SGT University, Chandu-Budhera, Gurugram
Faculty of Engineering & Technology
Department of Civil Engineering

M. Tech. **Geotechnical Engineering**

Scheme & Syllabus (2021-22)

Vision of SGT University

"Driven by Research & Innovation, we aspire to be amongst the top ten Universities in the Country by 2022

Geotechnical Engineering
First Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1.		Advanced Soil Mechanics	3	0	0	3	60	40	100
2.		Ground Improvement Techniques	3	0	0	3	60	40	100
3.		Earth retaining structures	3	0	0	3	60	40	100
4.		Design of pavements	3	0	0	3	60	40	100
5.		Experimental soil Mechanics Lab	0	0	2	1	40	60	100
6.		Computer application in Engineering Lab	0	0	2	1	40	60	100
7.		Value Added Courses-I	2	0	0	2	60	40	100
8.		Seminar	0	0	2	1	00	100	100
		Total	**14**	**0**	**6**	**17**	**380**	**420**	**800**

Second Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Rock Mechanics	3	0	0	3	60	40	100
2		Advanced Foundation Engineering	3	0	0	3	60	40	100
3		Soil Dynamics and Machine Foundations	3	0	0	3	60	40	100
4		Soil strength behavior	3	0	0	3	60	40	100
5		Rock Mechanics Lab	0	0	2	1	40	60	100
6		Advanced Geotechnical Laboratory	0	0	2	1	40	60	100
7		Seminar	0	0	2	1	00	100	100
		Total	**12**	**0**	**6**	**15**	**320**	**380**	**700**

Third Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Earth & Rock fill Dams	3	0	0	3	60	40	100
2		Research Methodology & IPR	3	0	0	3	60	40	100
3		Department Electives-XIII	3	0	0	3	60	40	100
4		Department Electives-XIV	3	0	0	3	60	40	100
5		Department Electives-XV	3	0	0	3	60	40	100
6		Research Methodology & IPR Lab	0	0	2	1	40	60	100
7		Department Electives Lab-XIII	0	0	2	1	40	60	100
8		Department Electives Lab-XIV	0	0	2	1	40	60	100
9		Department Electives Lab-XV	0	0	2	1	40	60	100
10		Value Added Courses-II	2	0	0	2	60	40	100
		Total	**17**	0	**8**	**21**	520	480	1000

Fourth Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Dissertation	0	0	**20 W**	**20**	100	0	100
		Total	0	0	**20 W**	**20**	**100**	0	**100**

Departmental Electives

S. No.	Specialization	Departmental Elective XIII	Departmental Elective XIV	Departmental Elective XV
5	Geotechnical Engineering	Strength and Deformation Behaviour of soil 3-0-2 (4) / Computational Methods in Geotechnical Engg 3-0-2 (4)	Construction Methods and Equipment 3-0-2 (4) / Advanced Pavement Materials 3-0-2 (4)	Advanced Surveying and Cartography 3-0-2 (4) / Offshore Foundations 3-0-2 (4)

First Semester

1. Name of the Department: Civil Engineering Department						
2. Course Name	Advanced Soil Mechanics	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core (✓)	PE()		OE()	
5. Pre-requisite (if any)	Soil Mechanics	**6.** Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			

8. Brief Syllabus

Students will understand the advanced concept of soil mechanics which includes soil properties, effective stresses acting on soil, consolidation behavior of soil and strength characteristics of different types of saturated and unsaturated soil.

9. Learning objectives:

1-To study the advanced methods of determination of engineering properties of different soil samples

2. To lay a firm theoretical background necessary in the design of geotechnical systems

3. Estimate shear strength, consolidation and effective stress of saturated, unsaturated and partially saturated soils.

10. Course Outcomes (COs):

At the end of course, the student will be able to:

1. Students are able to calculate effective stresses of soil
2. Determine the rate and magnitude of soil consolidation when the soil is restrained laterally and loaded axially.
3. Using shear strength concepts students able to design structures generally fail in shear
4. Analyze the results of shear strength in case of saturated soil and unsaturated soil.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Soil-water interaction**

Effective Stress: The principle of effective stress, Inter-granular pressure, Pore pressure, capillary pressure, problems

Unit – 2	**Number of lectures = 10**	**Title of the unit: Compressibility and Consolidation**

Consolidation: Principle of consolidation-compressibility, pressure-void ratio relationships, Terzaghi one dimensional consolidation parameters, pre-consolidation pressure, Estimation of total Settlement. Two- and three-dimensional consolidation, Secondary compression.

Unit – 3	**Number of lectures =10**	**Title of the unit: Strength behaviour of soil**

Shear Strength: Basic concepts, Mohr-Coulomb theory; measurement of shear strength, drainage conditions, stress paths, pore pressure parameters. Interpretation of triaxial test results.

Unit – 4	Number of lectures = 12	Title of the unit: Strength of Cohesionless and saturated cohesive Soils

Strength of Cohesion less Soils: Friction between solid surfaces, Frictional behaviour of minerals, strength of granular soil, Factors affecting strength and deformation, Dilatancy, critical void ratio, Liquefaction.

Strength of Saturated Cohesive Soils: Effective stress-water content relationship, stress history, structure, strain rate, sensitivity, Thixotropy, Hvorslev's strength parameters.

12. Books Recommended (3 Text Books + 2-3 Reference Books)

i) Atkinson, J.H. and Bransby, P.L, The Mechanics of Soils: An introduction to Critical soil mechanics, McGraw Hill, 1978.

ii) R.D. Holtz & W.D. Kovacs, "An Introduction to Geotechnical Engineering" – Prentice – Hall India, 1981.

iii) J. K. Mitchel, "Fundamentals of Soil behaviour" - John Wiley & Sons, 1993.

iv) T. W. Lambe & R. V. Whitman, "Soil Mechanics" - Wiley Eastern Ltd.,2000

v) Terzaghi, K., and Peck, R.B., Soil Mechanics in Engineering Practice, John Wiley & Sons, 2013.

1. Name of the Department: Civil Engineering Department						
2. Course Name	Ground Improvement Techniques	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core (✓)	PE()		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			

8. Brief Syllabus

This course will cover the various methods of ground improvement techniques and application of methods in designing of road, foundation and earth retaining structures.

9. Learning objectives:

1) Understand the mechanical behavior of weak ground

2) To make the foundation strong underlying heavy structures.

3) Study the various admixtures to modify the properties of weak ground by adding in specified amount.

10. Course Outcomes (COs):

At the end of course, the student will be able to:

1. Identify suitable ground improvement technique for specific project and its implications.
2. Understand the concept of bearing capacity and reduce settlement of soft ground, prevent earthquake liquefaction, control groundwater, stabilize excavation bottom, prevent deformation of surrounding ground due to presence of water.
3. Understand the usefulness of different chemical required to improve engineering behaviour of soil.
4. Understand the recent trend in the field of ground improvement techniques.

11. Unit wise detailed content

Unit-1	**Number of lectures =10**	**Title of the unit: Introduction – Ground Modification with mechanical modification**

Need and objectives of Ground Improvement, Classification of Ground Modification Techniques – suitability and feasibility, Emerging Trends in ground improvement.

Methods of compaction, Shallow compaction, Deep compaction techniques – Vibro-floatation, Blasting, Dynamic consolidation, precompression and compaction piles, Field compaction control.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Hydraulic Modification**

Methods of dewatering – open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering wells; pre-loading without and with sand drains, strip drains and rope drains, Design of vertical drains.

Unit – 3	**Number of lectures =10**	**Title of the unit: Thermal modification and chemical modification**

Thermal modification: Ground freezing and thawing. Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen; Grouting: Categories of grouting, Art of grouting, Grout materials, Grouting techniques and control.

Unit – 4	**Number of lectures = 12**	**Title of the unit: Soil Reinforcement and application of soil Reinforcement**

Reinforced Earth Technology: Concept of soil reinforcement, Reinforcing materials, Backfill criteria, Art of reinforced earth technology, Design and construction of reinforced earth structures.

Application of soil reinforcement: shallow foundations on reinforced earth, design of reinforced earth retaining walls, reinforced earth embankments structures, wall with reinforced backfill, road construction with geosynthetics.

12. Books Recommended (3 Text Books + 2-3 Reference Books)

i) Xanthakos, P.P., Abramson, L.W. and Bruce, D.A., Ground Control and Improvement, John Wiley & Sons, 1994.

ii) Robert M. Koerner "Construction and Geotechnical methods in Foundation Engineering", Mc.Graw-Hill Pub. Co., New York, 1985.

iii) Manfred R. Haussmann, "Engineering principles of ground modification", Pearson Education Inc. New Delhi, 2008.

iv) F. G., Bell, "Engineering Treatment of Soils", E& FN Spon, New York, 2006.

v) P. Purushothama Raj, " Ground Improvement Techniques" Laxmi Publications (P) Limited, 2006.

vi) Jie Han et. al., "Advances in ground Improvement" Allied Pub., 2009.

