pollution, Tata McGraw-Hill, 1989.

Wang, L. K., Pereira, N., C., Hung, Y. Advance air and noise pollution control, Humana press Inc, New Jersey, 2005.

Wang, L. K., Pereira, N. C., Hung, Y., Air pollution Control Engineering, Springer Science, New York, 2004.

Agarwal S. K., Noise pollution, A P H Publishing corporation, New Delhi, 2009.

Vallero, D., Fundamentals of air pollution, Academic Press Elsevier, California, USA, 2008

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

19.1	Software	no
19.2	Hardware	no
19.3	Teaching aides (videos, etc.)	no
19.4	Laboratory	no
19.5	Equipment	no
19.6	Classroom infrastructure	projector, laptop
19.7	Site visits	no

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

20.1	Design-type problems	25%
20.2	Open-ended problems	25%
20.3	Project-type activity	10%
20.4	Open-ended laboratory work	0%
20.5	Others (please specify)	40% Theory

Date: 15.01.2014

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Geotechnical Engineering Section, Department of Civil Engineering	
2.	Course Title (<i>< 45 characters</i>)	GROUND ENGINEERING	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	CEL XXX	
6.	Status (<i>category for program</i>)	DE	

7.	Pre-requisites (course no./title)	Geotechnical Engineering	
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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	nil	
8.2	Overlap with any UG/PG course of other Dept./Centre	nil	
8.3	Supercedes any existing course	nil	

9.	Not allowed for (indicate program names)	nil	
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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. Manoj Datta, Prof. G. V. Ramana, Prof. J. T. Shahu, Dr. R. Ayothiraman, Dr. B. Manna, Dr. T. Chakraborty		
12.	Will the course require any visiting faculty?	no	

13.	Course objective (<i>about 50 words</i>): To teach students different methods of ground investigation and subsequent ground improvement methods		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Planning of investigation programmes, Geophysical methods. Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, Methods of stabilizing the bore holes, measurement of water table, field record. Principles of compaction, Laboratory compaction, Engineering behaviour of compacted clays, Field compaction techniques- static, vibratory, impact, Compaction control. Shallow stabilization with additives: Lime, flyash, cement and other chemicals and bitumen; Deep Stabilization: sand column, stone column, sand drains, prefabricated drains, electroosmosis, lime column. soil-lime column, blasting. Grouting : permeation, compaction and jet. Vibro-floatation, dynamic		
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	compaction, thermal freezing. Dewatering systems. Functions and applications of geosynthetics – geotextiles, geogrids, geomembranes; soil reinforcement using strips, bars and geosynthetics; soil nailing and ground anchors, Earthmoving machines and earthwork principles, Piling and diaphragm wall construction, Tunneling methods in soils, Hydraulic barriers and containment systems for waste disposal in soil, Control and remediation of soil contamination.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Planning of investigation programmes, Geophysical methods.	3
2	Methods of site investigations: Direct methods, semi-direct methods and indirect methods.	3
3	Drilling methods. Boring in soils and rocks, Methods of stabilizing the bore holes, Measurement of water table, Field record.	4
4	Principles of compaction, Laboratory compaction, Engineering behaviour of compacted clays, Field compaction techniques- static, vibratory, impact, Compaction control.	6
5	Shallow Stabilization with Additives: Lime, flyash, Cement and other chemicals and bitumen.	4
6	Deep Stabilization: Sand column, Stone column, Sand drains, prefabricated drains, Electroosmosis, Lime column. Soil-lime column, Blasting.	4
7	Grouting : Permeation, Compaction and jet. Vibro-floatation, Dynamic compaction, Thermal freezing.	5
8	Dewatering systems.	3
9	Functions and applications of geosynthetics – geotextiles, geogrids, geomembranes, Soil reinforcement using strips, bars and geosynthetics, Soil nailing and ground anchors.	3
10	Earthmoving machines and earthwork principles.	2
11	Piling and diaphragm wall construction, Tunneling methods in soils.	3
12	Hydraulic barriers and containment systems for waste disposal in soil, Control and remediation of soil contamination.	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Hausmann, M.R. (1989). Engineering principles of ground modification. McGraw-Hill
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College.

2. Moseley, M.P. and Kirsch, K. (2004). Ground improvement. CRC Press.
3. Gulhati, S. K., and Datta M. (2005) Geotechnical Engineering, 1st edition, Tata Mcgraw Hill.

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.)	NONE
19.4	Laboratory	Well equipped Soil mechanics laboratory
19.5	Equipment	Fully Equiped
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	

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

20.1	Design-type problems	50
20.2	Open-ended problems	20
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	30 (explanation of theories)

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>)	ROCK ENGINEERING
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL XXX
6.	Status (<i>category for program</i>)	UG

7.	Pre-requisites (<i>course no./title</i>)	CEL XXX / GEOTECHNICAL ENGINEERING
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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	nil
8.2	Overlap with any UG/PG course of other Dept./Centre	nil
8.3	Supercedes any existing course	nil

9.	Not allowed for (<i>indicate program names</i>)	nil
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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. J. T. Shahu, Prof. K.S. Rao, Prof. K.G. Sharma, Prof. Manoj Datta, Prof. G.V. Ramana, Dr. R. Ayothiraman, Dr. Tanusree Chakraborty, Dr. B. Manna	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): To teach about evaluation and engineering properties of rock and rock masses for civil engineering construction. Analysis and design of some important civil engineering structures in rocks, namely, slopes, foundations and underground structures will also be introduced.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Geological classification, rock and rock mass classification, strength and deformation behaviour of rocks, pore pressures, failure criteria, laboratory and field testing, measurement of in-situ stresses and strains, stability of rock slopes and foundations, design of underground structures, improvement of in situ properties of rock masses and support measures.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Classification of rock and rock mass	7
2	Strength and deformation behaviour of rocks	6
3	Laboratory and field testing	6
4	Measurement of in situ stresses and strains	6
5	Rock slopes and foundations	6
6	Underground structures	5
7	Support measures	6
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Richard E. Goodman, Introduction to Rock Mechanics, John Wiley, 1989.
2. T. Ramamurthy, ed., Engineering in Rocks, PHI Limited, 2008.
3. Hoek E. and Bray J, Rock Slope Engineering, Spon Press, 3rd Ed., 2001.
4. Duncan Wyllie, Foundations on Rock, Spon Press, 1992.
5. Pietro Lunardi, Design and Construction of Tunnels, Springer, 2008.

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.)	NONE
19.4	Laboratory	Well equipped Rock Laboratory
19.5	Equipment	Fully Equiped
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	

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

20.1	Design-type problems	50
20.2	Open-ended problems	20
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	30 (explanation of theories)

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>)	DESIGN OF FOUNDATIONS AND RETAINING STRUCTURES
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL XXX
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	Geotechnical Engineering
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	NIL
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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 All Faculty of Geotechnical Engineering Section	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To teach design aspects of different types of foundations and retaining structures	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Shallow Foundations: Bearing Capacity, Generalized bearing capacity theory, Empirical methods, Layered soil, Foundations on or near slopes, Settlement of foundations, codal provisions. Pile Foundations: Types and their selection, Ultimate load of individual piles in compressive, uplift, and lateral loading, Pile load tests, Downdrag, Pile groups. Caissons. Codal provisions. Earth Retaining Structures: Types, Earth pressures, Design of rigid, flexible and reinforced soil retaining walls, braced excavations, and ground anchors for retaining walls. Introduction to design of foundation for dynamic loads.	
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Bearing capacity: Theory and empirical formulae, codal guidelines, Bearing capacity in Layered soil and foundation near slopes	6
2	Settlement: Estimation and permissible settlements, codal guidelines. Interpration of design parameters from soil report and design of shallow foundations. Codal provisions.	4
3	Pile foundations: Pile capacity in compression and uplift loadings, downdrag.	4
4	Pile foundations: Pile capacity in lateral loading. Pile group interaction, pile settlement, pile load testing, and codal guidelines.	6
5	Caissons: Design and construction/sinking, codal provisions	5
6	Earth Retaining Structures: Types, Earth pressures, Design of rigid retaining walls.	4
7	Design of flexible retaining walls: Types, analysis and design of cantilever sheet pile wall and anchored sheet pile wall. Design of waler beams, struts, and ground anchors. Codal provisions.	7
8	Theory of arching. Design of braced excavations.	4
9	Introduction to design of foundations for dynamic loads.	2
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

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: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Bowles. J. E., Foundation Analysis and Design, 5th Edition, Tata McGraw-Hill International Edition, 1997.
2. Das B. M., Shallow Foundations: Bearing capacity and settlement, CRC Press., 1999.
3. Kurian, N. P. (1994), Design of Foundation Systems - Principles and Practices, 2nd

Edition, Narosa Publishing House, 1994.

4. Tomlinson M. and Woodward, J. Pile design and construction Practice, 5th Edition, Taylors & Francis, 2008.
5. Clayton, C. R. I., Milititsky, J. and Woods, R. I., Earth Pressure and Earth Retaining Structures, Blackie Academic & Professional, 1993.

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.)	Black board, OHP, PPT, Videos and site visits
19.4	Laboratory	NA
19.5	Equipment	NA
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	YES

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

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

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>)	STABILITY OF SLOPES
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL XXX
6.	Status (<i>category for program</i>)	UG

7.	Pre-requisites (course no./title)	CEL XXX / Geotechnical Engineering
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	NIL
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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. Manoj Datta, Prof. G.V. Ramana, Prof. J. T. Shahu, Dr. R. Ayothiraman Dr. B. Manna, Dr. Tanusree Chakraborty,	
12.	Will the course require any visiting faculty?	NO

13.	Course objective (<i>about 50 words</i>): To teach design of finite and infinite slopes and earth dams to civil engineering structures	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Slope Stability: Short term and long term stabilities; Limit equilibrium methods; Infinite slopes; Finite height slopes - Swedish method, Bishop's simplified method, Stability charts; Conditions of analysis - steady state, end of construction, sudden draw down conditions; Factor of safety; Codal provisions; Earthquake effects. Seepage Analysis: Types of flow; Laplace equation; Flownet in isotropic, anisotropic and layered media; Entrance-exit conditions; Theoretical solutions; Determination of phreatic line. Earth Dams: Introduction; Factors influencing design; Design of components; Instrumentation. Reinforced Slopes: Steep slopes; Embankments on soft soils; Reinforcement design	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Slope Stability: Short term and long term stabilities; Limit Equilibrium Method	3
2	Infinite Slopes	4
3	Finite height slopes - Swedish method, Bishop's simplified method	7
4	Stability charts	4
5	Conditions of analysis - steady state, end of construction, sudden draw down conditions; Earthquake effects	4
6	Seepage Analysis: Types of flow; Laplace equation; Flownet in isotropic, anisotropic and layered media	6
7	Entrance-exit conditions; Theoretical solutions; Determination of phreatic line	4
8	Earth Dams: Introduction; Factors influencing design; Design of components; Construction; Instrumentation	6
9	Reinforced Slopes: Steep slopes; Embankments on soft soils; Reinforcement design	4
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

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: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Abramson, L. W., Lee, T. S., Sharma, S. and Boyce, G. M., *Slope Stability and Stabilization Methods*, Wiley & Sons Inc., 1995.
2. Duncan, J.M. and Wright, S.G., *Soil Strength and Slope Stability*, John Wiley & Sons., 2005.
3. Sowers, G. F. and Sally, H. L., *Earth and Rockfill Dam Engineering*, Asia Publishing House, 1962.