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Earth retaining Structures**	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core (✓)	PE()		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			

8. Brief Syllabus

Earth retaining structures include the brief of earth pressure and theories, types of earth retaining structures, retaining wall and its design, sheet piles and bulkheads in granular and cohesive soils

9. Learning objectives:

To calculate earth pressure on various earth retaining structures such as gravity retaining walls, sheet pile, bulkheads, bracing/struts and coffer dams.

10. Course Outcomes (COs):

At the end of course, the student will be able to:

1. Design a relevant earth retaining structure for given soil condition
2. Design of retaining wall in different soil condition
3. Design of bulk head structure for given soil condition
4. Design of tunnel and conduits

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Earth Pressure**

Rankine and Coulomb theories, active, passive and pressure at rest; concentrated surcharge above the back fill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Design of earth retaining structures**

Types of earth retaining structures – Classifications – specifications, Retaining walls – types – Design specifications and pressure distribution variations, stability of retaining walls.

Unit – 3	**Number of lectures = 12**	**Title of the unit: Bulkheads**

Bulkheads: bulkheads with free and fixed earth supports, equivalent beam method, Anchorage of bulkheads and resistance of anchor walls, spacing between bulkheads and anchor walls, resistance of anchor plates

Unit – 4	**Number of lectures = 10**	**Title of the unit: Tunnel and conduits**

Tunnel and Conduit: Stress distribution around tunnels, Types of conduits, Load on projecting conduits; Arching and Open Cuts: Arching in soils.

12. Books Recommended (3 Text Books + 2-3 Reference Books)
i) . E. Bowels, "Foundation Analysis and Design", Mc Graw Hill Companies, 1997
ii) B. M. Das, "Foundation engineering", Cengage Learning, 2007
iii) Gulhati, K. Shashi and M. Datta, "Geotechnical engineering", Mc.Graw Hill book company, 2005
iv) Earth Pressure and Earth-Retaining Structures by Chris R.I Clayton,Rick. I. Woods.ISBN 9781466552111,Published May 28, 2014
v) Bowles. J.E., Foundation Analysis and Design, Tata McGraw-Hill International Edition, 5th Edn, 1997
vi) Koerner, R.M., "Design with Geosynthetics", (3rd Edition) Prentice Hall, New Jersey, 2002

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Design of pavements**	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core (✓)	PE()		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			
8. Brief Syllabus Pavement design includes the pavement properties and types, design of flexible and rigid pavement, pavement evaluation and rehabilitation and stabilization of soil for road construction						
9. Learning objectives: 1-To develop methods through the knowledge of modern science and the technology and use them in the field. 2-To prepare a map or plan to represent an area on a horizontal plan.						
10. Course Outcomes (COs):						
At the end of course, the student will be able to:						
1. Understand the basic concepts of pavement analysis						
2. Students are able understand the material characterization for analytical flexible pavement design						
3. Analysis the rigid pavement						
4. Understand the techniques involved in road stabilization projects						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Pavements and pavements design parameters**				
Philosophy of design of pavements, Pavement selection criteria. Selection of pavement design input parameters – traffic loading and volume.						
Unit – 2	**Number of lectures = 11**	**Title of the unit: Flexible Pavement**				
Material characterization for analytical pavement design – CBR and stabilometer tests – Resilient modulus – Fatigue subsystem – failure criteria for bituminous pavements – IRC design guidelines.						
Unit – 3	**Number of lectures = 10**	**Title of the unit: Rigid Pavement**				
Design procedures for rigid pavement – IRC guidelines – Airfield pavements. Highway pavement – CRC pavements.						
Unit – 4	**Number of lectures = 11**	**Title of the unit: Stabilization of Soils For Road Constructions**				
The need for a stabilized soil – Design criteria and choice of stabilizers – Testing and field control –						

Stabilization in India for rural roads – Use of geofabrics in unpaved road construction. Case studies.
12. Books Recommended (3 Text Books + 2-3 Reference Books)
i) Sharma and Sharma, Principles and Practice of Highway Engg., Asia Publishing House, 1980
ii) KhannaS.K and Justo C.E.G, Highway Engineering, New Chand and Brothers, Roorkee, 1998
iii) Croney, D., Design and Performance of Road Pavements, HMO Stationary Office, 1979.
iv) Design and Specification of Rural Roads (Manual), Ministry of rural roads, Government of India, New Delhi, 2001
v) Yoder R.J and Witchak M.W., Principles of Pavement Design, John Wiley, 2000.
vi) Guidelines for the Design of Flexible Pavements, IRC:37 - 2001, The Indian roads Congress, New Delhi.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Experimental soil Mechanics Lab**	**L**	**T**		**P**	
3. Subject Code		0	0		2	
4. Type of Subject		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Soil Mechanics	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

6. Total Number of Lectures, Tutorials, Practical, Assuming 14 weeks in semester

Lectures = 00	**Tutorials = 00**	**Practical =28**

7. Learning objectives:

1. To understand the properties of soil.
2. To evaluate the and determine the properties of soil used in foundation and pavement design.

Outcomes:

On completion of this course, the students will be able to

1. Understand the properties and behavior of various soil used in construction
2. student able to understand Requirements of design as per their Indian standard specified value
3. Study and evaluate strength and consolidation behavior of various soils

8. Lab Content

Sr. No.	Title	CO covered
1	Water Content, specific gravity,	1,2
2	Liquid Limit, Plastic Limit,	1,2
3	Core cutter test for density determination	1,2
4	Compaction test	1,2
5	Permeability test	1,2
6	Constant head & falling head methods	1,2
7	Determination of density Sand replacement method	1,2
8	Estimation of settlement	2,3
9	Compression index parameter	2,3
10	Rate of settlement, coefficient of consolidation, Swell Pressure	2,3
11	Triaxial Compression Test - Unconsolidated	2,3
12	Undrained Tests, Consolidated Undrained Tests with Pore pressure measurement,	2,3

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Computer application in engineering Lab**	**L**	**T**		**P**	
3. Subject Code		0	0		2	
4. Type of Subject (use tick mark)		**Core (✓)**			**OE()**	
5. Pre-requisite (if any)	Nil	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 00		**Tutorials =00**	**Practical =28**			
8. **Detailed Syllabus**: ETABS for the Analysis and Design of various foundation Components of Civil Engineering						
9. Course Outcomes: Complete understanding of foundation systems						
10. Detailed Content						
1-Analysis and design of concrete footing						
2-Steel footing						
3-Raft foundation						
4-Pile cap						
5-Pile foundation						
6-Analysis of footing when soil soft						
7-Analysis of footing when soil soft						
8-Analysis of footing when soil soft						
9 – Composite footing						
10- Reinforcement Detailing of foundations						

Second Semester

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Rock Mechanics**	L	T		P	
3. Course Code		3	0		4	
4. Type of Course (use tick mark)		Core (✓)	PE()		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			

8. Brief Syllabus

Rock mechanics includes the testing methods of rock ,rock mass classification, in-situ testing and methods to improve the engineering properties of rock mass

9. Learning objectives:

1-To study and analyze the laboratory and field testing for a given project / construction.

2. To analyze the appropriate methods to improve stability of rock mass

10. Course Outcomes (COs):

At the end of course, the student will be able to:

1. Understand the laboratory method required for determination of rock properties
2. Concept of Discontinuities in rock mass
3. Understand strength and stability behaviour of rocks
4. Application and recent development in the field of soil mechanics

11. Unit wise detailed content

Unit-1	**Number of lectures =10**	**Title of the unit: Introduction and Laboratory Testing methods**

Introduction: Rock: Formation of rocks, Physical properties, Classification of rocks and rock masses, Elastic constants of rock; In-situ stresses in rock.

Laboratory Testing methods study: Rock sampling, Determination of density, Porosity and Water absorption, Uniaxial Compressive strength, Determination of elastic parameters, Tensile strength, Shear Strength, Flexural strength, Strength criterion in rocks, Swelling and slake durability, permeability, point load strength, Dynamic methods of testing, Factors affecting strength of rocks.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Discontinuities in Rock Masses**

Discontinuities in Rock Masses: Discontinuity orientation, Effect of discontinuities on strength of rock ;

Unit – 3	**Number of lectures =10**	**Title of the unit: In – Strength and failure criterion of Rock**

Strength Behaviour: Compression, Tension and Shear, Stress-Strain relationships, Rheological behavior.

Strength/ Failure Criterion: Mohr-Coulomb, Griffith theory, strength and other strength criteria.

Stresses in rock near underground openings.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Rock application and recent development in rock mechanics**
Application of rock mechanics: Rock tunneling, rock slope stability, bolting, blasting, grouting and rock foundation design. Modern modelling techniques & analyses in rocks.		
12. Books Recommended (3 Text Books + 2-3 Reference Books)		
i) Central Board of Irrigation and Power - Manual on Rock Mechanics, 1988.		
ii) R. E. Goodman, "Introduction to Rock Mechanics" John Wiley & Sons, New York, 1989.		
iii) Wakter Wittke, "Rock Mechanics" Springer Verlag, New York, 1990.		
iv) Kiyoo Mogi "Experimental Rock Mechanics" Taylor & Francis Group, UK, 2007.		
v) T. Ramamurthy, "Engineerng in Rocks for slopes, foundations and tunnels", PHI Learning Pvt. Limited, 2010.		