4. Das, B. M., Advanced Soil Mechanics, Taylor & Francis, 2nd Edition, 1997.

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.)	Black board, OHP, PPT, Videos
19.4	Laboratory	NA
19.5	Equipment	NA
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	NA

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

20.1	Design-type problems	Assignments (4)
20.2	Open-ended problems	NA
20.3	Project-type activity	Term Paper
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	NA

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 GEOTECHNICS & GEOSYNTHETICS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL XXX
6.	Status <i>(category for program)</i>	DE

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	20% with PG
8.2	Overlap with any UG/PG course of other Dept./Centre	nil
8.3	Supersedes any existing course	nil

9.	Not allowed for <i>(indicate program names)</i>	nil
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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. Manoj Datta, Prof. G.V. Ramana, Prof. J. T. Shahu, Dr. R. Ayothiraman, Dr. B. Manna, Dr. Tanusree Chakraborty	
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12.	Will the course require any visiting faculty?	NO
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13.	Course objective <i>(about 50 words):</i> To enable students to learn the methods for prevention of subsurface contamination. To enable students learn about use of geosynthetics in geotechnical engineering.	
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14.	Course contents <i>(about 100 words) (Include laboratory/design activities):</i> Causes and effects of subsurface contamination; Waste disposal on land; Characteristics of solid wastes; Waste Containment Principles; Types of landfills; Planning of landfills; Design of liners and covers for landfills; Environmental Monitoring around landfills; Detection, control and remediation	
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	of subsurface contamination; Geotechnical re-use of solid waste materials. Types of geosynthetics; Manufacturing; Functions; Testing and evaluation; Designing with geotextiles, geogrids, geonets and geomembranes.
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15.	Lecture Outline <i>(with topics and number of lectures)</i>	
Module no.	Topic	No. of hours
1	Causes and effects of subsurface contamination	2
2	Solid waste characteristics, disposal on land, containment principles	3
3	Landfills - types and planning	3
4	Design of Liners and Covers	6
5	Environmental monitoring	3
6	Detection, control, remediation of subsurface contamination	3
7	Geotechnical re-use of solid waste materials	2
8	Geosynthetics - types and functions,	3
9	Manufacturing, uses, testing and evaluation	3
10	Designing with geotextiles	6
11	Designing with geomembranes	4
12	Designing with geogrids and geonets	4
COURSE TOTAL (14 times 'L')		42

16.	Brief description of tutorial activities
NIL	

17.	Brief description of laboratory activities	
Moduleno.	Experiment description	No. of hours
1	NIL	
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18.	Suggested texts and reference materials STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., <i>Fundamentals of Thermodynamics</i> , 5 th Ed., John Wiley, 2000.
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1. Gulhati, S. K., and Datta Manoj, Geotechnical Engineering, 1st edition, Tata Mcgraw Hill 2005.
2. Daniel, D.E., Geotechnical Practice for Waste Disposal, Chapman and Hall, 1993
2. Koernor, R. M., Designing with Geosynthetics, Prentice hall 1998

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.)	NONE
19.4	Laboratory	Well equipped Geoenvironmental and geosynthetics Laboratory
19.5	Equipment	Fully Equiped
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	

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	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	50 (explanation of basic theories)

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>)	UNDERGROUND STRUCTURES
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL XXX
6.	Status (<i>category for program</i>)	UG

7.	Pre-requisites (course no./title)	CEL XXX Rock Engineering
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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	CEL758
8.2	Overlap with any UG/PG course of other Dept./Centre	nil
8.3	Supercedes any existing course	nil

9.	Not allowed for (indicate program names)	nil
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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. K.G. Sharma, Prof. K.S. Rao, Prof. G.V. Ramana	
12.	Will the course require any visiting faculty?	NO

13.	Course objective (<i>about 50 words</i>): To teach the analysis and design of underground structures together with coverage of simple softwares and field practices.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Types and classification of underground structures, Functional aspects, Sizes and shapes, Support systems, Design methodology. Stresses- deformation analysis of openings (circular, elliptical, spherical, ellipsoidal) using analytical and numerical methods Design of underground structures using analytical methods, empirical methods and observational methods, Rock support interaction analysis, NATM Hydraulic tunnels, Shafts, Tunnel portals, Metro tunnels	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Types and classification of underground structures, Functional aspects, Sizes and shapes, Support systems, Design methodology.	5
2	Stress, Strain, Stress-Strain Relations	4
3	Stresses- deformation analysis of openings (circular, elliptical, spherical, ellipsoidal) using analytical method	8
4	Stresses- deformation analysis of openings (circular, elliptical, spherical, ellipsoidal) using numerical methods, Introduction of software Phase2	5
5	Design of underground structures using empirical methods (RMR and Q Systems)	6
6	Rock support interaction analysis	3
7	Design of underground structures using observational methods, NATM	3
8	Hydraulic tunnels	3
9	Shafts, Tunnel portals, Metro tunnels	5
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Hoek, E. and Brown, E.T., *Underground Excavations in Rock*, The Institution of Mining & Metallurgy, 1980.
2. Singh, B. and Goel, R.K., *Engineering Rock Mass Classification*, Elsevier, 2011.
3. Bieniawski, Z.T., *Rock Mechanics in Mining & Tunnelling*, A.A. Balkema, 1984.
4. Goodman, R.E., *Introduction to Rock Mechanics*, John Wiley, 1980.
5. Obert, L. and Duvall, W.I., *Rock Mechanics and the Design of Structures in Rock*, John

Wiley, 1967.

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.)	NONE
19.4	Laboratory	None
19.5	Equipment	None
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	

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

20.1	Design-type problems	40
20.2	Open-ended problems	20
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	40 (explanation of basic theories)

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	CIVIL ENGINEERING		
2.	Course Title (< 45 characters)	GEOTECHNICAL DESIGN STUDIO		
3.	L-T-P structure	0 - 0 - 4		
4.	Credits	2		
5.	Course number	CEL XXX		
6.	Status (category for program)	DE		

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

9.	Not allowed for (indicate program names)	nil		
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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 Faculty of geotechnical engineering section			
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12.	Will the course require any visiting faculty?	NO		
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13.	Course objective (about 50 words): To enable the students use commercially available softwares such as modules of Geo-Studio, RockScience and PLAXIS for the solution of practical engineering problems such as consolidation, seepage, slope stability, foundation and retaining structures.			
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14.	Course contents (about 100 words) (Include laboratory/design activities): Seepage analysis through an earth dam. Slope stability analysis of a dam. Settlement analysis of shallow and deep foundations; Analysis and design of retaining structures; Analysing the structural forces in a tunnel lining.			
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15.	Lecture Outline <i>(with topics and number of lectures)</i>
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Module no.	Topic	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		0

16.	Brief description of tutorial activities
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NIL

17.	Brief description of laboratory activities
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Moduleno.	Experiment description	No. of hours
1	Introduction to Geotechnical Software	4
2	Establishing the Phreatic Line and Analysis of Seepage	8
3	Slope Stability Analysis	12
4	Settlement analysis of shallow and deep foundations	8
5	Analysis and design of a retaining structures	8
6	Analysis of structural forces in tunnel lining	8
7	Design Project	8
8		
9		
10		
COURSE TOTAL (14 times 'P')		56

18.	Suggested texts and reference materials
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STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Gulhati, S. K., and Datta Manoj, Geotechnical Engineering, 1st edition, Tata Mcgraw Hill 2005.
2. Manuals of Softwares such as Geo-Studio, PLAXIS and FLAC.

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19.	Resources required for the course (<i>itemized & student access requirements, if any</i>)
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19.1	Software	Available
19.2	Hardware	Available
19.3	Teaching aides (videos, etc.)	NONE
19.4	Laboratory	Well equipped computational laboratory
19.5	Equipment	Fully Equiped
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	Yes

20.	Design content of the course (<i>Percent of student time with examples, if possible</i>)
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20.1	Design-type problems	50
20.2	Open-ended problems	20
20.3	Project-type activity	30
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	NA

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>)	SOIL DYNAMICS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL XXX
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	Geotechnical Engineering
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	NIL
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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 All Faculty of Geotechnical Engineering Section	
12.	Will the course require any visiting faculty?	NO

13.	Course objective (<i>about 50 words</i>): To teach (i) behaviour of soil under dynamics loads including earthquake loads, (ii) design of foundations and retaining structures under machine-induced dynamic loads and earthquake loads	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Engineering problems involving soil dynamics; Role of inertia; Theory of Vibrations: Single and two-degree freedom systems; Wave propagation in elastic media; Soil behaviour under cyclic/dynamic loading; Small and large strain dynamic properties of soils; Design criteria for machine foundations; Elastic homogeneous half space and lumped parameter solutions; Vibration isolation; Codal provisions; Causes of Earthquakes; Strong Ground Motion: Measurement, characterization and estimation; Amplification theory and ground response analysis; Liquefaction of soil and its remediation; Seismic slope stability; Seismic bearing capacity and earth pressures	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Engineering problems involving soil dynamics; Role of inertia	2
2	Theory of Vibrations: Single and two-degree freedom systems	6
3	Wave propagation in infinite and semi-infinite elastic medium	2
4	General nature of soil behaviour under cyclic/dynamic loading; Small and large strain dynamic properties of soils: measurement from field and lab tests and estimation using empirical equations	6
5	Design criteria for machine foundations; Elastic homogeneous half space and lumped parameter solutions; Vibration isolation; Codal provisions	8
6	Causes of Earthquakes: Mechanism, Plate tectonic and elastic rebound theories, Magnitude and Intensity	3
7	Strong Ground Motion: Measurement, characterization and estimation; Amplification theory and ground response analysis	5
8	Liquefaction of soil: Definition, Assessment of liquefaction susceptibility, Evaluation of liquefaction potential, Principles of liquefaction remediation	5
9	Seismic slope stability; Seismic bearing capacity and earth pressures.	5
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Das, B.M. and Ramana, G. V. Principles of Soil Dynamics, 2nd Edition, CENGAGE Learning, USA, 2011.
2. Day, R. W. Geotechnical Earthquake Engineering Handbook. McGraw-Hill, New York, 2002.

3. Kramer, S.L. Geotechnical Earthquake Engineering. Prentice-Hall, Inc., 1996.
4. Prakash, S., Soil Dynamics, McGraw Hill, 1981.
5. Prakash, S. and Puri, V. K., Foundation for machines: Analysis and Design, John Wiley & Sons, 1998.
6. Swami Saran. Soil Dynamics and Machine Foundations. Galgotia Publishers, New Delhi, 2006.

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.)	Black board, OHP, PPT, Videos and site visits
19.4	Laboratory	NA
19.5	Equipment	NA
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	YES

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

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

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Geotechnical Engineering Section, Department of Civil Engineering	
2.	Course Title (<i>< 45 characters</i>)	FINITE ELEMENT METHOD IN GEOTECHNICAL ENGINEERING	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	CEL XXX	
6.	Status (<i>category for program</i>)	UG	

7.	Pre-requisites (course no./title)	CEL XXX / Soil Mechanics, Geotechnical Engineering	
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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	nil	
8.2	Overlap with any UG/PG course of other Dept./Centre	nil	
8.3	Supercedes any existing course	nil	

9.	Not allowed for (indicate program names)	nil	
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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. K. G. Sharma, Prof. M. Datta, Prof. G. V. Ramana, Prof. J. T. Shahu, Dr. R. Ayothiraman, Dr. B. Manna, Dr. T. Chakraborty		
12.	Will the course require any visiting faculty?	no	

13.	Course objective (<i>about 50 words</i>): To teach students basics of the Finite Element Method (FEM) and application of FEM in geotechnical analyses.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Steps in FEM. Stress-deformation analysis: One dimensional, Two dimensional and Three-dimensional formulations. Discretization of a Continuum, Elements, Strains, Stresses, Constitutive, Relations, Hooke's Law, Formulation of Stiffness Matrix, Boundary Conditions, Solution Algorithms. Settlement Analysis, 2-D elastic solutions for homogeneous, isotropic medium, Steady Seepage Analysis: Finite element solutions of Laplace's equation, Consolidation Analysis: Terzaghi consolidation problem, Choice of Soil Properties for Finite Element Analysis, Introduction to PHASE2.		
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Steps in FEM.	4
2	Stress-deformation analysis: One dimensional, Two dimensional and Three-dimensional formulations.	4
3	Discretization of a Continuum, Elements.	3
4	Strains, Stresses, Constitutive Relations, Hooke's Law.	5
5	Formulation of Stiffness Matrix.	2
6	Boundary conditions.	2
7	Solution algorithms.	2
8	Settlement Analysis, 2-D elastic solutions for homogeneous, isotropic medium.	4
9	Steady Seepage Analysis: Finite element solutions of Laplace's equation.	4
10	Consolidation Analysis: Terzaghi consolidation problem, FEM programming.	5
11	Choice of Soil Properties for Finite Element Analysis.	3
12	Introduction to PHASE2.	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Daryl L Logan, Martin Logan (2010) A First Course in the Finite Element Method. Cengage Learning.
2. Leanne Hinton, D. R.J. Owen (1980) Finite Element Programming. Academic Press.
3. Bathe Klaus-Jsrgen (1996) Finite Element Procedures, Prentice-Hall.
4. J N Reddy (2005) An Introduction to the Finite Element Method. McGraw-Hill.