1. Name of the Department: Civil Engineering Department						
2. Course Name	Advanced Foundation Engineering	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core (✓)	PE()		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			

8. Brief Syllabus

In this course, the students will know the importance of foundation engineering, bearing capacity of soil and study the characteristics and design of various foundations.

9. Learning objectives:

1- To study the different types of foundations based on site conditions.

2. To Analyze and suggest remedial measures against foundation failures.

10. Course Outcomes (COs):

At the end of course, the student will be able to:

1. Understand soil exploration planning for different foundation projects
2. Design shallow foundation
3. Design pile foundation and well foundation
4. Identifying and measuring the failure criteria of foundation and measures.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Soil Exploration**

Planning of soil exploration for different projects, methods of subsurface exploration, and methods of borings along with various penetration tests.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Shallow Foundations**

Shallow Foundations: Foundation classification; Choice of foundations; Isolated foundations – individual and combined foundations, Raft foundations - Necessity; Types of rafts; Bearing capacity and settlement of rafts – Beams on elastic foundations.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Pile Foundations and well foundations**

Pile Foundations: Classification and Uses, Carrying capacity of Single pile, Pile load tests, cyclic pile load test, pull out resistance, laterally loaded Piles; Pile groups - Group efficiency, Settlement of single pile and pile groups, Negative skin friction, sharing of loads

Well Foundations: Caissons – Types, advantages and disadvantages, Shapes and component parts, Grip length, Bearing capacity and settlement, Forces acting, Sinking of wells, Rectification of Tilts and Shifts

Unit - 4	Number of lectures = 12	Title of the unit: Foundation Failure and remedial measure
Foundation Failures : Types and causes of failures, Remedial measures, Shoring and Underpinning		
12. Books Recommended (3 Text Books + 2-3 Reference Books)		
i) J. E. Bowles, "Foundation Analysis & Design", Mc.Graw Hill Book Co.		
ii) W. C. Teng, "Foundation Design", Prentice Hall of India Ltd		
iii) Tomlinson, "Foundation Design and Construction", ELBS, Longman Group Ltd.		
iv) Winterkorn and Fang, "Foundation Engineering Hand Book", Van Nostrand Reinhold Co, New York.		
v) Bowles. J.E., Foundation Analysis and Design, Tata McGraw-Hill International Edition, 5th Edn, 1997.		

1. Name of the Department: Civil Engineering Department						
2. Course Name	Soil Dynamics and Machine Foundations	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core (✓)	PE()		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			
8. Brief Syllabus						

Learning objectives:

1-To analyse and design behaviour of a machine foundation resting on the surface, embedded foundation and foundations on piles by elastic half space concept.

2. To analyse and design vibration isolation systems

9. Course Outcomes (COs):

At the end of course, the student will be able to:

1. Apply theory of vibrations to solve dynamic soil problems
2. Understand the mechanism of vibration isolation
3. 3-Understand the concept of shocks and vibration useful to design machine foundation
4. 4-Analysis the public works account

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Theory of vibrations**

Theory of vibrations: Introduction – Soil behavior under dynamic loads, Vibration of single and two degree freedom system, Vibration of six and multi degree freedom system, Mass spring analogy - Barkan's Theory.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Vibration Isolation**

Vibration Isolation: Introduction, Active and passive isolation, Methods of vibration isolation.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Machine Foundations**

Machine Foundations: General principles of machine foundation design, Types of machines and foundations, General requirements of machine foundation, Permissible amplitudes and stresses.

Unit – 4	**Number of lectures = 12**	**Title of the unit: Public Works Account**

Tender and acceptance of tender, Earnest money, security money, retention money, measurement book, cash book, preparation, examination and payment of bills, first and final bills, administrative sanction,

technical sanction.
11. Books Recommended (3 Text Books + 2-3 Reference Books)
i) Bharath Bhusan Prasad, “Soil Dynamics and Earthquake Engineering”, PHI, New Delhi, 2009.
ii) 2. S. Prakash, “Soil Dynamics”, McGraw Hill Book Co., New York, 1999
iii) S. Prakash and V. K. Puri, “Analysis and Design of Machine Foundations”, McGraw Hill Book Co., New York, 1993
iv) 2. P. Sreenivasulu and C. V. Vidyanathan, “Hand Book of Machine Foundation”, Tata McGraw Hill, New Delhi, 1981

1. Name of the Department: Civil Engineering Department						
2. Course Name	Soil strength behavior	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core (✓)	PE()		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =36		**Tutorials =0**	**Practical =0**			

8. Brief Syllabus

This Course will introduce the knowledge about soil formation and mineralogy, soil fabric and its measurement, clay-water interaction, effective granular and total stress, volume change, shear strength and deformation behavior.

9. Learning objectives:

1. Define possible reasons for the observed phenomenon under scientific investigations for solving engineering problems.
2. Identify soil fabric by direct and indirect measuring method.

10. Course Outcomes (COs):

At the end of course, the student will be able to:

1. Understand the soil formation phenomenon and identify minerals as per their properties
2. Identify soil fabric elements and measure properties of fabric
3. Understand the concept of clay -water interaction
4. Measure and analysis volume change, shear strength and deformation behaviour of soil

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Soil formation and mineralogy**

Soil formation and mineralogy: Origin of clay minerals, sediment erosion, transport and deposition; clay mineral types and their importance in geotechnical engineering; gravel, sand and silt particles; Determination of soil composition, X-Ray diffraction, Scanning Electron Microscope

Unit - 2	**Number of lectures = 10**	**Title of the unit: Soil fabric and its measurement**

Soil fabric and its measurement: Fabrics and fabric elements, contact force characterization, voids and their distribution, pore size distribution analysis, methods of fabric characterization

Unit - 3	**Number of lectures = 10**	**Title of the unit: Clay-water interactions**

Clay-water interactions: Mechanisms of soil-water interaction, properties of adsorbed water; clay-water-electrolyte system, diffuse double layer theory; cation exchange, Soil chemical interactions

Unit - 4	**Number of**	**Title of the unit : Volume change, shear strength and**

	lectures = 12	**deformation behavior**
Volume change, shear strength and deformation behavior: General volume change behaviour of soils, physical interactions, fabric, structure and volume change; General characteristics of strength and deformation, fabric, structure and strength; friction and physical interactions among soil particles		
12. Books Recommended (3 Text Books + 2-3 Reference Books)		
i) L. D., Baver, "Soil Physics", Asia Publishing House, 1960.		
ii) 2. Malcom D. Bolton, "A Guide to Soil Mechanics", University Press (India) Pvt. Ltd., 2003.		
iii) J. K., Mitchell, "Fundamentals of Soil Behavior", John Wiley & Sons Inc., 1993.		
iv) 2. Nyle C. Brady and Ray R. Weil, "The Nature and Properties of Soils", Pearson Education Inc., 2002		

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Rock Mechanics Lab	**L**	**T**		**P**	
3. Subject Code		0	0		2	
4. Type of Subject		Core (✓)	PE()		OE()	
5. Pre-requisite (if any)	Nil	Frequency (use tick marks)	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials = 00**	**Practical = 28**			
7. Learning objectives: 1-To study and analyze the laboratory and field testing for a given project / construction. 2 -To analyze the appropriate methods to improve stability of rock mass.						
8. Course Outcomes (COs):						
At the end of the lab course student able to						
1-Understand the laboratory method required for determination of rock properties						
2-Concept of Discontinuities in rock mass						
3-Understand strength and stability behaviour of rocks						
4-Application and recent development in the field of soil mechanics						
9. Unit wise detailed content(Tutorial / Extended Tutorial /presentation/Case study components/laboratory)						
10. Tutorial / Extended Tutorial /Case study components/laboratory						
Sr. No	**Title**					
1	Study phenomenon of rock formation					
2	Determination of physical properties of rocks					
3	Calculation of in-situ stresses in rocks					
4	Rock sampling methods					
5	Study about discontinuities of rock mass					
6	Laboratory study to determine strength characteristics of rocks					
7	Recent development to improve the stability of rocks					
8	Modern modelling techniques & analyses in rocks.					

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Advanced Geotechnical Lab**	**L**	**T**		**P**	
3. Subject Code		0	0		2	
4. Type of Subject		Core (✓)	PE()		OE()	
5. Pre-requisite (if any)	Nil	Frequency (use tick marks)	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials = 00**	**Practical = 28**			

7. Learning objectives:

1. To understand the properties of soil.
2. To evaluate the and determine the properties of soil used in foundation and pavement design

8. Course Outcomes (COs):

At the end of the lab course student able to

Understand the bearing strength of soil

2. student able to understand Requirements of design as per their Indian standard

3. Study and evaluate bearing capacity of soil required for designing foundation structure

9. Unit wise detailed content

10. Tutorial / Extended Tutorial /Case study components/laboratory/Field visit

Sr. No	**Title**
1	Test includes determining the bearing capacity of soil.
2	California bearing Ratio test (CBR) for soft soil, Medium hard soil and stiff and hard soil sample.
3	Dynamic cone penetration test (DCPT) for different types of soil sample
4	Static cone penetration test (SPT) for different types of soil
5	Plate load tests for soft ,medium and hard soil sample
6	Pile load test analysis
7	Core cutter test

Third Semester

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Earth & Rock fill Dams**	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core (✓)	PE()		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			

8. Brief Syllabus

This Course will introduce the knowledge about dam and its selection criteria ,seepage through the foundation and dam section, foundation treatment methods ,stability analysis and study of failure and remedial measure in dam

9. Learning objectives:

1 To analyze seepage through a given earth/rockfill dam section and select effective seepage control measures for the prevailing site conditions.

2. To study and analyze stability of slopes and evaluate the failure criteria.

10. Course Outcomes (COs):

At the end of course, the student will be able to:

1. Select a suitable site, materials and equipment for construction of earth/rockfill dams
2. Design earth and rock fill dams.
3. Understand the concept of foundation treatment
4. Measure and analysis the failure inside the body of dam

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Dams and site selection of dam**

Introduction: Classification of dams- Selection of Site-Basic design requirements Preliminary section.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Seepage through dam section and foundation**

Seepage through dam section and control : fundamentals of seepage flow, flow nets, seepage through dam section and foundation, seepage control filters, Impervious core, drainage.

Control of seepage through foundation: types of foundations trench cutoff, upstream impervious blanket, horizontal drainage blanket, relief wells, drainage trenches, cut-off walls, downstream loading berm.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Foundation treatment and Stability analysis**

Foundation treatment: treatment of pervious, impervious and rock foundations, core contact treatment, grouting, foundation excavation.

Stability analysis: critical slip surfaces, test conditions, strength parameters, pore pressures, stability analysis-method of slices

Unit – 4	**Number of lectures = 10**	**Title of the unit: Construction and failure in dams**
Construction of earth dams: construction equipment, procedures for pervious, semi pervious, impervious and rock fill sections, construction supervision. **Failures and damages of earth dams:** nature of failures – piping, settlement cracks, slides, earthquake & miscellaneous damages –case studies.		
12. Books Recommended (3 Text Books + 2-3 Reference Books)		
i) Sherard, et.al., "EARTH AND ROCK DAMS", john wiley inc..1963.		
ii) H. D. Sharma, "Embankment dams", Oxford and IBH Publishing Co..1991		
iii) Bharath Singh and R. S. Varshney, "engineering for embankment dams" A. A. Balekema publications, 1995.		
iii) Nyle C. Brady and Ray R. Weil, "The Nature and Properties of Soils", Pearson Education Inc., 2002		

1. Name of the Department	**CIVIL ENGINEERING**					
2. Course Name	Research Methodology and IPR	L	T	P		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		Core (✓)	PE-()	OE()		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials = 00	Practical = 0			

8.Brief Syllabus:

The aim of the course is to make students understand the importance of Research Paper Writing. Also, it covers all the concepts which involved in writing the Research Paper.

9 Learning objectives:

The objectives of the course are:

1. The students are able to recognize the steps involved in doing research work.
2. The students will be able to collect data using various media and using the best possible sample available.
3. The students would learn to propose their Hypothesis and build models for the problem.
4. The students would be able to correctly document their findings in the form of a report.

10.Course Outcomes:

After completion of this course, the student will be able to:

1. Recognize the various steps involved in research.
2. Collect data from samples, Examine and analyze the data.
3. Develop models for problems.
4. Explain the entire process in the form of a report.

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction**

Research - Types, Research process and steps, Hypothesis, Research Proposal and aspects. Research Design- Need, Problem Definition, Variables, Research Design concepts, Literature survey and review, Research design process, Errors in research. Research Modeling- Types of models, model building and stages, Data consideration.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Sampling**

Sampling and data collection- Techniques of sampling, Random, Stratified, Systematic, Multistage-sampling, Primary and secondary sources of data. Design of questionnaire.

Unit - 3	Number of lectures = 10	Title of the unit: Data Collection and Experiments
Design of Experiments- Objectives, strategies, Factorial experimental design, designing engineering experiments, basic principles-replication, randomization, blocking, guidelines for design of experiments.		
Unit - 4	**Number of lectures = 12**	**Title of the unit: Models and Hypothesis & Report writing**
Single factor experiment- Hypothesis testing, analysis of Variance component (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effect model, estimation of variance components, Model adequacy checking. Structure and components of Scientific Reports, Types of Report, Technical Reports and Thesis; Different steps in the preparation – Layout, structure and Language of typical reports; Illustrations and tables, Bibliography, Referencing and foot notes.		
12.Brief Description of self learning / E-learning component https://research-methodology.net/research-methodology/ https://gradcoach.com/what-is-research-methodology/		
13.Books Recommended **Text Book:** 1. Research Methodology – Methods and Techniques – C.R. Kothari, New Age International, New Delhi, 2004. **Reference Book:** 1. Design and Analysis of Experiments – Douglas C. Montgomery, Wiley India, 8th Edition, 2012. 2. Practical Research: Planning Design – Paul D. Leddy, London, 1980.		

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Research Methodology and IPR Lab**	**L**	**T**		**P**	
3. Subject Code		0	0		2	
4. Type of Subject		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	**Research Methodology and IPR**	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

1. Learning objectives:

The objectives of the course are:

2. The students are able to recognize the steps involved in Identifying research problem.
3. The students will be able to collect data using various media and using the best possible sample available.
4. The students would learn to propose their Hypothesis and build models for the problem.
5. The students would be able to correctly document their findings in the form of a report.

Outcomes:

On completion of this course, the students will be able to

1. Choose the topic for writing research paper.
2. Develop models for problems.
3. The students would learn to write the research paper.

7. Lab Content

Sr. No.	Title	CO covered
1	How to choose topic for research	1,2
2	How to collect data for the particular research problem	1,2
3	Writing Abstract	1,2
4	Writing Literature review	1,2
5	Explaining and writing methodology	1,2
6	How to analyze the data collected	1,2
7	Presentation of analysis and findings	1,2
8	How to write result and conclusion	2,3
9	References in research article	2,3

Departmental Elective

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	**Strength and Deformation Behavior of soil**	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core ()	PE (✓)		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =38		**Tutorials =0**	**Practical =0**			

8. Brief Syllabus

This subject includes the strength characteristics and different types of fine and coarse soils and their deformation behavior

9. Learning objectives:

1. To understand the strength behavior of soils.
2. To know the different concepts for the analysis of failure behavior of soil.
3. To identify the failure pattern of soil .

10. Course Outcomes (COs):

At the end of course, the student will be able to:

5. Identify the method of shear strength determination.
6. Understand the importance of various shear parameter and deformation behavior of various soils
7. Understand Yield criterion of soil
8. Measure and analysis volume change, and deformation behaviour of soil

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Shear strength of cohesion less soils**

Shear strength of granular soils - Direct shear - Triaxial Testing- Drained and undrained Stress strain behaviour - Dilation, contraction and critical states - Liquefaction on saturated sands. Factors influencing stress-strain shear strength.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Shear strength of cohesive soils**

Shear strength of clays - Stress-strain behaviour - Triaxial testing and stress path plotting - pore pressure parameter of Skempton and Henkel - Total stress and effective stress approach - shear strength of partially saturated clay in terms of stress state variables. Factors influencing stress strain shear strength.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Yield criterion**

Yield criterion: Concepts of yield and failure in soils- yield criteria of von Mises, Tresca and their extended form, their applicability to soils - Detailed discussion of Mohr. - Coulomb failure criterion

Unit - 4	**Number of lectures = 12**	**Title of the unit: Stress - strain laws for soils**

hyperbolic law - Linear visco-elastic and Elasto -plastic laws - yield functions, hardening law, flow rules and plastic strain computation - Rheological models of Kelvin, Maxwell and Burger and Burger as applied to soils.
12. Books Recommended (3 Text Books + 2-3 Reference Books)
v) Hotlz, R.D and Kovacs, W.D., Introduction Geotechnical Engineering, Prentice-Hall, 1981
vi) Braja, M, Das., Advanced soil mechanics, McGraw Hill, 1997.
vii) Lambe, T.W. and Whitman R.V. Soil Mechanics in S.I. Units John Wiley, 1979.
viii) Atkinson J.H. and BrandsbyP.L. Introduction to critical state soil mechanics McGraw Hill, 1978.
ix) Wood, D.M., Soil behaviour and Critical State Soil Mechanics, Cambridge University Press, New York, 1990.
x) Bazant, Z.P., Mechanics of Geo-materials, Rocks, Concrete and Soil, John Willey and Sons, Chilchester, 1985.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Strength and Deformation Behaviour of soil**	**L**	**T**		**P**	
3. Subject Code		0	0		4	
4. Type of Subject		Core ()	PE (✓)		OE()	
5. Pre-requisite (if any)	Nil	Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 00	**Tutorials = 00**	**Practical = 28**

7. Learning objectives:

1. To understand the strength behaviour of soils.
2. To know the different concepts for the analysis of failure behaviour of soil.
3. To identify the failure pattern of soil

8. Course Outcomes (COs):

At the end of the lab course student able to

1- Identify the method of shear strength determination.