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.)	NONE
19.4	Laboratory	Well equipped Computational Laboratory
19.5	Equipment	Fully Equiped
19.6	Classroom infrastructure	Black board and PPT Projector required
19.7	Site visits	

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

20.1	Design-type problems	50
20.2	Open-ended problems	20
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	30 (explanation of theories)

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>)	STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	
6.	Status (<i>category for program</i>)	ELECTIVE

7.	Pre-requisites (<i>course no./title</i>)	Structural Analysis-II RC and Steel Design
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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	CEL719 & CEL724
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supersedes any existing course	None

9.	Not allowed for (<i>indicate program names</i>)	
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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 Jain, Prof. Alok Madan, Prof. Ashok Gupta, Dr. G S Benipal, Dr. V Matsagar, Dr. D R Sahoo, Dr. Abhijit Ganguli
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12.	Will the course require any visiting faculty?	No
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13.	Course objective (<i>about 50 words</i>): To learn the fundamentals of modeling and analyzing dynamic behavior of civil engineering structures, To develop students' understanding the analysis of structures under earthquake excitations.
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Analysis of single-degree-of-freedom systems; Equation of motions; Free and forced vibration; Response of harmonic, impulsive, periodic and general dynamic loading; Analysis of multi-degrees-of-freedom system; Modal damping and classical damping; Systems with distributed mass and elasticity; Earthquakes: Causes, Magnitude and Intensity; Ground Motions and site effects; Concepts of spectral quantities and response spectrum; Response history and response spectrum analysis; Numerical evaluation of dynamic response, Indian code applications.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Analysis of single-degree-of-freedom systems; Equation of motions; Free and forced vibration	06
2	Response of harmonic, impulsive, periodic and general dynamic loading	04
3	Analysis of multi-degrees-of-freedom system; Modal damping and classical damping	09
4	Systems with distributed mass and elasticity;	04
5	Earthquakes: Causes, Magnitude and Intensity; Ground Motions and site effects	02
6	Concepts of spectral quantities and response spectrum	04
7	Response history and response spectrum analysis	08
8	Numerical evaluation of dynamic response	03
9	Indian code applications	02
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

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

- A. K. Chopra, Dynamics of Structures: Theory and Applications to Earthquake Engineering, 4th Edition, Prentice Hall, Englewood Cliffs, New Jersey, 2012.
- A. K. Chopra, Earthquake Dynamics of Structures: A Primer, Second Edition, Monograph published by Earthquake Engineering Research Institute, Oakland, Calif., 2005, 129 pgs.
- T. K. Dutta, Seismic Analysis of Structures, John Wiley & Sons (Asia) Pte Ltd, Clements Loop, Singapore, 2010.
- P. Agarwal and M. Shrikhande, Earthquake Resistant Design of Structures, PHI Learning Private Limited, New Delhi, 2010.
- Clough R.W. and J. Penzien – Dynamics of Structures, McGraw-Hill, 1975.

- Craig, R.R. – Structural Dynamics: an Introduction to Computer Methods, John Wiley & Sons, 1981.
- Craig, R.R. and A.J. Kurdila, Fundamentals of Structural Dynamics, 2nd ed., Wiley, 2006.
- Humar, J.L. – Dynamics of Structures, Balkema 2002
- Meirovitch, L. – Elements of Vibration Analysis, McGraw-Hill, Inc.
- Thomson, W.T. – Theory of Vibration with Applications, 2004.

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

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

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)	

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 STEEL DESIGN
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	
6.	Status (<i>category for program</i>)	ELECTIVE

7.	Pre-requisites (<i>course no./title</i>)	Design of Steel Structures
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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	CEL718
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supercedes any existing course	None

9.	Not allowed for (<i>indicate program names</i>)	
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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. Alok Madan, Dr. V. Matsagar, Dr. D R Sahoo	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To develop competency in analysis and design of multi-story steel buildings subjected to gravity, wind and earthquake loadings, including study of connections, framing systems, composite design and plastic design of steel members.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Types of construction; Basic properties of steel, Design philosophy; Loading/load cases; Flexural members-Nominal strength, Moment magnification; Compression members- Axial stability, Buckling; Torsion behaviour-Shear stress, Bending analogy; Combined loading; Connections- Simple shear, Seated, Column base; Frame stability; Lateral bracing design; Biaxial bending; Design for seismic loading- Moment-resisting frames, Braced frames; Detailing requirements for seismic conditions; Plate girders- Elastic and inelastic buckling, Web stiffeners	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Types of construction; Design philosophy; Loading/load cases; Basic properties of steel	04
2	Flexural member-Nominal strength, Moment magnification;	03
3	Compression members- Axial stability, Buckling	06
4	Torsion behaviour-Shear stress, Bending analogy	03
5	Combined loading;	03
6	Connections-Simple shear, Seated, Column base;	04
7	Frame stability; Lateral bracing design;	03
8	Biaxial bending;	02
9	Design for seismic loading- Moment-resisting frames, Braced frames;	08
10	Detailing requirements for seismic conditions;	03
11	Plate girders- Elastic and inelastic buckling, Web stiffeners	03
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

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

- I. C. G. Salmon, J. E. Johnon, F. Malhas, Steel Structures: Design and Behavior; Emphasizing Load and Resistance Factor Design, Fifth Edition, Pearson Prentice Hall; 2009.
- II. R. Engelkirk, Steel Structures, Prentice Hall, 1995.
- III. T. V. Galambos, and A. E. Surovek, Structural Stability of Steel, Wiley, 2005.
- IV. W. T. Segui, Design of Steel Structures, Cengage Learning, 2007.
- V. M. Bruneau, C. M. Uang, and R. Sabeli, Ductile Design of Steel Structures, Second Edition, McGraw Hill Companies, Inc., 2011.
- VI. Subramanian, N. Design of Steel Structures, Oxford University Press, 2008.

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

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

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)	

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>)	MASONRY AND COMPOSITE STRUCTURES
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	
6.	Status (<i>category for program</i>)	ELECTIVE

7.	Pre-requisites (course no./title)	
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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	Supercedes any existing course	None

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 Prof. Alok Madan, Dr. Shashank Bishnoi, Dr. D R Sahoo	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To introduce basic structural concepts in masonry and composite construction, To develop students' skills of analysis and design in modern composite and masonry structures.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Introduction to masonry; Properties of Units, Mortar, and Masonry; Types and grades of masonry; Structural design for gravity and lateral loads; General and detailing requirements for gravity and lateral loading conditions; Introduction to composite materials and their applications; Fundamentals- Composite effect, Material properties, Shear connectors, Bond-slip effect; Analysis and design for composite floor and composite beam; Analysis and design for composite columns- Encased section, Concrete filled tube; Thin-skinned composite wall panels; Instability and ductility of composite members; Composite connections; Composite frames.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to masonry; Properties of Units, Mortar, and masonry	03
2	Types and grades of masonry	02
3	Structural design for gravity and lateral loads	10
4	General and detailing requirements for gravity and lateral loading conditions	04
5	Introduction to composite materials and their applications	02
6	Fundamentals- Composite effect, Material properties, Shear connectors, Bond-slip effect	03
7	Analysis and design for composite floor and composite beam	05
8	Analysis and design for composite columns- Encased section, Concrete filled tube	05
9	Thin-skinned composite wall panels	03
10	Instability and ductility of composite members	02
11	Composite connections; Composite frames	03
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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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.

- R. P. Johnson, Composite Structures of Steel and Concrete (Part-1), Blackwell Scientific Publications, 1994.
- P. K. Sinha, Composite Material and Structures, Composite Centre of Excellence, AR & DB,. Department of Aerospace Engineering, IIT Kharagpur.
- Abolhassan Astaneh-Asl, Behavior and Design of Steel and Composite Structures, 2008 Edition.
- Viest et al., Composite Construction, Design for Buildings, ASCE/McGraw-Hill, Inc., 1997.
- P Agarwal and M Srihande, Earthquake Resistant Design of Structures, PHI Learning, 2006.

- P. C. Varghese, Building Construction, PHI Learning, 2007.
- T. Paulay and M. J. N. Priestley, Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley & Sons, Inc. 1992.

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

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

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)	

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>)	CONSTRUCTION PROJECT MANAGEMENT
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL_____
6.	Status (<i>category for program</i>)	Elective

7.	Pre-requisites (<i>course no./title</i>)	DC6S (CONSTRUCTION MANAGEMENT)
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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	CEL769 and CEL767
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>)	
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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. JUM, Dr. KNJ, Dr. KCI, Dr. BB	
12.	Will the course require any visiting faculty?	NO

13.	Course objective (<i>about 50 words</i>): This course is intended to provide sufficient background about managing construction projects. After studying the course the students would learn- (a) Essentials/Basics of Construction Project management – planning, scheduling & control (b) construction contracts	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Introduction to Project inputs – activities, duration, logic. Additional network analysis- PDM, LoB, Resource planning and scheduling, Time Cost trade off, project updating and control using EVM, introduction to Construction contracts and its types, tendering procedure, estimation and fixing of markup, bidding models, claims compensation and disputes, dispute resolution models, FIDIC contracts	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	WBS, defining activities, duration, logic, constraints	3
2	Additional Network schedules and analysis – PDM, LoB, etc.	3
3	Time Cost trade off	2
4	Multi Project and Multi Resource planning and scheduling	4
5	Project update and Earned Value Analysis	4
6	Project closeout	2
7	Material & inventory management	2
8	Tender , Contracts and types, ICA 1872	6
9	Client's and Contractors Estimation and Markup	3
10	Bidding Procedure and Models	3
11	Claims, compensation and disputes – extra work, alterations, etc.	3
12	Delay analysis	2
	Dispute resolution techniques – an overview, ACA 1996	3
	International Contracts – FIDIC, JCT, etc.	2
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

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

Jha, K.N., Construction Project Management, First Edition, Pearson Publishers, 2011.
Harris, F. and McCaffer, R. (2006). Modern Construction Management. BSP Professional Books (Sixth Ed.)
Mubarak, S., Construction Project Scheduling and Control, John Wiley & Sons, (Second Ed.)
G. L. Richardson, Project Management Theory and Practice, Special Indian Edition, CRC Press, 2011
J. Murdoch & W. Hughes, Construction contracts, Taylor & Francis, 2008
Allan Ashworth, Contractual Procedures in the construction industry, Pearson, 2012, Sixth edition

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

19.1	Software	Optional
19.2	Hardware	Available
19.3	Teaching aides (videos, etc.)	Not required
19.4	Laboratory	Not required
19.5	Equipment	
19.6	Classroom infrastructure	LCD Projector and video playing facilities
19.7	Site visits	

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

20.1	Design-type problems	
20.2	Open-ended problems	No
20.3	Project-type activity	No
20.4	Open-ended laboratory work	No
20.5	Others (please specify)	

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>)	INFRASTRUCTURE PLANNING AND MANAGEMENT
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3 (Three)
5.	Course number	CEL
6.	Status (<i>category for program</i>)	OPEN ELECTIVE

7.	Pre-requisites (<i>course no./title</i>)	CELXXX (Construction Management)
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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	CEL866
8.2	Overlap with any UG/PG course of other Dept./Centre	
8.3	Supercedes any existing course	CEL338

9.	Not allowed for (<i>indicate program names</i>)	
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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. K.C. Iyer / Dr. J. Uma Maheshwari	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To make students aware of importance of infrastructure for both economic growth and overall development of the nation; government's initiatives on various sectors of infrastructures; planning and implementation methodology in infrastructure projects - problems and risks; Public Private Partnership; contractual arrangements in PPP projects; Risk management of infrastructure projects; Environmental Impact Assessment	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): As discussed in the course outline below.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to Indian Infrastructure & Economic impact of physical infrastructure	3
2	Five year plans: government's initiatives	3
3	Overview of various sectors of infrastructure	3
4	Financial analysis of infrastructure projects	3
5	Economic considerations infrastructure projects	2
6	Introduction to PPP - comparison with conventional form	3
7	Conventional forms of contracts and concession agreements	8
8	RFQ and RFP	3
9	Risk Management Issues in Infrastructure Projects	3
10	Environmental impact assessment	2
11	Problems in Infrastructure Development and Management	4
12	Case Studies / term paper presentation	5
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Nil

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')		Nil

18. Suggested texts and reference materials

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

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| <ol style="list-style-type: none"> 1. Goodman, A. and Hastak, M. Infrastructure Planning Handbook: Planning, Engineering, and Economics, McGraw Hill, ASCE Press, 2006. 2. Grimsey, D. and Lewis, M.K. Public Private Partnerships: The Worldwide Revolution in Infrastructure Provision and Project Finance 3. Martland, Carl D. Toward more sustainable Infrastructure: Project Evaluation for Planners and Engineers, John Wiley & Sons 4. Joshi R.N. Public Private Partnership in Infrastructure - Perspectives, Principles and Practice, Vision Books 5. Tan, W. Principles of Project and Infrastructure Finance |
|--|

6. Gómez-Ibáñez, J.A. Regulating Infrastructure: Monopoly, Contracts, and Discretion
7. <http://3inetwork.org/reports/reports1.shtml> for PDF files of Indian Infrastructure Reports for the years 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009
8. <http://infrastructure.gov.in/>

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

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	Yes
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	Yes
19.7	Site visits	2-3 Guest (professional) lectures will add flavour to course

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)	

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>)	TEMPORARY AND ENABLING STRUCTURES
3.	L-T-P structure	2 - 0 - 0
4.	Credits	2
5.	Course number	CEL____
6.	Status (<i>category for program</i>)	ELECTIVE

7.	Pre-requisites (<i>course no./title</i>)	DC13S (CONSTRUCTION PRACTICES)
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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	Yes, CEL _ (PG Course on Formwork for Concrete Structures) about 25% overlap based on number of lectures.
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>)	
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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 K N Jha, B Bhattacharjee, and A K Jain	
12.	Will the course require any visiting faculty?	NO

13.	Course objective (<i>about 50 words</i>): After going through the course, the students will be familiar with temporary structures which enable the construction of permanent structures. These are : Formwork, scaffolding, shoring, cofferdams, underpinning, diaphragm walls, earth-retaining structures, and construction dewatering. They will be exposed to design and construction of enabling structures and they will be also exposed to the industry practices.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Introduction to Formwork , Requirements and selection for Formwork ,	
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	Formwork Materials, and Accessories, Wall and slab form Design, Formwork failures-causes and Case Studies in Formwork Failure, Shoring and Scaffolding cofferdams, underpinning, diaphragm walls, earth-retaining structures, and construction dewatering.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to Temporary Structure , Formwork for Concrete	1
2	Formwork Materials	2
3	Wall form Design	2
4	Slab and Beam Formwork Design	2
5	Shroing and Scaffolding	2
6	Proprietary Systems of Formwork	2
7	Underpinning	3
8	Coffer-dams	3
9	Excavation and Excavation Supports	3
10	Diaphragm wall	2
11	Construction Dewatering	3
12	Top down construction	3
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

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

Jha, K.N., Formwork for Concrete Structures, First Edition, McGraw Hill. 2012.
 Peurifoy, R.L. and Oberlender, G.D. , Formwork for concrete structures, McGraw Hill. 2011.
 Robinson, J.R., Piers, abutments, and formwork for bridges-.Library Accn No. 29797
 Austin, C.K., Formwork to concrete-Library Accn No. 87018,
 Moore, C.E., Concrete Form Construction-Library Accn No. 79825
 Hurd, M. K. Formwork for Concrete. 6th edition, American Concrete Institute, Detroit, Michigan, 1995.
 Ratay, Robert T. Handbook of Temporary Structures in Construction. 2nd edition, McGraw Hill, New York, 1996.