2- Understand the importance of various shear parameter and deformation behavior of various soils

3- Understand Yield criterion of soil

4- Measure and analysis volume change, and deformation behaviour of soil

9. Unit wise detailed content

10. Tutorial / Extended Tutorial /Case study components/laboratory/Field visit

Sr. No	**Title**
1	Drained undrained tests on soil
2	Study of liquefaction and remedial measure
3	Skempton and Henkel - Total stress and effective stress analysis
4	Concepts of yield and failure in soils
5	Plastic strain computation
6	Rheological models of Kelvin
7	Mohr. - Coulomb failure criterion

1. Name of the Department: Civil Engineering Department						
2. Course Name	Computational Methods in Geotechnical Engg	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core ()	PE(✓)		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			

8. Brief Syllabus

This course imparts the student's knowledge of solution of non-linear equations, solution of ODE using numerical techniques.

Learning objectives:

To develop the understanding of computational methods in geotechnical engineering.

9. Course Outcomes (COs):

At the end of course, the student will be able to:

1. Solve non-linear equations using numerical techniques.
2. Apply the basic concepts of tensor algebra and calculus in continuum mechanics problems and solve linear equation using numerical techniques.
3. Apply finite difference and finite element method for analyzing behavior of geotechnical structures
4. Apply the basic concepts of critical state soil mechanics for constitutive modeling in Geomechanics

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Solution of Non-linear Equations**

Solution of Non-linear Equations: Bisection, False Position, Newton-Raphson, Successive approximation method, Iterative methods.

Unit – 2	**Number of lectures =10**	**Title of the unit: Solution of set of Linear Equations**

Solution of set of Linear Equations: Jacobi's method, Gauss Seidal method, Successive over relaxation method.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Solution of ODE using numerical techniques:**

Solution of ODE using numerical techniques: Initial value problems and boundary value problems; Taylor series method, Picard's method, Euler's method, Runge-Kutta method

The continuum theory of Soil Mechanics, methodology of continuum mechanics, introduction to tensor algebra and tensor calculus, deformation and strain, traction and stress

Unit – 4	Number of lectures = 12	Title of the unit: Finite Difference Method
Finite Difference Method: Boundary value and Initial value problems – Disichlet conditions, Neumann conditions; ordinary and partial differential equations; Nonlinear problems Introduction to Finite Element Method: Formulation of weak form, interpolation functions Constitutive modelling of soil: Critical state soil mechanics; Elastic-plastic constitutive models; Original Cam-Clay model and Modified Cam-Clay model.		
11. Books Recommended (3 Text Books + 2-3 Reference Books)		
i) 1. S. Chandrakant., Desai and John T. Christian, "Numerical Methods in Geotechnical Engineering", Mc. Graw Hill Book Company, 1977.		
ii) 2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering computations", Third edition, New Age International (P) Ltd. Publishers, New Delhi. 2010.		
iii) D.J. Naylor and G.N. Pande, "Finite Elements in Geotechnical Engineering", Pineridge Press Ltd., UK. 1981		
iv) 2. Sam Helwany, "Applied Soil Mechanics with ABAQUS Applications", John Wiley & sons, Inc, USA, 2007.		
v) 3. Alexander Puzrin, "Constitutive Modelling in Geomechanics: Introduction", Springer, 2012		

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Computational Methods in Geotechnical Engg Lab	**L**	**T**		**P**	
3. Subject Code		0	0		4	
4. Type of Subject		Core ()	PE (✓)		OE()	
5. Pre-requisite (if any)	Nil	Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

6. Total Number of Lectures, Tutorials, Practical

Lectures = 00	**Tutorials = 00**	**Practical = 28**

7. Learning objectives:

1. To develop the understanding of computational methods in geotechnical engineering.

8. Course Outcomes (COs):

At the end of the lab course student able to

1- Solve non-linear equations using numerical techniques

2-Analyse and calculate the set of linear equations

3-Undestand the cam clay model and constitutive modeling of soil

9. Unit wise detailed content

10. Tutorial / Extended Tutorial /Case study components/laboratory

Sr. No	**Title**
1	Bisection methods for Non-linear Equations
2	Iterative methods comparisons
3	Solution of set of Linear Equations by using successive over relaxation method.
4	Analysis of Finite Difference Method
5	To study methodology of continuum mechanics
6	Study of Modified Cam-Clay model
7	Constitutive modelling of soil

1. Name of the Department: Civil Engineering Department						
2. Course Name	Construction Methods and Equipment	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core ()	PE (✓)		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			

8. Brief Syllabus

Construction Methods and Equipment course includes the study of modern construction material, modern construction methods and equipment's and advanced study of polymers in the field of civil engineering.

9. Learning objectives:

1. To create an awareness in Engineers about construction methods and equipment's.
2. To understand the modern materials used in modern construction.

10. Course Outcomes (COs):

At the end of course, the student will be able to:

1. Students understand the technology of uses of modern material and equipment.
2. Understand the significance of construction methods involve in modern construction techniques
3. Use of different construction equipment's and their capabilities.
4. Identify the properties of advanced polymers

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Modern Construction Materials**

Study of Advance Building Materials like, Aluminium, Glass, fabric, various types of finishes & treatments, Construction chemicals – sealants, engineering grouts, mortars , admixtures and adhesives, Plastic,FRP.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Construction Methods**

Precast Flat Panel System, 3d Volumetric Construction, Tunnel Boring Methods, Precast Foundations. Fabrication of Pre-Cast and Pre-Stressed Components, Reinforcing Steel: Types, Bending, Placing, Splicing and Spacing, Tendons- Soil Improvement - Mechanical, Thermal.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Construction Equipment**

Equipment for Excavating, Dredging, Trenching, Tunneling, Drilling, Blasting-Equipment for compaction-Erection Equipment- Types of pumps used in construction-Equipment for Dewatering and Grouting-Foundation and Pile Driving Equipment.

Unit – 4	Number of lectures = 12	Title of the unit: Study of advanced Polymers in Civil Engineering
Polymers in Civil Engineering-Structural Plastics and Composites- Polymer Membranes Coatings-Adhesives, Non - Weathering Materials-Flooring and Facade Materials- Glazed Brick, Photo Catalytic Cement, Acid Etched Copper and Composite Fiber Metals-Metals and Special Alloys Of Steel.		

12. Books Recommended (3 Text Books + 2-3 Reference Books)

i) Shan Somayaji, “Civil Engineering Materials ", 2nd Edititon , Prentice Hall Inc., 2001.

ii) Mamlouk, M.S. and Zaniewski, J.P., " Materials for Civil and Construction Engineers ", Prentice Hall Inc., 1999.

iii) Derucher, K.Korfiatis. G. and Ezeldin, S., " Materials for Civil and Highway Engineers ", Prentice Hall Inc., 1999. 4th Edition

iv) Peurifoy, R.L., Ledbetter, W.B.and Schexnayder, C., “Construction Planning, Equipment and Methods ",5th Edition, McGraw Hill, Singapore, 1995. 5. Sharma S.C. “Construction Equipment and Management ", Khanna Publishers New Delhi, 1988.

v) Dr. Mahesh Varma, “Construction Equipment and its Planning and Application ", Metro-politan Book Company, New Delhi-, 1983.

vi) Deodhar, S.V. “Construction Equipment and Job Planning ", Khanna Publishers, New Delhi, 1988.

1. Name of the Department	**CIVIL ENGINEERING**					
2. Subject Name	**Construction methods and Equipments Laboratory**	**L**	**T**		**P**	
3. Subject Code		0	0		4	
4. Type of Subject		Core ()	PE (✓)		OE()	
5. Pre-requisite (if any)	Nil	Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical						
Lectures = 00		**Tutorials = 00**	**Practical = 28**			

7. Learning objectives:

1. To create an awareness in Engineers about construction methods and equipment's.
2. To understand the modern materials used in modern construction

8. Course Outcomes (COs):

At the end of the lab course student able to

1-Students understand the technology of uses of modern material and equipment.

2-Understand the significance of construction methods involve in modern construction techniques

3-Use of different construction equipment's and their capabilities.

4-Identify the properties of advanced polymers

9. Unit wise detailed content

10. Tutorial / Extended Tutorial /Case study components/laboratory

Sr. No	**Title**
1	Identification and determination of properties of modern building materials
2	Tunnel Boring Methods
3	Study about precast and cast in-Situ construction methods of foundation
4	Understanding the pre-tensioning and post tensioning methods
5	Field Grout methods and its effect
6	Drilling methods
7	Understanding of different types of polymers used in construction
8	Freezing and thawing test for materials

1. Name of the Department: Civil Engineering Department						
2. Course Name	Advanced Pavement Materials	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core ()	PE (✓)		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			
8. Brief Syllabus						
Advance pavement materials course includes						
9. Learning objectives:						
1 To understand the properties of different paving materials 2. To study the behavior of bituminous binder and modified binder as per their use in pavement layer.						
10. Course Outcomes (COs):						
At the end of course, the student will be able to:						
1. Understand the characteristics and behaviour of soil subgrade and various soil deposits						
2. Understand the behavior of various material used in construction of pavement design						
3. Select appropriate asphalt binder for construction of a flexible pavement depending upon the traffic and climatic conditions.						
4. Determine the proportions of ingredients required for the mix design of both asphalt mixtures and cement concrete.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction-Sub grade**				
Introduction -Sub grade functions, Importance of sub grade soil properties on pavement performance. Identification and significance of soil characteristics, Soil classification, Effect of water on swelling and shrinkage, Cohesion and Plasticity						
Unit – 2	**Number of lectures = 10**	**Title of the unit: Road making aggregates**				
Road making aggregates – Classification, Properties of aggregates, design of aggregate gradation, texture, polishing and skid resistance						
Unit – 3	**Number of lectures = 10**	**Title of the unit: Bituminous road binders**				
Bituminous road binders – Straight- run bitumen, emulsions, Cutback and modified binders. Rheology of bituminous binders.						
Unit – 4	**Number of lectures = 12**	**Title of the unit: Modified binders and Requirements of paving concrete, design of mixes**				
Modified binders – Adhesion and stripping, penetration index, viscosity, temperature susceptibility of						

viscosity. Additives and their suitability, Fillers. Design of Bituminous mixes – Marshall method and super paves procedure. **Requirements of paving concrete, design of mixes –** IRC, absolute volume, Vibrated Concrete mix design, design of DLC and SFRC mixes, Soil stabilization techniques. CBR Test
12. Books Recommended (3 Text Books + 2-3 Reference Books)
i) PapagiannakisA. T., MasadEyad,"Pavement design and materials", John Wiley & Sons.
ii) Athanassios Nikolaides, "Highway Engineering: Pavements, Materials and Control of Quality", CRC Press
iii) Read, J. And White oak, D., "The Shell Bitumen Handbook", Fifth edition, Shell Bitumen, Thomas Telford Publishing, London 2003
iv) Atkins, N. Harold, Highway Materials, Soils and Concretes, Fourth Edition, 2002, PrenticeHall.
v) Kerbs Robert D. and Richard D. Walker, Highway Materials, McGraw-Hill, 1971.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Advanced Pavement Material Lab**	**L**	**T**		**P**	
3. Subject Code		0	0		4	
4. Type of Subject		Core ()	PE (✓)		OE()	
5. Pre-requisite (if any)	Nil	Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical						
Lectures = 00		**Tutorials = 00**	**Practical = 28**			

7. Learning objectives:

1. To understand the properties of different paving materials.
2. To study the behaviour of bituminous biner and modified binder as per their use in pavement layer

8. Course Outcomes (COs):

At the end of the lab course student able to

1-Understand the characteristics and behaviour of soil subgrade and various soil deposits

2-Understand the behavior of various material used in construction of pavement design

3-Select appropriate asphalt binder for construction of a flexible pavement depending upon the traffic and climatic conditions.

4-Determine the proportions of ingredients required for the mix design of both asphalt mixtures and cement concrete.

9. Unit wise detailed content

10. Tutorial / Extended Tutorial /Case study components/laboratory

Sr. No	**Title**
1	Sub grade properties and strength analysis
2	Tests to analyze effects of water on swelling and shrinking behaviour of soil
3	Study Engineering properties of Road making aggregates
4	To determine compressive strength of road aggregates by impact tests
5	To study properties and characteristics of bitumen binders
6	Physical testing of bitumen
7	Study engineering properties and uses of modified binders
8	Vibrated Concrete mix design

1. Name of the Department: Civil Engineering Department						
2. Course Name	Offshore Foundations	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core ()	PE (✓)		OE()	
5. Pre-requisite (if any)	Foundation Engineering	**6.** Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			

8. Brief Syllabus

Student will study the challenges of an offshore engineering design, main components of an offshore site investigation.

9. Learning objectives:

1. To introduce the concepts of offshore engineering and types of offshore foundation.
2. The student is exposed to the use the urban storm water models for better storm water management.

10. Course Outcomes (COs):

At the end of course, the student will be able to:

1. Apply the basic concepts of offshore engineering in foundation construction.
2. Analyse the main components of an offshore site investigation
3. Identify the types of offshore foundation
4. Select appropriate design method for construction of an offshore foundation

11. Unit wise detailed content

Unit-1	**Number of lectures =12**	**Title of the unit: Challenges of offshore engineering design**

Identify and describe key challenges of offshore engineering design; describe the aspects of the marine environment that feed into offshore engineering design

Unit - 2	**Number of lectures = 10**	**Title of the unit: Main Component of an offshore site investigation**

Describe the main components of an offshore site investigation; Interpret selected geotechnical site investigation data

Unit - 3	**Number of lectures = 10**	**Title of the unit: Types of offshore foundation**

Identify the main types of offshore foundation systems and describe the drivers during foundation design, Perform selected foundation design calculations to illustrate the interplaying mechanisms

Unit - 4	**Number of lectures = 10**	**Title of the unit: Geotechnical pipeline design aspects**

Identify key aspects of geotechnical pipeline design and perform selected design calculations to illustrate the interplaying mechanisms, determine the loads acting on the offshore structures

12. Books Recommended (3 Text Books + 2-3 Reference Books)
i) Ben C. Gerwick, “Construction of Marine and Offshore Structures”, CRC Press, 1999.
ii) 2. B. Gou, S. Song, J. Chacko and A. Ghalambor, “Offshore Pipelines”, GPP Publishers, 2006.
iii) S. K. Hakrabarti, “Handook of Offshore Engineering”, Elsevier, 2005.
iv) 2. M. J. Tomlinson, “Pile Design and Construction”, E and F Spon, 1994

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Offshore Foundations Laboratory	**L**	**T**		**P**	
3. Subject Code		0	0		4	
4. Type of Subject		Core ()	PE(✓)		OE()	
5. Pre-requisite (if any)	Foundation Engineering	Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			
7. Learning objectives: 1. To introduce the concepts of offshore engineering and types of offshore foundation. 2. The student is exposed to the use the urban storm water models for better storm water management.						
8. Course Outcomes (COs):						
At the end of the lab course student able to						
1-Apply the basic concepts of offshore engineering in foundation construction.						
2-Analyse the main components of an offshore site investigation						
3-Identify the types of offshore foundation						
4-Select appropriate design method for construction of an offshore foundation						
9. Unit wise detailed content						
10. Tutorial / Extended Tutorial /Case study components/laboratory						

Sr. No	**Title**
1	Offshore engineering design Requirements
2	To study the main components of an offshore site investigation
3	Analysis of geotechnical site investigation data
4	To study main types of offshore foundation systems
5	Analysis of foundation design calculations to illustrate the interplaying mechanisms
6	Geotechnical pipeline design procedures
7	Determination of loads acting on the offshore structures

1. Name of the Department: Civil Engineering Department						
2. Course Name	Advanced Surveying and Cartography	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core ()	PE(✓)		OE()	
5. Pre-requisite (if any)	Nil	**6.** Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials =0**	**Practical =0**			
8. Brief Syllabus Students will learn the concept of advanced Surveying						
9. Learning objectives: To teach the students about the Triangulation and Trilateration . 2. To enable the students to understand the Photogrammetry and Remote Sensing.						
10. Course Outcomes (COs):						
At the end of course, the student will be able to:						
1. Understand the concept of triangulation survey and Trilateration						
2. Analysis the project survey						
3. Understand the field astronomy requirements and methods						
4. Role of Photogrammetry, Remote Sensing,GPS and GIS in the field of surveying						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Triangulation, Trilateration and Adjustment Computations**				
Triangulation and Trilateration: Necessity of Control Surveying, Principle of Triangulation and Trilateration classification of Triangulation Systems Station Marks, Towers and Signals, Satellite station, Intersected and Resected points, Reconnaissance, Indivisibility of stations, Angular Measurement, Base line measurement and its extension **Adjustment Computations:** Treatment of random errors, Normal law of errors, Most Probable Value, Weight of observations, Propagation of errors and variances, Principle of Least Squares, Observations and correlative Normal Equations, Adjustment of triangulation figures and level nets.						
Unit - 2	**Number of lectures = 10**	**Title of the unit: Curves and project survey**				
Curves: Classification of curves, Elements of Simple Circular, Transition and Vertical curves, Theory and methods of setting out circular, transition and vertical curves, special field problems. **Project Surveys:** General requirements and specifications for Engineering project surveys, Reconnaissance, Preliminary and Location surveys for highways, railways and canals.						
Unit - 3	**Number of lectures = 10**	**Title of the unit: Field Astronomy:**				

Field Astronomy: Astronomical terms, co-ordinate systems, Spherical trigonometry, Astronomical triangle, Relationship between coordinates.