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

19.1	Software	Optional
19.2	Hardware	Available
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	Not required
19.5	Equipment	Not required
19.6	Classroom infrastructure	LCD Projector and video playing facilities
19.7	Site visits	ONE

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

20.1	Design-type problems	15%
20.2	Open-ended problems	No
20.3	Project-type activity	No
20.4	Open-ended laboratory work	No
20.5	Others (please specify)	

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>)	SOLID MECHANICS AND FEM
3.	L-T-P structure	2 - 0 - 2
4.	Credits	3
5.	Course number	
6.	Status (<i>category for program</i>)	DES2

7.	Pre-requisites (course no./title)	-
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NA

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	
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12.	Will the course require any visiting faculty?	NO
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13.	Course objective (<i>about 50 words</i>): To introduce students with advanced concepts in solid mechanics that will be applied in finite element analysis (FEA) of structures. To teach the students finite element (FE) programming and use of FE software will results interpretation from solid mechanics background. To implement the concepts for real-life applications in the civil engineering structures.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Stress-strain relations and constitutive equations for solids; elasticity problems and methods of their solution with illustrative examples for solids; yield criteria, and flow rules. Introduction to finite element (FE) methods for structural analysis; 0, 1, 2, 3 dimensional FE formulations; example problems; FE programming and software.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Theory of stress and strain, Constitutive laws/ equations for different materials	3
2	Hooke's law for isotropic linear elastic solids	3
3	Elasticity problems-plane elasticity problem	4
4	Failure/ yield criteria; flow rules; associative and non-associative	2
5	Introduction to finite element (FE) techniques	3
6	Zero dimensional elements	3
7	One dimensional elements	3
8	Two dimensional elements	2
9	Three dimensional elements	1
10	Computational aspects in FEA	1
11	MATLAB environment and FE programming	2
12	FE software - structure, solvers	1
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Programming in MATLAB	
2	Programming in Excel	
3	Programming in ABAQUS/ANSYS	
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6		
7		
8		
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10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

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

- | |
|--|
| <ol style="list-style-type: none"> 1. M. L. Gambhir, "Fundamentals of Solid Mechanics: A Treatise on Strength of Materials", Prentice-Hall of India Learning Pvt. Ltd., 2009. 2. Ferdinand P. Beer, E. R. Russell Johnston Jr., John T. DeWolf, David Mazurek, "Mechanics of Materials", Tata McGraw-Hill, 2011. 3. Stephen P. Timoshenko, Donovan H. Young, G. H. MacCullough, "Elements of Strength of Materials", D. van Nostrand Company, 1968. 4. Martin H. Sadd, "Elasticity: Theory, Applications, and Numerics", Elsevier, 2009. 5. Irving H. Shames, James M. Pitarresi, "Introduction to Solid Mechanics", Prentice Hall of India, 1999. 6. Y. C. Fung and Pin Tong, "Classical and Computational Solid Mechanics", World Scientific Publishing, 2001. |
| <ol style="list-style-type: none"> 1. Daryl L. Logan, "A First Course in the Finite Element Method, Thomson, ISBN-10: |

0534552986; ISBN-13: 9780534552985.

2. D. J. Dawe, "Matrix and Finite Element Displacement Analysis of Structures", Clarendon Press, Oxford.
3. O. C. Zienkiewicz and Robert Leroy Taylor, "The Finite Element Method", Butterworth-Heinemann, Oxford.
4. Klaus-Jürgen Bathe, "Finite Element Procedures", Prentice Hall, Englewood Cliffs.
5. J. N. Reddy, "An Introduction to the Finite Element Method", McGraw-Hill.
6. Robert Davis Cook, "Finite Element Modeling for Stress Analysis", Wiley.

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

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

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)	

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>)	STRUCTURAL STABILITY AND PLASTIC ANALYSIS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	
6.	Status (<i>category for program</i>)	ELECTIVE

7.	Pre-requisites (course no./title)	STRUCTURAL ANALYSIS-II
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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	X
8.2	Overlap with any UG/PG course of other Dept./Centre	X
8.3	Supercedes any existing course	X

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. G S BENIPAL, DR. ABHIJEET GANGULY, DR. D R SHAHOO	
12.	Will the course require any visiting faculty?	NO

13.	Course objective (<i>about 50 words</i>): TO DEVELOP SKILLS FOR PLASTIC ANALYSIS AND STABILITY ANALYSIS OF STRUCTURES	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Complete stress-strain curves for structural materials, Moment-curvature curves for beam sections, Effect of axial force and shear force, Plastic hinges and their rotation capacity, Collapse mechanisms of beams and plane frames, lower and upper bound theorems, Methods of plastic analysis and their limitations, Equilibrium method and method of virtual work, Application to beams and frames, Finite deformations of structures, Nonlinear and second order analysis, Elastic buckling of columns, Effective length for different end conditions, Effect of eccentricity and initial curvature, Lateral and flexural-torsional buckling, Transverse stiffness and buckling of beam-columns, Elastic and inelastic buckling analysis of sway and non-sway plane frames, Buckling of plates, Codal recommendations for concrete, steel and masonry structures	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Complete stress-strain curves for structural materials Moment-curvature curves for beam sections Effect of axial force and shear force	3
2	Plastic hinges and their rotation capacity Collapse mechanisms of beams and plane frames	3
3	Lower and upper bound theorems Methods of plastic analysis and their limitations Equilibrium method and method of virtual work	3
4	Application to beams and frames	6
5	Finite deformations of structures Nonlinear and second order analysis	3
6	Elastic buckling of columns Effective length for different end conditions	3
7	Effect of eccentricity and initial curvature Inelastic buckling	3
8	Lateral and flexural-torsional buckling	3
9	Transverse stiffness and buckling of beam-columns	3
10	Elastic and inelastic buckling analysis of sway and non-sway plane frames	6
11	Buckling of plates	3
12	Code recommendations for concrete, steel and masonry structures	3
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

Neal, B. G., Plastic Methods of Structural Analysis

Hodge, P. G., Plastic Analysis of Structures

Maelstrom, Plastic Analysis and Design of Steel structures

Subramanian, N. Design of Steel Structures,

Chajes, A., Principles of Elastic Stability, Prentice Hall, NJ, 1974

Timoshenko, S. P. and Gere, J. M., Theory of Elastic Stability, McGraw-Hill, London, 1963

Iyengar, N. G. R. Structural Stability of Columns and Plates, Affiliated East-West press, New Delhi, 1986

Ghali and Neville , Plastic Analysis of Structures

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

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

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)	

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>)	NONLINEAR ANALYSIS OF STRUCTURES
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	
6.	Status (<i>category for program</i>)	ELECTIVE

7.	Pre-requisites (course no./title)	Structural Analysis-II
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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	CEL717
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supercedes any existing course	None

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. G S Benipal, Dr. V Matsagar, Dr. D R Sahoo, Dr. Abhijit Ganguli	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To develop students' ability to apply engineering concepts and mathematical knowledge in modelling structural systems, To improve better understanding of the behaviour of more complex structural systems.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Model ingredients; Solution strategies for nonlinear equilibrium equations- Newton-Raphson, Secant stiffness and constant stiffness methods, Load-step and displacement control strategies; Nonlinear geometric response of trusses, beams and frames for moderate and large displacements- P-Δ effect; Stability of structures; Nonlinear material response-Truss element, Beam element; Nonlinear section response- Axial force-moment interaction diagrams, Plastic analysis and design	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Modeling of structures- Model ingredients	02
2	Virtual work and complementary virtual work principles	04
3	Analysis of plates and shells	12
4	Solution strategies for nonlinear equilibrium equations- Newton-Raphson, Secant stiffness and constant stiffness methods, Load-step and displacement control strategies	10
5	Nonlinear geometric response of trusses, beams and frames for moderate and large displacements- P- Δ effect; Stability of structures	04
6	Nonlinear material response-Truss element, Beam element	02
7	Nonlinear section response- Axial force-moment interaction diagrams, Effect of shear	02
8	Plastic analysis and design of frames	06
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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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.

- W. McGuire, R. H. Gallagher and R. D. Ziemian. " Matrix Structural Analysis", second edition, John Wiley and Sons, 2000.
- Z. M. Elias. "Theory and Methods of Structural Analysis", John Wiley and Sons, 1986.
- M.A. Crisfield. "Nonlinear Finite Element Analysis of Solids and Structures", Volume 1, John Wiley and Sons, 1991, reprinted 1995.
- K.J. Bathe. "Finite Element Procedures", Prentice Hall, 1996.
- Ghali, A. and Neville, A. M., (2003), Structural Analysis (Unified Classical and Matrix Approach), 5th Edition, Chapman and Hall, Ltd.
- McCarmac, J. and Elling, R.E., Structural Analysis: A Classical and Matrix Approach, Harper and Row Publishers.

- P. L. Gould, Analysis of shells and plates, Springer-Verlag Newyork, Inc., 1988.
- S. Timoshenko and S. Woinowsky-Krieger, Theory of plates and shells, McGraw Hill Book Company, 1959.

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

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

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)	

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>)	PRESTRESSED CONCRETE THEORY AND APPLICATIONS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL__
6.	Status (<i>category for program</i>)	DES6

7.	Pre-requisites (course no./title)	-
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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	
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NA

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 Prof Alok Madan, Dr. Vasant Matsagar	
12.	Will the course require any visiting faculty?	NO

13.	Course objective (<i>about 50 words</i>): To introduce students concept of prestressed concrete structures. To teach analysis and design of prestressed members. To make the students familiar with real-life prestressed concrete construction and practices.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Concept of prestressed concrete structures; theory of prestressing; types of prestressed concrete members: pre-tensioning and post-tensioning. End anchorage systems. Prestress losses. Analysis and design of prestressed members. Real-life prestressed concrete construction and practices.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Prestressed concrete structures; theory of prestressing	2
2	Methods of prestressing: pre-tensioning and post-tensioning; systems for prestressing; grouted/bonded and ungrouted/unbonded; partial prestressing	2
3	High-strength materials and requirements; properties and current uses	2
4	End anchorage systems; end block stresses and design	4
5	Prestress losses: long-term and short-term	4
6	Prestressed concrete section design: theories and design philosophies	4
7	Analysis of prestressed concrete members: flexure and shear	6
8	Design of prestressed concrete members: flexure and shear	6
9	Types of prestressed concrete members: beams, pipes, tanks etc.	5
10	Concepts of decompression, draping, debonding, tendon profiling, external and internal prestressing	3
11	Camber, deflection and ductility of prestressed concrete members	2
12	Real-life prestressed concrete construction and practices	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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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.

1. IS-1343 (1980) "Code of Practice for Prestressed Concrete", Bureau of Indian Standards, New Delhi, India.
2. N. Krishna Raju (2009) "Prestressed Concrete", Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, India.
3. Pasala Dayaratnam (1996) "Prestressed Concrete Structures", India Book House Limited, Mumbai, India.
4. Michael P. Collins and Denis Mitchell (1994) "Prestressed Concrete Structures", Prentice Hall, New Jersey, USA.
5. Tung Yen Lin and Ned Hamilton Burns (2004) "Design of Prestressed Concrete Structures", Third Edition, John Wiley and Sons Private Limited, Singapore.
6. Edward G. Nawy (2005) "Prestressed Concrete - A Fundamental Approach", Fifth Edition,

Prentice Hall International.
 7. Antoine E. Naaman (2004) "Prestressed Concrete Analysis and Design - Fundamentals",
 Second Edition, Techno Press, Korea.