Unit – 4	**Number of lectures = 12**	**Title of the unit: Photogrammetry ,Remote Sensing,GPS and GIS**

Photogrammetry and Remote Sensing: Photogrammetry-Introduction, Scale of photograph, Tilt and height displacement, Stereoscopic vision and stereoscopes, Principles of remote sensing, Electro Magnetic Radiation (EMR)

GPS and GIS: Global Positioning System (GPS)-Introduction, principle, and applications of GPS in different fields of Surveying, Geographic Information System (GIS) – Introduction, Geographical concepts and terminology, Applications of GIS

12. Books Recommended (3 Text Books + 2-3 Reference Books)

i- Agor, R., "Surveying", Vol. II & III, Khanna Publications, Delhi, 1995.

ii- Punmia, B.C., "Surveying", Vol.II & III Laxmi Publications, New Delhi

iii- Duggal S.K., Surveying Vol. I & II TMH Basak, Surveying TMH. Kanetkar, Surveying Chandra, A.M. "Plane Surveying", New Age International Publisher,.

iv. Dent, B. D., "Cartography – Thematic Map Design",. 5th" Edition, W C B McGraw-Hill, Boston, 1999.

v- "Rampal .K.K, "Mapping and Compilation". Concept Publishing Co.,New Delhi, 1993.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Advanced Surveying and Cartography Laboratory	**L**	**T**		**P**	
3. Subject Code		0	0		4	
4. Type of Subject		Core ()	PE (✓)		OE()	
5. Pre-requisite (if any)	Nil	Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)	
Lectures = 00	**Tutorials = 00**	**Practical = 28**

7. Learning objectives:

1. To teach the students about the Triangulation and Trilateration
2. To enable the students to understand the Photogrammetry and Remote Sensing

8. Course Outcomes (COs):

At the end of the lab course student able to

1-Understand the concept of triangulation survey and Trilateration

2-Analysis the project survey

3-Understand the field astronomy requirements and methods

4-Role of Photogrammetry ,Remote Sensing,GPS and GIS in the field of surveying

9. Unit wise detailed content

10. Tutorial / Extended Tutorial /Case study components/laboratory/Field visit

Sr. No	**Title**
1	To study about Triangulation and Trilateration methods
2	Theory and methods of setting out circular, transition and vertical curves
3	General requirements and specifications for Engineering project surveys
4	Photogrammetry and Techniques of photo-interpretation
5	GPS Technology
6	GIS Technology
7	Laboratory study of Total Station

Curriculum
(Scheme of Examination)
&
Syllabus for
M.Tech
Geo-informatics and Remote Sensing

Batch 2021 onwards

SGT University Gurgaon

Credit Based Scheme w.e.f. 2021-2022

Scheme of Examination for M.Tech– Geo-informatics and Remote Sensing Program

SEMESTER WISE COURSE STRUCTURE

First Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Geographical Information System	3	0	0	3	60	40	100
2		Photogrammetric & Remote Sensing	3	0	0	3	60	40	100
3		Remote Sensing & GIS for Hydrology and Water Resources	3	0	0	3	60	40	100
4		Emerging Trends in Geoinformatics	3	0	0	3	60	40	100
5		Photogrammetric & Remote Sensing Lab	0	0	2	1	40	60	100
6		Computer application in Engineering Lab	0	0	2	1	40	60	100
7		Value Added Courses-I	2	0	0	2	60	40	100
8		Seminar	0	0	2	1	00	100	100
		Total	**14**	**0**	**6**	**17**	**380**	**420**	**800**

Second Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Digital Image Processing	3	0	0	3	60	40	100
2		GPS & Electronic Surveying	3	0	0	3	60	40	100
3		Pattern Recognition and Machine Learning	3	0	0	3	60	40	100
4		Remote Sensing & GIS for Urban Planning and Management	3	0	0	3	60	40	100
5		Digital Image Processing Lab	0	0	2	1	40	60	100
6		GPS Lab	0	0	2	1	40	60	100
7		Seminar	0	0	2	1	00	100	100
		Total	**12**	**0**	**6**	**15**	**320**	**380**	**700**

Scheme of Examination for M.Tech– Geo-informatics and Remote Sensing Program

SEMESTER WISE COURSE STRUCTURE

Third Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Basics and Digital Cartography	3	0	0	3	60	40	100
2		Research Methodology & IPR	3	0	0	3	60	40	100
3		Department Electives-XIII	3	0	0	3	60	40	100
4		Department Electives-XIV	3	0	0	3	60	40	100
5		Department Electives-XV	3	0	0	3	60	40	100
6		Research Methodology & IPR Lab	0	0	2	1	40	60	100
7		Department Electives Lab-XIII	0	0	2	1	40	60	100
8		Department Electives Lab-XIV	0	0	2	1	40	60	100
9		Department Electives Lab-XV	0	0	2	1	40	60	100
10		Value Added Courses-II	2	0	0	2	60	40	100
		Total	**17**	0	**8**	**21**	520	480	1000

Fourth Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Dissertation	0	0	20	20	100	0	100
		Total	**0**	**0**	**20**	**20**	100	0	100

Departmental Elective

S. No.	Specialization	Departmental Elective XIII	Departmental Elective XIV	Departmental Elective XV
1	Geoinformatics & Remote Sensing	Advanced Surveying and Cartography 3-0-2(4)	Applications of Remote Sensing in Geosciences 3-0-2(4)	Non-Topographic Photogrammetry 3-0-2(4)

First Semester

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	Geographical Information System	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 00**	**Practical = 00**

Brief Syllabus: Basic Introduction to GIS, Basic Spatial Analysis to GIS, Concept of Integration and Modeling, Web GIS and Introduction to DTM.

8. Learning objectives:

1. To give the students an insight about Geographical Information System.
2. To study different concepts of Modeling and DTM.

9. Course Outcomes:

1. Knowledge about Geographical Information System
2. Understanding concepts of integration and modelling.
3. Understanding the concepts of Web GIS.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Basic Introduction and Understanding**

Introduction, Definitions, Basic Concepts, history and evolution, Components, Need, Scope, interdisciplinary relations, applications areas, and overview of GIS. GIS data: spatial and non-spatial, spatial data model: raster, vector, Topology and topological models; Spatial referencing using coordinates and geographic identifiers, metadata; Spatial data acquisition; Attribute data sources; Spatial and attribute data input; Data storage, RDBMS, database operations; Spatial and non-spatial data editing functions; Quality of spatial data; GIS analysis functions: Retrieval, classification, measurement, neighborhood, topographic, interpolation, overlay, buffering, spatial join and query, connectivity, network functions, watershed analysis, view-shed analysis, spatial pattern analysis, spatial autocorrelation, trend surface analysis; GIS presentation functions: data visualization methods, exporting data; Modern trends: Internet GIS, 3DGIS.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Basic Spatial Analysis, Integration and Modeling**

Logic operations, general arithmetic operations, general statistical operations, geometric operations, query and report generation from attribute data, geometric data search and retrieval, complex operations of attribute data, classification reclassification, integrated geometry and attributes, overlay, buffer zones, raster data overlay, integrated data analysis.

Unit - 3	Number of lectures =10	Title of the unit: Introduction to DTM

Digital surface modeling by DTM/DHM and DSM/DEM, Interpolation techniques, GRID and TIN, break lines, profiles, mass points, / random points, factors influencing choice of sampling patterns, DTM generation process, preprocessing, main processing, post processing, differential rectification, mosaicing, automatic production of digital orthophotos. Differential sampling techniques- manual, Semiautomatic, automatic sampling techniques, storage of TIN Grid and its data base structure. Data sources, / input to DTM, Direct and indirect data collection method.

Unit - 4	Number of lectures = 12	Title of the unit: Web GIS

Definition, concept of Web GIS, History of web GIS, components of web
GIS, internet, web GIS v/s Internet GIS, Fundamentals of computer networking – network environment –network communication models –protocols – TCP/IP. Applications of web GIS, users and stake holders of web GIS, advantages and limitations of web GIS, Participatory GIS -Web-based GIS For Collaborative Planning And Public Participation, Digital Democracy for planning, web GIS An Aid To Local Environmental Decision making, web GIS for regional and local level planning. Community GIS, Internet GIS Applications in intelligent transportation systems, planning and resource management.

11. Brief Description of self-learning / E-learning component

1. https://www.coursera.org/specializations/gis
2. https://www.edx.org/learn/gis-geographic-information-systems
3. https://www.learning-gis.com/

12. Books Recommended

TEXT BOOKS

1. Principal of GIS for Land Resources Assessment P.A.Vurrough
2. GIS Principal Vol-1 Goodchild
3. Zhong- Ren Peng, Ming-Hsiang Tsou, (2003) Internet GIS: Distributed Geographic
4. Information Services for the Internet and Wireless Networks, Wiley.