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

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

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)	

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 CONCRETE DESIGN
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	
6.	Status (<i>category for program</i>)	ELECTIVE

7.	Pre-requisites (<i>course no./title</i>)	Civil Engineering Materials Reinforced Concrete Design
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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	Design of Concrete Structures (CEL721)
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supercedes any existing course	None

9.	Not allowed for (<i>indicate program names</i>)	
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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. G S Benipal, Dr. D R Sahoo	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To develop students' in-depth understanding of structural principles in reinforced concrete structures. To develop students' skills of analysis, modelling and design in modern concrete structures.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Basic properties-Uniaxial, Biaxial and Triaxial behaviour, Confinement, Creep and Shrinkage; Constitutive modelling; Design concepts-Flexure, Compression, Shear, Torsion and Combined stresses; Beam-column Joints; Serviceability-Control of Deflection and Cracking; Moment-Curvature relationship; Ductility; Deformations under repeated and cyclic loading; Design for seismic loading; Code provisions; Design of Deep beams, Design of Shear walls, Flat slabs; Limit-elastic analysis-Yield-line Theory, Strip method; Concrete plasticity-Theory and Applications	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Basic properties-Uniaxial, Biaxial and Triaxial behaviour, Confinement, Creep and Shrinkage	03
2	Constitutive modelling	02
3	Design concepts-Flexure, Compression, Shear, Torsion and Combined stresses	10
4	Beam-column Joints	02
5	Serviceability-Control of Deflection and Cracking	03
6	Moment-Curvature relationship; Ductility; Deformations under repeated and cyclic loading	05
7	Design for seismic loading; Code provisions	04
8	Design Deep beams, Shear walls, Flat slabs	05
9	Limit-elastic analysis-Yield-line Theory, Strip method	04
10	Concrete plasticity-Theory and Applications	04
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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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.

- | |
|---|
| I. R. Park and T. Paulay, Reinforced Concrete Structures, John Wiley & Sons, 1995.
II. S.N. Sinha, Reinforced Concrete Design, Tata McGraw-Hill, 2nd Edition, 2002.
III. P.C. Varghese, Advanced Reinforced Concrete Design, Prentice Hall of India, 2nd Ed, 2005.
IV. S.U. Pillai and D. Menon, Reinforced Concrete Design, Tata McGraw-Hill, 3rd Ed, 1999.
V. C-K Wang, C.H. Solomon and J. A. Pincheira, Reinforced Concrete Design, John Wiley and Sons, 7th Ed, 2007.
VI. J.G. MacGregor and J. K. Wight, Reinforced Concrete: Mechanics and Design, Pearson Education, 5th Ed, 2008.
VII. T.T.C. Hsu and Y.L. Mo, Unified Theory of Concrete Structures, John Wiley & Sons, 2010. |
|---|

IX. W. F. Chen, Plasticity in Reinforced Concrete, McGraw Hill, Inc., 1982.

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

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

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)	

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 CONCRETE TECHNOLOGY
3.	L-T-P structure	2 - 0 - 0
4.	Credits	2
5.	Course number	
6.	Status (<i>category for program</i>)	Departmental elective

7.	Pre-requisites (<i>course no./title</i>)	Civil Engineering Materials
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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	
8.2	Overlap with any UG/PG course of other Dept./Centre	
8.3	Supercedes any existing course	

9.	Not allowed for (<i>indicate program names</i>)	
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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 B. Bhattacharjee, S. Gupta, S. Bishnoi	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To expose the students to the advances in concrete technology and to develop an understanding of concrete for proper use of the material in construction.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Hydration models for ordinary portland cement, blended and composite cements, chemical admixtures and their mechanism of action, mineral additives and their role in properties of fresh and hardened concrete, rheology of fresh concrete leading to self compacting concrete, shrinkage, creep, durability modelling and service life; proportioning mixes for SCC, HPC and other special concrete; non-destructive testing, repair, special concreting processes	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction	1
2	Hydration and advanced hydration models	2
3	Composite cements	3
4	Chemical admixtures	3
5	Mineral additives	3
6	Rheology of concrete and SCC	2
7	Mixture design of special concretes	3
8	Shrinkage, creep and durability and service life	4
9	Non-destructive testing and repair	4
10	Special concreting processes	3
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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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.

Mehta P.K. and Monteiro P.J.M., Concrete Microstructure Properties and Materials, Third Edition, Tata McGraw Hill, 2006

Newman J. and Choo B.S., Advanced Concrete Technology - Processes, Elsevier, 2003

Newman J. and Choo B.S., Advanced Concrete Technology - Testing and Quality, Elsevier, 2003

Neville A.M., Properties of Concrete, Fourth Edition, Pearson, 2006

J. Bensted and P. Barnes (Ed.), "Structure and Performance of Cements", Second Edition, Spon Press 2002

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

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

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)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Department of Civil Engineering	
2.	Course Title (<i>< 45 characters</i>)	INTRODUCTION TO INTELLIGENT TRANSPORTATION SYSTEMS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	CEL 3ZZ	
6.	Status (<i>category for program</i>)	Program elective: BTech Civil (transportation specialization) Open elective: BTech Civil (other specializations)	

7.	Pre-requisites (<i>course no./title</i>)	Transportation Engineering I	
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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	Nil	
8.2	Overlap with any UG/PG course of other Dept./Centre	Nil	
8.3	Supercedes any existing course	Nil	

9.	Not allowed for (<i>indicate program names</i>)		
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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. Kalaga Ramachandra Rao Prof. Geetam Tiwari Dr. Aravind Krishna Swamy		
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12.	Will the course require any visiting faculty?		
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13.	Course objective (<i>about 50 words</i>): This course is designed to provide over view of emerging aspects of the intelligent transportation systems. The following are the expected outcomes of the course i) To grasp the basic concepts of the ITS ii) To understand the structure and modules of a typical ITS setup iii) To get an overview of the applications - mobile, voice, internet iv) To understand the relevant hardware and software v) To have an idea of the necessary orgnaizational structure for implementation		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Introduction to Intelligent Transportation Systems (ITS); ITS Organizational		
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	Issues, the fundamental concepts of Intelligent Transportation Systems (ITS) to students with interest in engineering, transportation systems, communication systems, vehicle technologies, transportation planning, transportation policy, and urban planning. ITS in transportation infrastructure and vehicles, that improve transportation safety, productivity, environment, and travel reliability. Mobile device applications of ITS such as trip planners
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to Intelligent Transportation Systems (ITS)	1
2	Advanced Traveler Information Systems (ATIS)	3
3	ITS Highway Safety Perspective	3
4	Environmental Aspects of ITS; Connected Vehicle Technology and Applications	5
5	ITS Standards and Architecture; Organizational structure	6
6	ITS Telecommunications	3
7	Travel Information Systems	6
8	Interactive Voice Recognition (IVR)	1
9	Mobile Applications	2
10	Economics of ITS – Revenue Generation Models	3
11	ITS and Security; ITS Policy Issues	3
12	International ITS Programs Case Studies: applications in bus transport, metro and highways	6
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

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')		

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

Sussman, J.M. *Perspectives on Intelligent Transportation Systems*, Springer, Berlin, 2010

Ghosh, S., Lee, T.S. Intelligent Transportation Systems: New Principles and Architectures, CRC Press, 2000
 Mashrur A. Chowdhury, and Adel Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House, Inc., 2003.

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

19.1	Software	MS Excel, Matlab
19.2	Hardware	NIL
19.3	Teaching aides (videos, etc.)	NIL
19.4	Laboratory	NIL
19.5	Equipment	NIL
19.6	Classroom infrastructure	OHP, overhead projector
19.7	Site visits	

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)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Department of Civil Engineering	
2.	Course Title (<i>< 45 characters</i>)	AIRPORT PLANNING AND DESIGN	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	CEL 846	
6.	Status (<i>category for program</i>)	Program elective for MTech in Transportation Engineering Open elective for other MTech programs	

7.	Pre-requisites (<i>course no./title</i>)	BTech Students: Should have earned atleast 120 credits	
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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	Yes, CEL 341 ~25%	
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>)	CEL 341	
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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. Aravind Krishna Swamy Dr. Kalaga Ramachandra Rao		
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12.	Will the course require any visiting faculty?	No	
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13.	Course objective (<i>about 50 words</i>): This course is designed to provide the student with tools and methods to analyze and plan airports. The topics covered in course can be broadly classified into (i) Aircraft characteristics as related to airport configuration, (ii) Demand modeling, (iii) Design of airport facilities, (iv) Financial aspects of airport construction and operation.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Overview of air transport; Forecasting demand-passenger, freight; Aircraft		
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	characteristics; Airport planning-requirements site selection, layout plan; Geometric design of runway, taxiway and aprons; Airport capacity-airside, landside; Passenger terminal-functions, passenger and baggage flow; Airport pavement design and drainage; Parking and apron design; Air cargo facilities; Air traffic control lighting and signing; Airport safety; Environmental impact of airports; Airport financing and economic analysis.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Overview of air transport	2
2	Forecasting demand-passenger, freight	4
3	Aircraft characteristics	2
4	Airport planning-requirements site selection, layout plan	4
5	Geometric design of runway, taxiway and aprons	4
6	Airport capacity-airside, landside	4
7	Passenger terminal-functions, passenger and baggage flow	4
8	Airport pavement design and drainage; Parking and apron design	3
9	Air cargo facilities	4
10	Air traffic control lighting and signing	4
11	Airport safety; Environmental impact of airports	3
12	Airport financing and economic analysis	4
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')		

18. Suggested texts and reference materials

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

Ashford, N. J., Mumayiz, S., and Wright, P. H., Airport Engineering: Planning, Design and Development of 21st Century Airports, John Wiley and Sons, 2011.

Horonjeff, R., McKelvey, F., Sproule, W. and Young, S., Planning and Design of Airports, McGraw-Hill, 2010.

DeNeufville, R. and Odoni, A., Planning Design and Management, McGraw-Hill, 2003.

Young, S. and Wells, A., Airport Planning and Management, McGraw-Hill Professional Publishing, 2011.

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

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

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	5
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	10 (Simulation)

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Department of Civil Engineering	
2.	Course Title (<i>< 45 characters</i>)	INTRODUCTION TO RAILWAY ENGINEERING	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	CEL 3ZZ	
6.	Status (<i>category for program</i>)	Program elective: BTech Civil (transportation specialization) Open elective: BTech Civil (other specializations)	

7.	Pre-requisites (<i>course no./title</i>)	Transportation Engineering I	
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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	Nil	
8.2	Overlap with any UG/PG course of other Dept./Centre	Nil	
8.3	Supercedes any existing course	Nil	

9.	Not allowed for (<i>indicate program names</i>)		
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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. Aravind Krishna Swamy Dr. Kalaga Ramachandra Rao Prof. Geetam Tiwari		
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12.	Will the course require any visiting faculty?	No	
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13.	Course objective (<i>about 50 words</i>): This course is designed to provide over view of engineering aspects of railway infrastructure with special reference to Indian conditions. The topics to be covered can be broadly classified into (i) Planning issues, (ii) Structural and geometric design of railway track, (iii) Railway stations and yards, (iv) Locomotives and rolling stock, (v) Traffic control and signalling.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): History: Indian railways, international perspective; Railway track gauge: factors affecting gauge choice, multi gauge; New project planning and surveys;		
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	Alignment of railway track; Structure of railway track: rails, sleepers, ballast, subgrade, track fittings; Structural design of railway track: stresses, creep; Geometric design of rail track: gradients, curves, superelevation; Locomotives and rolling stock: resistance and tractive power; Points and crossings; Railway stations and yards; Traffic control; Signalling and interlocking; Public rail transportation in metros.
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	History: Indian railways, international perspective	1.5
2	Railway track gauge: factors affecting gauge choice, multi gauge	1.5
3	New project planning and surveys; Alignment of railway track	3
4	Structure of railway track: rails, sleepers, ballast, subgrade, track fittings	6
5	Structural design of railway track: stresses, creep	6
6	Geometric design of rail track: gradients, curves, superelevation	4
7	Locomotives and rolling stock: resistance and tractive power	3
8	Points and crossings	3
9	Railway stations and yards	4
10	Signalling and interlocking	6
11	Public rail transportation in metros	4
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

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')		

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

Munday, J.S., *Railway Track Engineering*, Tata McGraw Hill, New Delhi, 2011.

Chandra, S. and Agarwal, M.M., *Railway Engineering*, Oxford University, New Delhi, 2013.

Hay, W. W., *Railroad Engineering*, John Wiley and Sons, New York, 1988.

Bonnett, C.F., *Practical Railway Engineering*, Imperial College Press, 2005.

Ponnuswamy, S. *Railway Transportation Engineering, Operation and Management*. Narosa Publishing House New Delhi, 2012.

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

19.1	Software	MS Excel, Matlab
19.2	Hardware	NIL
19.3	Teaching aides (videos, etc.)	NIL
19.4	Laboratory	NIL
19.5	Equipment	NIL
19.6	Classroom infrastructure	OHP, overhead projector
19.7	Site visits	

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	5
20.3	Project-type activity	10
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Department of Civil Engineering	
2.	Course Title (<i>< 45 characters</i>)	TRANSPORTATION INFRASTRUCTURE MANAGEMENT	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	CEL 848	
6.	Status (<i>category for program</i>)	Program elective for MTech in Transportation Engineering Open elective for other MTech programs	

7.	Pre-requisites (<i>course no./title</i>)	BTech Students: Should have completed pavement design course	
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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>)		
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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. Aravind Krishna Swamy Dr. Kalaga Ramachandra Rao Prof. Geetam Tiwari		
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12.	Will the course require any visiting faculty?	No	
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13.	Course objective (<i>about 50 words</i>): To provide students with an understanding of deterioration mechanisms in transportaiton infrastructure, identify and collect relavent information, and develop prioritization/optimization mtheods to manage the transportaion infrastructure.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Transportation infrastructure components; Deterioration phemomena; Effect of external factors like environment, traffic loading, material properties on deterioration mechanisms; Evaluation techniques to evaluate damage: destructive, nondestructive; Performance models: development, calibration; Infrastructure management systems; Serviceability of condition and safety; Decision making techniques applied to infrastructure management; Life cycle cost analysis techniques.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Transportation infrastructure components	2
2	Deterioration phenomena; Effect of external factors like environment, traffic loading, material properties on deterioration mechanisms	7
3	Evaluation techniques to evaluate damage: destructive, nondestructive	8
4	Performance models: development, calibration	5
5	Infrastructure management systems	5
6	Serviceability of condition and safety	5
7	Decision making techniques applied to infrastructure management	5
8	Life cycle cost analysis techniques	5
9		
10		
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')		

18. Suggested texts and reference materials

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

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

19.1	Software	MS Excel, Matlab
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Laptop, Multimedia projector
19.4	Laboratory	Nil
19.5	Equipment	Yes
19.6	Classroom infrastructure	Yes (~15 students)
19.7	Site visits	Nil

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	40
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	40 (Independent reading and synthesis of data)

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Department of Civil Engineering	
2.	Course Title (<i>< 45 characters</i>)	LOGISTICS AND FREIGHT TRANSPORT	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	CEL 3ZZ	
6.	Status (<i>category for program</i>)	Program elective: BTech Civil (transportation specialization) Open elective: BTech Civil (other specializations)	

7.	Pre-requisites (<i>course no./title</i>)	Transportation Engineering I or Instructor Permission	
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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	SML843 Supply chain logistics management (~30%)	
8.3	Supercedes any existing course	Nil	

9.	Not allowed for (<i>indicate program names</i>)		
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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. Kalaga Ramachandra Rao Dr Aravind Krishna Swamy Prof. Geetam Tiwari		
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12.	Will the course require any visiting faculty?	No	
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13.	Course objective (<i>about 50 words</i>): The objectives of this course are: (i) To understand the freight movement at different levels (city, state, nation) from engineering perspective, (ii) To understand fundamentals of supply chain, (iii) To understand principles behind developing transportatio network development.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Evolution of freight and logistics; Interrelationships between society,		
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	environment and freight transport; Survey methodologies to understand freight movement; Cost measurement: Production, Holding, Transportation, Handling; Effect of internal and external variables on cost; Demand forecasting; Inventory planning and management; Transportation and distribution network: Design, Development, Management; Ware house operations; Pricing: Perishable, seasonal demand, uncertainty issues; Vehicle routing: One-to-one distribution, One-to-many distribution, Shortest path algorithm, Quickest time algorithm; logistics information system; Multi-modal transportation issues;
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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	NA	
2	NA	
3	NA	
4	NA	
5	NA	
6	NA	
7	NA	
8	NA	
9	NA	
10	NA	
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

Daganzo, C.F. *Logistics Systems Analysis*, 4th edition, Springer, Berlin, 2005

Frazelle, E.H. *Supply chain strategy*, Tata McGraw Hill, 2004

Chopra, S., Meindl, P., Kalra, D.V. *Supply chain management: strategy, planning and operations*, 4th edition, Pearson, 2010

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

19.1	Software	
19.2	Hardware	NIL
19.3	Teaching aides (videos, etc.)	NIL
19.4	Laboratory	NIL
19.5	Equipment	NIL
19.6	Classroom infrastructure	OHP, overhead projector
19.7	Site visits	

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	5
20.3	Project-type activity	10
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

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 RESOURCES MANAGEMENT
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	CEL (Engineering Hydrology)
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	Nil

9.	Not allowed for (indicate program names)	Nil
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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 Dhanya C.T., Dr R. Khosa, Prof A.K. Gosain	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To impart knowledge of water resources management issues and planning & design of water resources projects.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Scope of water resources management, Global trends in water utilization, Crop water requirements and irrigation, Planning and desing of various irrigation methods, Soil salinity and water logging, Hydropower systems management, Strom water system management, Economic analysis of water resources projects, Flood Control studies.	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Scope, global water utilization trends	2
2	Crop water requirements	9
3	Planning and scheduling	2
4	Planning and design of various irrigation methods	8
5	Soil salinity and water logging, reclamation	2
6	Planning and management of reservoirs	2
7	Hydropower system management	4
8	Conjunctive use	2
9	Flood control	4
10	Integrated water resources management urban areas	2
11	Economic analysis of water resources projects	5
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

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: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

- 1) David Chin, Water Resources Engineering, 3rd edition, Pearson, 2013
- 2) Mays L.W., Water Resources Engineering, John Wiley & Sons, 2010
- 3) Ward, R.C., and Robinson, M., Principles of Hydrology, Tata Mcgraw-Hill, 2011
- 4) Michael, A.M., Irrigation Theory and Practice, Vikas Publishing House Pvt. Ltd., New Delhi
- 5) D.K. Majumdar, Irrigation water management: Principles and practice, PHI Learning Pvt. Ltd, 2001.
- 6) Smith, A. A., Hinton, E., and Lewis, R.W. Civil Engineering Systems Analysis and Design, John Wiley and Sons, 1983
- 7) James, L.D., and Lee, R.R. Economics of Water Resources Planning. McGraw-Hill, 1971

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

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

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	Conflicts and Conflict Resolution in Water Resources Management
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

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>)	GEOINFORMATICS ENGINEERING
3.	L-T-P structure	2 - 0 - 2
4.	Credits	3
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	EC
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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	Remote Sensing & GIS (partially)
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
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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. Keshari, Prof. A. K. Gosain	
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12.	Will the course require any visiting faculty?	No
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13.	Course objective (<i>about 50 words</i>): To understand the basics of emerging technologies for capturing spatial and temporal data and its application in engineering survey, natural resources assessment, resources and infrastructure planning, water, climate, environment, agriculture, etc.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Geospatial and temporal data, Data acquisition, Global positioning system, Global Navigational Satellite System, GPS survey, Aerial and laser scanning surveys, Data acquisition using remote sensing techniques, Sensors and satellite imageries, Stereoscopic 3D viewing, Fly view, Satellite data formats and specifications, Data acquisition for natural resources management and weather forecast, Image processing and interpretation, GIS concepts and Spatial data models, Introduction to microwave remote sensing & LiDAR,	
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	Geospatial analysis, DEM/DTM generation & 3D modelling, Inferential statistics, Spatial interpolation, Integrated use of geospatial technologies, Applications and case studies
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Geospatial & temporal data	1
2	GNSS & GPS	2
3	Aerial & laser scanning surveys	3
4	Data acquisition, Data acquisition using remote sensing techniques, Sensors and satellite imageries	2
5	Stereoscopic 3D viewing, Fly view,	2
6	Satellite data formats and specifications	1
7	Image processing and interpretation	4
8	GIS concepts and Spatial data models	4
9	Introduction to microwave remote sensing & LiDAR,	2
10	Geospatial analysis, DEM/DTM generation & 3D modelling	2
11	Inferential statistics, Spatial interpolation	3
12	Integrated use of geospatial technologies, Applications and case studies	2
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	GPS Survey	2
2	DGPS Survey	2
3	Image loading, reading & displays	2
4	Image interpretation	4
5	Image processing	4
6	GIS mapping	4
7	DEM/DTM Generation	2
8	Geospatial analysis	2
9	Integrating GPS, GIS and RS Data and Outputs	2
10	Minor project	4
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Lillesand, T.M. and Kieffer 1979 Remote Sensing and Image Interpretation, Wiley
2. Curran, P.J. 1985 Principles of Remote Sensing, ELBS
3. Lloyd, C.D. 2010 Spatial Data Analysis, Oxford
4. Kinson, A.T. 1999 Advances in Remote Sensing and GIS, Wiley
5. Bhatta, B. 2011 Remote Sensing and GIS, Oxford
6. Chang, K.-t. 2008 Introduction to Geographic Information System, Tata McGraw-Hill

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

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

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	15
20.4	Open-ended laboratory work	25
20.5	Others (please specify)	

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>)	INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS
3.	L-T-P structure	2 - 0 - 2
4.	Credits	3
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	CSL101
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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	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	Nil
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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. Gosain, Prof A.K. Keshari
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12.	Will the course require any visiting faculty?	No
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13.	Course objective (<i>about 50 words</i>): The major course objective is to develop an understanding of the theory behind the GIS and to develop skills in the application of GIS to problems from a very large cross-section of areas.
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): What is GIS. Geographic concepts for GIS. Spatial relationships, topology, spatial patterns, spatial interpolation. Data storage, data structure, non-spatial database models. Populating GIS, digitizing data exchange, data conversion. Spatial data models, Raster and Vector data structures and algorithms. Digital Elevation Models (DEM) and their application. Triangulated Irregular Network (TIN) model. GIS application areas, Spatial analysis, quantifying relationships, spatial statistics, spatial search. Decision making in GIS context
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Definition of GIS, Why GIS is important?, Contributing disciplines and technologies to GIS	1
2	Geographic concepts for GIS: Coordinate system, Representing earth digitally, Discrete Georeferencing, Global Positioning Systems, Projections and transformations, Maps as representations of the world	3
3	Spatial relationships: Connections and topology, spatial patterns, sampling the world, scale and geographic detail, uncertainty, spatial interpolation	2
4	Implementing geographic concepts in GIS: Fundamentals of Data storage, data structure, non-spatial database models	3
5	Populating GIS: Creating digital data, digitizing and scanning, remote sensing and GPS as data source. Accessing existing data, data exchange, data conversion, transfer standards, Open GIS. Metadata.	3
6	Spatial data models: storing relationships, Raster and Vector GIS models	2
7	Vector data structures and algorithms. Storage of complex spatial objects. Storage of lines, polygons. Polygon overlay operation	3
8	Raster data structures and algorithms. Storage options for a raster data. Scan order. Decoding scan order	3
9	Digital Elevation Models (DEM) and their application. Creation of DEMs, various functions on DEM.	3
10	The Triangulated Irregular Network (TIN) model. Alternative methods of creating TINs. Storing TINs. Algorithms on TINs.	2
11	GIS application areas: Spatial analysis. Combining data, map algebra, terrain modelling, quantifying relationships, spatial statistics, spatial search. Decision making in GIS context. Strategies for development implementation and management of GIS	3
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	Hands-on with some real-life GIS applications taken from various disciplines,	4
2	Study of various kinds of maps.	4
3	Hands-on on Digitization process. Process of removal of digitization errors. Registration and geo-referencing.	6
4	Exercises on real-life problems using Raster and Vector data models. Creation of vector layers of various kinds and topology building. Exercises on vector overlay operations. Creation of raster layers.	6
5	Exercises on operations involving map algebra. Hands-on with creation of DEM using the grid model and the use of DEM for various real-life problems taken from various disciplines. Hands-on with	8

	creation of DEM using the TIN model and the use of such DEM for various real-life problems taken from various disciplines.	
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

Bailey T C, Gatrell A C, 1995, Interactive spatial data analysis, Harlow, Longman/New York, John Wiley & Sons Inc.

Bonham-Carter G F, 1994, Geographical information systems for geo-scientists: modelling with GIS, New York, Pergamon Press

Burrough P A, Frank A U (eds.) 1996, Geographic objects with intermediate boundaries, London, Taylor and Francis

Clifford J, Tuzhilin A, 1995, Recent advances in temporal databases, Berlin, Springer

Goodchild M F, Parks B O, Steyaert L T, 1993, Environmental modelling with GIS, Oxford, Oxford University Press

Hearnshaw H M, Unwin D J (eds.), 1994, Visualisation in geographical information systems, Chichester, John Wiley & Sons

Isaaks E H, Srivastava R M, 1989, Applied geostatistics, Oxford University Press.

Langran G, 1992, Time in geographic information systems, London, Taylor and Francis

Longley P A, Goodchild M F, Maguire D J, Rhind D W (eds.), 1999, Geographical information systems: principles and technical issues, Second Edition, John Wiley & Sons Inc.

Maguire D J, Goodchild M F, Rhind D W (eds.), 1991, Geographical information systems: principles and applications, Harlow, Longman/New York, John Wiley & Sons Inc.

Martin D J, 1996, Geographic information systems: socioeconomic applications, 2nd edition, London, Routledge

Masser I, Blakemore M (eds.), 1991, Handling geographic information: methodology and potential applications, Harlow, Longman/New York, John Wiley & Sons Inc.

Mather P M (ed.), 1993, Geographical information handling: research and applications, Chichester, John Wiley & Sons

Muller J C, Lagrange J P, Weibel R (eds.), 1995, GIS and generalisation: methodological and practical issues, London, Taylor and Francis

Parker D (ed.), 1996, Innovations in GIS 3, London, Taylor and Francis

Pleuwe B, 1997, GIS Online: information retrieval, mapping and the internet, Santa Fe, Onward Press

Pickles J (ed.), 1995, Ground truth: the social implications of geographic information systems, New York, Guilford Press

Raper J F (ed.), 1989, Three-dimensional modelling with geoscientific information systems, London, Taylor and Francis

Star J L, Estes J E, McGwire K C, 1997, Integration of geographic information systems and remote sensing, New York, Cambridge University Press

Tomlin C D, 1992, Geographic information systems and cartographic modeling, Englewood Cliffs, Prentice Hall

Worboys M (ed.), 1994, Innovations in GIS 1, London, Taylor and Francis

Worboys M, 1995, GIS: a computing perspective, London, Taylor and Francis

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

19.1	Software	The students shall be exposed to a range of GIS software, which include ArcInfo, ArcView, AutoDesk Map, GeoMedia, GeoConcepts, GRAM++.
19.2	Hardware	Hardware in the form of PCs.
19.3	Teaching aides (videos, etc.)	Yes
19.4	Laboratory	Yes
19.5	Equipment	
19.6	Classroom infrastructure	yes existing
19.7	Site visits	

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	10
20.3	Project-type activity	
20.4	Open-ended laboratory work	30
20.5	Others (please specify)	40

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>)	FUNDAMENTALS OF REMOTE SENSING
3.	L-T-P structure	2 - 0 - 2
4.	Credits	3
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	EC
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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)	Nil
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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. A.K. Keshari, Dr. Dhanya C.T.	
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12.	Will the course require any visiting faculty?	No
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13.	Course objective (<i>about 50 words</i>): To understand the basics of remote sensing and its application potential in diverse areas and to familiarise emerging technologies of data acquisition by Satellite	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): What is Remote Sensing? Historical development of remote sensing, Remote sensing components, Data collection and transmission, Sensors and satellite imageries, Electromagnetic energy and spectrum, Wavebands, Interactions of electromagnetic energy with atmosphere and earth's surface, radiometric quantities, Photogrammetry and aerial photography, Vertical and tilted photographs, Photographic materials, Photo-processes, Stereoscopic viewing, fly view, Aerial mosaics, Various satellite systems and monitoring programs, Data Products, Satellite data, Data formats, Data acquisition for natural resources management and weather forecast, Random errors and least	
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	square adjustment, Coordinate transformation, Photographic interpretation, Image processing, Potential applications of remote sensing in diverse areas and decision making, Integrated use of remote sensing and GIS, Case studies
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Remote Sensing Components & Historical Development	2
2	Data Collection & Transmission, Sensors & Satellite imageries	2
3	Electromagnetic energy, spectrum & interaction with atmosphere and earth's surface	6
4	Photogrammetry & aerial photography	4
5	Photographic process & materials	1
6	Viewing, mosaics	1
7	Satellite "systems and monitoring programs	3
8	Data products, formats & acquisition	2
9	Random errors & Least square adjustment	1
10	Coordinate Transformation.	1
11	Photographic Interpretation image processing	2
12	Potential applications & integrated use with GIS, case studies	3
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	Studying aerial photographs and Satellite images	3
2	Stores copic and fly view	2
3	Image loading	2
4	Reading & displays	2
5	Image interpretation	6
6	Geo registration	6
7	Image analysis	7
8		
9		
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Lillesand, T.M. and Kieffer 1979 Remote Sensing and Image Interpretation, Wiley
2. Curran, P.J. 1985 Principles of Remote Sensing, ELBS
3. Sabins, F.F. 1978 Remote Sensing: Principles and Interpretation, W.H. Freeman & Co.
4. Kinson, A.T. 1999 Advances in Remote Sensing and GIS, Wiley
5. Rampal, K.K. 1982 Textbook of Photogrammetry, Oxford & IBH Publishing co.7

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

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

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	15
20.4	Open-ended laboratory work	25
20.5	Others (please specify)	

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>)	FREQUENCY ANALYSIS IN HYDROLOGY
3.	L-T-P structure	2 - 0 - 0
4.	Credits	2
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	CEL (Engineering Hydrology)
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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	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	No

9.	Not allowed for (indicate program names)	Nil
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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. R. Khosa, Dr. Dhanya C.T.	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To impart knowledge on concepts of probability and time series analysis and modeling of hydrologic variables	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Concepts of probability in Hydrology, Random events, Random variables; moments and expectations; Common probabilistic distributions; goodness of fit tests; Stochastic processes;	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Uncertainty, Random Variables, Concepts of Probability, Return Period and Relevance in design	4
2	Descriptive statistics for location, scale and shape of distribution	1
3	Moments and Expectations	1
4	Sample, Population, Sampling Variability and Standard Error of Estimate	2
5	Method of summarizing data; Annual Maximum vs Partial Duration Series	2
6	Normal Distribution, Bernoulli Process, Binomial Distribution, Risk and Concept of Reduced Variate	2
7	Flood Frequency Analysis using Gumbel, Log Normal, Exponential, LPT3 and GEV density functions	4
8	Order Statistics and Probability Plotting	2
9	Hypothesis and Test of Significance	2
10	Method of Maximum Likelihood, Probability Weighted Moments	4
11	Stochastic Processes and concepts of dependence, persistence and covariance	2
12		
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

NIL

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: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

- 1) J.R. Benjamin and C.A. Cornell, *Probability Statistics and Decision for Civil Engineers*, McGraw Hill, 1975.
- 2) Wilks., D.C., *Statistical Methods in the Atmospheric Sciences*, Academic Press, 2011

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

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

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
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

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>)	GROUNDWATER
3.	L-T-P structure	2 - 0 - 0
4.	Credits	2
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	CEL (Engineering Hydrology or EC)
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	Nil
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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 BR Chahar, AK Keshari, Shashi Mathur, Rakesh Khosa	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To impart knowledge of, and to mathematically model, basic processes in the domain of groundwater hydrology.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Introduction, importance and occurrence of groundwater Aquifers and groundwater scenario in India Surface and subsurface investigation of groundwater Construction, development and maintenance of wells Flow through porous media, Darcy's law, regional flow Well hydraulics Groundwater management	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Introduction, importance and occurrence of groundwater	2
2	Aquifers and groundwater scenario in India	3
3	Surface and subsurface investigation of groundwater	3
4	Construction, development and maintenance of wells	2
5	Flow through porous media, Darcy's law, regional flow	4
6	Well hydraulics	8
7	Groundwater management	6
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

NIL

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: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Bear, J., *Hydraulics of Groundwater*, Dover Pub Inc, New York, 2007.
2. Bouwer, H., *Groundwater Hydrology*, McGraw Hill, New York, 1978.
3. DeWiest, R.J.M., *Geohydrology*, John Wiley & Sons, New York, 1967.
4. Harr, M.E., *Groundwater and Seepage*, Dover Pub Inc, New York, 1990.
5. Karanth, K.R., *Groundwater Assessment, Development and Management*, Tata McGraw Hill, New Delhi, 2002.
6. Raghunath, H.M., *Groundwater*, New Age Int Pub, New Delhi 2003.
7. Schwartz, F.M. and Zhang, H., *Fundamentals of Groundwater*, John Wiley & Sons, 2005.
8. Todd, D. K. and Mays L.W., *Groundwater Hydrology*, John Wiley & Sons, 2005

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

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

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)	

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 POWER ENGINEERING
3.	L-T-P structure	2 - 0 - 2
4.	Credits	3
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	CEL (Hydraulics and EC)
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	Nil
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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. Keshari, Dr. D.R. Kaushal, Dr R. Khosa	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To learn planning, analysis and design of various components of hydropower projects and its implications on water resources, environment, socio-economics and national economy.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Basic principle of hydropower generation, Hydropower Project Planning, Site selection, Hydropower development schemes, Reservoir storage, Assessment of power potential, Hydrologic analysis: Flow duration and load duration curves, Dependable flow, Design flood, Reservoir operation; Hydraulic design of various components of hydropower plants: intakes, hydraulic turbines, conduits and water conveyance, penstock; Performance characteristics of turbines, Specific and unit quantities, Electrical load on hydro-turbines, Power house dimension and planning, Water hammer and surge analysis, Surge tanks, Small and micro hydro power development, tidal plants, Current scenarios in hydropower development, Project feasibility, Impact of	
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	hydropower development on water sources systems, environment, socioeconomic conditions and national economy.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Basic Principle of Hydropower Generation	1
2	Hydropower project Planning, Site Selection	2
3	Hydropower Development Schemes	2
4	Reservoir Storage, Assessment of Power Potential	2
5	Reservoir analysis: FDC, LDC, Dependable Flow etc	3
6	Performance Characteristic of turbines, specific unit quantities	2
7	Hydraulic design of various components of Hydropower plant, intakes, testing, pumps, conveyance, resources	8
8	Water hammer & surge Analysis, Surge Tanks	3
9	SHP, Tidal Plants	2
10	Current Scenarios, Project feasibility, Impact Assessment	3
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	Performance characteristics of pelton, Francis & Kaplan turbines with reference to river flows	6
2	Design of various components of hydropower plants	12
3	Assessment of water potential, Surge Analysis	10
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Water Resources Engg. by Linsley, frey berg, Tchobano Irans.
2. Fundamentals of Hydraulic Engg. Systems by Hwang & Hila.
3. Water Power Engg. by Dandekar & Sharma
4. Hydropower Structures by R.S.Varshney
5. International Course on small Hydro Development by International Association an Small Hydro.

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

19.1	Software	No
19.2	Hardware	No
19.3	Teaching aides (videos, etc.)	yes
19.4	Laboratory	yes
19.5	Equipment	Yes
19.6	Classroom infrastructure	yes
19.7	Site visits	yes(preferable if institute allocates money)

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

20.1	Design-type problems	25
20.2	Open-ended problems	
20.3	Project-type activity	10
20.4	Open-ended laboratory work	15
20.5	Others (please specify)	

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>)	GROUNDWATER AND SURFACE WATER POLLUTION
3.	L-T-P structure	2 - 0 - 0
4.	Credits	2
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	CEL (Engineering Hydrology and EC)
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	Nil
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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. Keshari, Dr. S. Chakma	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To impart basic knowledge of groundwater and surface water problems encountered in real life and its complexities and linkages with environment, hydrological regime, ecosystem, and how they influence economic, civic and social development of the region.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Groundwater contamination; River and Lake pollution Pollution sources, Geogenic and anthropogenic pollution Soil Pollution Contaminant transport mechanisms Pollution control, remediation technologies and role of wetlands. Environmental impact assessments, Hydrological impacts, Vulnerability, Case studies	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Groundwater pollution	3
2	River and lake pollution	3
3	Pollution sources, Geogenic & anthropogenic pollution	3
4	Soil pollution	1
5	Contaminant transport mechanisms	4
6	Pollution control ,Remediation strategies and role of wetlands	5
7	Environmental impact assessment	2
8	Hydrological impacts	2
9	Vulnerability assessments	2
10	Case studies	3
11		
12		
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Bear, J and Verruijt, A., *Modelling Groundwater Pollution*, Dover Pub Inc, New York.
2. Schwartz, F.M. *Physical and Chemical Hydrogeology*, John Wiley & Sons.
8. Chapra, *Surface Water Pollution*
4. Canter, *EIA*

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

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

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

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

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 RESOURCES SYSTEMS
3.	L-T-P structure	2 - 0 - 0
4.	Credits	2
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	CEL (Engineering Hydrology)
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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	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	Nil
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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. R. Khosa, Dr. Dhanya C.T., Other Water Resources Engineering Faculty	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To impart knowledge of Integrated Water Resources Planning, Development and Management concepts on River Basin Scale	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Water Resources Planning Purposes and Objectives Multi-component, multi-user, multi-objective and multi-purpose attributes of an Integrated Water Resources System Economic basis for selection of a Plan Alternative Introduction to Linear Programming and applications in Water Resources Engg Linear, Deterministic Integrated Water Resources Management Model on River Basin Scale	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Scope and Nature of a Water Resources System	2
2	Water Resources Development Purposes and Planning Objectives	2
3	Introduction to Principles of Economic Analysis	5
4	Introduction to Linear Programming	5
5	Environmental and Water Quality aspects of River Basin Management	2
6	Introduction to Multi-Objective Analysis	3
7	Reservoir Sizing and Design	2
8	Integrated Deterministic Multi-purpose, Multi-component River Basin Model	5
9	Uncertainties in Water Resources Systems Analysis	2
10		
11		
12		
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
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8		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

- 1) Loucks, D.P., Stedinger, J.R., and Haith, D.A. *Water Resources Systems Planning and Analysis*, 1st edition, Prentice Hall, 1980
- 2) ReVelle, C.S., Whitlatch Jr, E.E., and Wright, J.R. *Civil and Environmental Systems Engineering*, Pearson Prentice Hall, 2004.
- 3) Smith, A. A., Hinton, E., and Lewis, R.W. *Civil Engineering Systems Analysis and Design*, John Wiley and Sons, 1983
- 4) James, L.D., and Lee, R.R. *Economics of Water Resources Planning*. McGraw-Hill, 1971
- (5) Vedula, S. and Mujumdar, P.P. *Water Resources Systems: Modelling Techniques and Analysis*. Tata McGraw-Hill, 2005

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

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

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

20.1	Design-type problems	
20.2	Open-ended problems	10 % - Risk, Equity, Conflicts in Integrated Water Resources System Management
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

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>)	COMPUTATIONAL ASPECTS IN WATER RESOURCES
3.	L-T-P structure	1 - 0 - 4
4.	Credits	3
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	CEL (Hydraulics & EC)
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	Nil
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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 NK Garg and other Water Resoruces Engineering Faculty	
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12.	Will the course require any visiting faculty?	No
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13.	Course objective (<i>about 50 words</i>): To develop computer programs for solution of Hydraulics problems	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Numerical Interpolation and Integration and application to water resources problems; Numerical solution of differential equations in Water Resources such as groundwater flow, pipe flows, open channel flows..	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Numerical Interpolation and Integration and application to water resources problems	4
2	Numerical solution of differential equations in Water Resources such as groundwater flow, pipe flows, open channel flows.	10
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6		
7		
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		14

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Development of computer programs for water resources problems	56
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		56

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

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|-----|---|
| (1) | Computer programming in Fortran 90 and 95, by V. Rajaraman, Prentice Hall |
| (2) | Fortran 90 and Engineering computations, W. Schick and G. Silverman, John Wiley |
| (3) | Open Channel Flow, by H.M. Chaudhary, Prentice Hall |
| (4) | Open Channel Hydraulics, by V.T. Chow, McGraw Hill |

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

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

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	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	90

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>)	URBAN HYDROLOGY
3.	L-T-P structure	2 - 0 - 0
4.	Credits	2
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (<i>course no./title</i>)	CEL (Engineering Hydrology or EC)
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (<i>indicate program names</i>)	Nil
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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 R. Khosa, Prof. A.K. Gosain, and other Water Resources Faculty	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To develop a basic understanding of the distinctive aspects of Hydrology in an urban milieu. The course will seek to quantify the changes in Hydrologic attributes that are likely to occur as the basin setting changes from an essentially natural state to that with progressively increasing levels of urbanization	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Distinctive characteristics of natural and urban watersheds; Urban Heat Island; Changes in rainfall, infiltration and runoff characteristics in urban watershed; IDF relationship and its adaptation for urban settings; Adjusting runoff record for urbanization; Stormwater Management and rainwater harvesting; Urban drainage: layout, structures, flooding and control, combined sewer overflows, sedimentation; Management of stormwater	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Distinctive characteristics of natural and urban watersheds	2
2	Urban Heat Island	1
3	Changes in rainfall, infiltration and runoff characteristics in urban watershed	2
4	IDF relationship and its adaptation for urban settings	2
5	Estimation techniques for urban stormwater quantification	4
6	Adjusting runoff record for urbanization	3
7	Urban drainage layout and design methodologies	4
8	Flood Propagation through urban storm drainage system	3
9	Stormwater Management and rainwater harvesting	4
10	Combined sewer systems and conjunctive management of storm and waste water	3
11		
12		
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

- 1) Viessmann Jr., W., and Lewis, G.L., *Introduction to Hydrology*, 5th Ed., Pearson Prentice Hall
- 2) Ward, R.C., and Robinson, M., *Principles of Hydrology*, Tata Mcgraw-Hill, 2011
- 3) Zevenbergen, C et al., *Urban Flood Management*, CRC Press, 2011
- 4) Butler, D., and Davies, J.W., *Urban Drainage*, 3rd Ed., Spon Press, New York, 2011.
- 5) Chow, V.T., Maidment, D.R., and Mays, L.W., *Applied Hydrology*, Tata McGraw Hill

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

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

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)	

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>)	RIVER MECHANICS
3.	L-T-P structure	2 - 0 - 2
4.	Credits	3
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (<i>course no./title</i>)	CEL (Hydraulics)
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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	Mech Sediment Trans
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (<i>indicate program names</i>)	Nil
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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 D.R. Kaushal, Dr S. Chakma and other Water Resources Faculty	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To provide basic understanding of river processes and mechanics and to model river behaviour so as to provide an engineering approach. A river adjusts its cross section, course and pattern of flow and its longitudinal profile due to the processes like sediment transport, scour and deposition. To sustain development activity along the river, it becomes very essential to first understand the concepts of river mechanics.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Introduction, river morphohology, drainage patterns, stream order. Properties of mixture of sediment and water, Incipient motion and quantitative approach to incipient motion, channel degradation and armoring. Bed forms and resistance to flow, various approaches for bed load transport, suspended load profile and suspended load equations, total load transport including total load transport equations. Comparison and evaluation of sediment transport equations. Stable channel design with critical tractive force theory	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Introduction	1
2	River morphology, drainage patterns and stream order	3
3	Properties of water and sediment	2
4	Incipient motion criteria and applications	3
5	Resistance to flow and bed forms	3
6	Bed load transport	5
7	Suspended load transport	5
8	Total load transport	3
9	Comparison and evaluation of sediment transport functions	2
10	Channel design	1
11		
12		
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

NIL

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Computational aspects in River Mechanics	14
2	Experimental determination of sediment properties	6
3	Experimental determination of Rheological properties of mixtures	4
4	Experimental determination of sediment retention capacity	4
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

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| (1) | Sediment Transport, Theory and Practice, by Chih Ted Yang, 1996, Mcgraw Hill, ISBN 0-07-114884-5 |
| (2) | Hydraulics of sediment transport, by Graf, W.H., 1971, McGraw Hill |
| (3) | Loose Boundary Hydraulics, by A.J. Raudkivi, Latest Edition, Pergamon Press, ISBN 0-08-018771-4 |
| (4) | Mechanics of sediment transport, by Ranga Raju and Garde, 1977 |

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

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

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

20.1	Design-type problems	60
20.2	Open-ended problems	5
20.3	Project-type activity	15
20.4	Open-ended laboratory work	
20.5	Others (please specify)	10

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>)	MECHANICS OF SEDIMENT TRANSPORT
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	CEL
6.	Status (<i>category for program</i>)	DE

7.	Pre-requisites (course no./title)	CEL (Hydraulics)
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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	PG Course
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	NIL

9.	Not allowed for (indicate program names)	Nil
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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 DR Kaushal and other WRE faculty	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): Mechanics of sediment transport has wide application in river engineering and hydrotransport through pipeline. The river morphology is self-organized by the interaction between flow and the channel configuration. It is important to predict river morphology formed under given conditions from viewpoints of flood protection, sustainable development of water resources, and high level of land planning. The purpose of this lecture is to obtain knowledge on fluid mechanics, sediment transport, optimum design of hydraulic conveying systems and morphodynamics in rivers.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Introduction; Equations of Particle Motion particle in a moving fluid, collision with the bed, diffusion of turbulence; Macroscopic View of Sediment Transport – bedload, suspended load; Threshold Condition for Sediment Motion – Critical stress for flow over a granular bed, Shields diagram; Mechanics of Bedload Transport: Bagnold hypothesis of bedload transport, bedload transport	
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	relations; Mechanics of Suspended Sediment Transport; mass conservation of suspended sediment, vertically-averaged concentration, relation for sediment entrainment; Total load transport; Descriptive Analysis of Bedforms – introduction of bedform mechanics, dunes, antidunes, ripples, bars; Stability Analysis of Bedforms: modified St. Venant stability model, shear flow model; Mechanism of transportation of materials by fluid flow through pipeline; Rheology and classification of complex mixtures; Fundamentals of two-phase flow; Phase separation and settling behaviour; Flow of non-Newtonian fluids through pipes: Turbulent flows of Complex mixtures, Slurry pipeline transportation, Design methods.
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Introduction	1
2	Equations of Particle Motion	3
3	Macroscopic View of Sediment Transport	2
4	Threshold Condition for Sediment Motion	3
5	Mechanics of Bedload Transport	4
6	Mechanics of Suspended Sediment Transport	6
7	Total load transport	3
8	Descriptive Analysis of Bedforms	3
9	Stability Analysis of Bedforms	3
10	Rheology and classification of complex mixtures	4
11	Fundamentals of two-phase flow: Phase separation and settling behaviour	4
12	Flow of non-Newtonian fluids through pipes: Turbulent flows of Complex mixtures, Slurry pipeline transportation, Design methods	6
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

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: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

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| (1) | Sediment Transport, Theory and Practice, by Chih Ted Yang, 1996, Mcgraw Hill, ISBN 0-07-114884-5 |
| (2) | Hydraulics of sediment transport, by Graf, W.H., 1971, McGraw Hill |
| (3) | Loose Boundary Hydraulics, by A.J. Raudkivi, Latest Edition, Pergamon Press, ISBN 0-08-018771-4 |
| (4) | Mechanics of sediment transport, by Ranga Raju and Garde, 1977 |
| (5) | M.Selim Yalin, Mechanics of Sediment Transport, Elsevier, 360p, 1977. |

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

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

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

20.1	Design-type problems	60
20.2	Open-ended problems	5
20.3	Project-type activity	15
20.4	Open-ended laboratory work	10
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	CIVIL ENGINEERING DEP[ARTMENT	
2.	Course Title (<i>< 45 characters</i>)	CIVIL ENGG MATERIALS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number		
6.	Status (<i>category for program</i>)	PLC	

7.	Pre-requisites (course no./title)	-	
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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	NIL	
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL	
8.3	Supercedes any existing course	NA	

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. S. Bishnoi, Dr. Supratic Gupta, Prof. b.Bhattacharjee, Dr. G.S. Benipal		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): The objective of the course is to first impart the knowledge on the important properties of the material used in infrastructure construction and maintenance. Followed by above, the students will be introduced to commonly used engineered materials used in infrastructure construction. Lastly the basic knowledge about production and manupulation of these materials to obtain desired properties will be covered.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Mechanical properties of engineered materials, Temperature and time effects. Failure and safety.Non-mechanical properties. Durability. Nature of materials, classes of materials based on bonding, inorganic and organic solids. Variability in materials and its implication on measurement. Cement based materials, concrete production and processes; properties. Steel and other metals used in construction. Bricks and Masonry; wood and engineered wood products; glass and heat transmission properties. Polymers for construction		
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	and maintenance of infrastructure. Composites: fiber reinforced composites, particle reinforced composites. Introduction to sustainable materials.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Mechanical Properties: types of stress strain behaviour, elastic, elasto-plastic behaviour, ductility, rheological models, fatigue, impact and damping. Temperature and time effects. Failure and safety. Non-mechanical properties Durability	4
2	Nature of materials: bonding and classes of materials based on bonding, metallic materials, lattice and grain structure. inorganic solids and their bond structure; Organic solids: polymers development, structure and cross-linking, melting, GT etc. .	3
3	Variability in materials and its implication on measurement and Quality Control.	1
4	Introduction to Cement based materials and Concrete production processes;	3
5	Cement hydration and type of cements	3
6	Frseh state behaviour of concrete and factors effecting including aggregate influence	4
7	Mechanical properties of concrete, Introduction to creep shrinkage and fatigue, Durability and mix proportioning	12
8	Enhancing the properties of steel and other metals by heat treatment, alloying and corrosion	2
9	Bricks and Masonry: unit strength and masonry strength, strength reduction through factors	3
10	wood and engineered wood products; glass and heat transmission properties.	3
11	Polymers for construction and maintenance of infrastructure.	2
12	Composites: fiber reinforced composites, fiber parallel to grain and perpendicular grain fiber with random orientation	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NIL

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: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1. Mamlouk, M.S. and Zaniewski, J.P., *Materials for Civil and Construction Engineers*. 3rd Ed., Pearson 2011.
2. Bhattacharjee, B., NPTEL Lecture Series on Building Materials and Construction by Dr. B. Bhattacharjee, Department of Civil Engineering, IIT Delhi. <http://www.youtube.com/playlist?list=PL8BA090E69BF01BC2>
3. Marin, J., *Mechanical Behaviour of Engineering Materials* Prentice-Hall of India (Pvt.) Ltd. 1966
4. Neville, A.M. and Brooks, J.J., *Concrete Technology*, ELBS .1990.
5. Mehta, P.K. et al , "CONCRETE Structure, Material and Properties" Prentice-Hall 1986.
6. Soroka, I., *Portland Cement Paste And Concrete*, Macmillan Press London 1979
7. Popovics, S., *Fundamentals of Portland Cement Concrete: A Quantitative Approach* Vol. 1: Fresh concrete. John Wiley and Sons New York 1982
8. Hollaway, L. C., "POLYMER AND POLYMER COMPOSITES IN CONSTRUCTION"
9. Newman, John & Choo, Ban Sang. "ADVANCED CONCRETE TECHNOLOGY-" Elsevier 2003.

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

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

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	Material selection of specific Infra structure project
20.4	Open-ended laboratory work	Determination of mix proportions of concrete
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)