REFERENCE BOOKS

1. Principles of GIS for Land Resources Assessment by P.A.Burrough, Oxford: Science publications, 1986.
2. Geographic Information Systems – An introduction by Tor Bernhardsen, John Wiley and Sons, Inc., New York, 2002.
3. GIS – A computing Perspective by Micheal F. Worboys, Taylor & Francis, 1995.
4. Remote Sensing and Image Interpretation by Thomas M. Lillesand and Ralph W. Kiefer, John Wiley and Sons Inc., New York, 1994.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	**Photogrammetry & Remote Sensing**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Surveying	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			
8. Brief Syllabus: Basic Introduction to Remote Sensing, Concept of Photogrammetry, Remote Sensing: Applications and Errors.						
9. Learning objectives: 1. To give the students an insight about Remote Sensing 2. To study different concepts of Photogrammetry and its application areas.						
10. Course Outcomes: 1. Knowledge about Remote Sensing. 2. Understanding concepts of Photogrammetry and its application areas.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Basic Introduction and Understanding**				
Definition and terms, history of Photogrammetry, concepts, principles and types of Photogrammetry, types of aerial photographs vertical photographs, tilted photographs, orthophotographs, aerial cameras, geometry and scale orientation and measurements, distortions, displacements and their corrections, rectification and orthophotographs.						
Unit - 2	**Number of lectures = 10**	**Title of the unit: Basic Principles of Remote Sensing**				
Physics of remote sensing, Characteristics of electro-magnetic radiation; Interactions between matter and electro-magnetic radiation; energy interaction in the atmosphere; energy interactions with the earth's surface spectral reflectance curves. Types of remote sensing with respect to wavelength regions; active and passive remote sensing, Sensor types characteristics: imaging systems, photographic sensors, characteristics of optical sensors; FOV, IFOV; Sensor resolution - spectral, spatial, radiometric and temporal; Dispersing element; Spectroscopic filter; Spectrometer; Characteristic of optical detectors; imaging sensors, Thermal sensors; Atmospheric sensors; Sonar; Laser, radar, hyper spectral sensors.						
Unit - 3	**Number of lectures = 10**	**Title of the unit: Remote Sensing satellites and data products**				
EMR characteristics and interaction in atmosphere and with ground objects; Atmospheric errors and removal; Geometric and radiometric distortions, Applications of optical remote sensing techniques in						

natural resources management. Interpretation elements; Systems and techniques of extraction and analysis of information from aerial/satellite stereo data.

Unit - 4	Number of lectures = 12	Title of the unit: Fundamentals of Photogrammetry

Photograph v/s image, Panchromatic, Multispectral, hyper spectral, stereo images, Optical mechanical line scanner; Push broom scanner; Imaging spectrometer.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13.Books Recommended

TEXT BOOKS

1. Remote Sensing and Image Interpretation Thomas M. Lillesand & Palph W. Kiefer
2. Elements of Photogrammetry with application in GIS Paul R. Wolf & Bon A. Dewitt
3. Remote Sensing Geology Ravi P. Gupta

REFERENCE BOOKS

1. Elements of Photogrammetry with applications in GIS by Paul R Wolf and Bon A. Dewitt, 3rd edition, 2004, ISBN 007-123689-9.
2. Aerial Photography and Image interpretation second edition by David P paine, and James D Kiser, 2003, John Wiley and Sons Inc. ISBN 0-471-20489-7

1. Name of the Department		**CIVIL ENGINEERING**					
2. Course Name	Remote Sensing and GIS for Hydrology and Water Resources	**L**	**T**		**P**		
3. Course Code		3	0		0		
4. Type of Course		**Core (✓)**	**PE()**		**OE()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 42		**Tutorials = 00**	**Practical = 00**				
8. Brief Syllabus: Basic Introduction to Hydrology, Drainage Basins, Quality of water and Groundwater And Irrigation Management							
9. Learning objectives: 1. To give the students an insight about Remote Sensing and Hydrology. 2. To give the students an insight about GIS and Hydrology. 3. To give the students an insight about Remote Sensing and Water Resources. 4. To give the students an insight about GIS and Water Resources.							
10. Course Outcomes: 1. Knowledge about Remote Sensing in Water Resources and Hydrology. 2. Understanding concepts of GIS in Water Resources and Hydrology.							
11. Unit wise detailed content							
Unit-1	**Number of lectures = 10**	**Title of the unit: BASICS OF HYDROLOGY**					
hydrological cycle – estimation of various components of hydrology cycle – clouds – rainfall – runoff – evaporation – transpiration – evapo–transpiration – interception – depression storage – spectral properties of water – GIS application in surface water modeling – case studies.							
Unit - 2	**Number of lectures = 10**	**Title of the unit: DRAINAGE BASIN**					
Watershed divide – stream networks – Delineation and codification of watersheds morph metric analysis – linear – areal –relief aspects – Rainfall- runoff modeling – urban hydrology – case studies.							
Unit - 3	**Number of lectures =10**	**Title of the unit: GROUND WATER AND WATER QUALITY**					
Ground water prospects – surface water indicators – vegetation, geology, soil aquifer – aquifer parameters – well hydraulics – estimation of ground water potential – hydrologic budgeting – mathematical models – GIS application in ground water modeling – study on sea water intrusion – modeling of sea water intrusion – water quality parameters –physical, chemical, biological properties. Water quality mapping and monitoring –correlation model for pollution detection and suspended sediment concentration– case studies							
Unit - 4	**Number of lectures = 12**	**Title of the unit: IRRIGATION AND WATERSHED MANAGEMENT**					
Project investigation, implementation, maintenance stage- location of storage/ diversion works – canal							

alignment –depth-area capacity curve generation, - conjunctive use of surface and ground water – Mapping and monitoring the catchment command area – artificial recharge of groundwater – water harvesting structures – sediment yield – modeling of reservoir siltation – prioritization of watershed – modeling of sustainable development – Development of information system for Natural resource management case studies.

12. Brief Description of self-learning / E-learning component

1. https://elearning.iirs.gov.in/
2. https://elearning.iirs.gov.in/e-Learning.html
3. https://gis.e-education.psu.edu/remote_sensing

13. Books Recommended

TEXT BOOKS

1. Eric C. Barrett, Clare H.Power, Satellite Remote Sensing for Hydrology and Water Management, gordon @ Breach Science publications - new York 1990,
2. Dr. David Maidment, Dr. Dean Djokic, Hydrologic and Hydraulic Modeling Support with Geographic Information Systems, Esri Press 2000,
3. Wilfried Brutsaert, Hydrology: An Introduction Cambridge University Press, 2005,
4. Andy D. Ward and Stanley W. Trimble, Environmental Hydrology, second edition, Lewis Publishers, 2004,
5. U.M. Shamsi, GIS Applications for Water, Wastewater, and Storm water Systems, CRC; first edition 2005,

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Emerging trends in Geoinformatics**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core (✓)**	**PE-III()**		**OE()**	
5. 5 Pre-requisite (if any)	Nil	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials =00**	**Practical =00**			

7. Learning objectives:

1. To study the new concepts of Geoinformatics at global level

8. Subject Outcomes:

On completion of this course, the students will be able to

1. To understand the global scenario of Geoinformatics and the space programs
2. To understand the education facility, laws and the policies

9. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Global and Indian Scenario of Geo-informatics**

Current status and Recent Advances in the field of RS, GIS, Photogrammetry, GPS, products and process, software and hardware. Global Institutions- NASA, ESRI, ERDAS, Canadian Institute of Remote Sensing, International Institute of Photogrammetry and Remote Sensing, Google, India-ISRO and its subunits, NRSA, SAC, Antrix, IIRS, RRSSCs; State Remote Sensing Centers; Funding Sources for R&D projects; Global and National Spatial Data Centers, Satellite data sources and procurement procedures.

Unit - 2	**Number of lectures = 10**	**Title of the unit: World and Indian Space Programs**

Satellites and sensors and their products and applications; Geoinformatics usage by Government and Private Sectors - User Departments of Central Govt. and State Govt. and their major projects: Central - SOI, MOEF, MOUD, MOD, few Case studies.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Education and Training facilities in Geoinformatics**

Global Geoinformatics Courses, scholarships; Web Resources for e-learning; eBooks; open sources of free software; International Journals, Review magazines, News Letters, e-journals.

Unit - 4	**Number of**	**Title of the unit:**

	lectures = 12	**Laws and Policy Perspectives and International Co-operations**

Laws and policy matters at international and national level with respect to Space, Sea, Photogrammetry, data sharing and data security, interoperability; Global and national Geoinformatics survey reports, case-studies, show cases of best practices.

10. Brief Description of self learning / E-learning component

The students will be encouraged to learn using the SGT e-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

Journal papers; Patents in the respective field.

11. Text Book

1. "GIS Development".net, ESRI web site, NCGIA, UCGIA, Google Earth, Yahoo Maps, NASA web site, ISRO website.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	Photogrammetric & Remote Sensing Lab	**L**	**T**		**P**	
3. Course Code		0	0		2	
4. Type of Course		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials = 00**	**Practical = 28**			

Brief Syllabus: The fundamental principle used by Photogrammetry is triangulation. By taking photographs from at least two different locations, so-called "lines of sight" can be developed from each camera to points on the object.

8. Learning objectives:

The fundamental principle used by Photogrammetry is triangulation. By taking photographs from at least two different locations, so-called "lines of sight" can be developed from each camera to points on the object.

9. Course Outcomes:

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

1) Will learn about the Photogrammetry and its types.
2) Will learn about the stereoscopy.
3) Will able to learn about the analytical Photogrammetry

10. Unit wise detailed content

1. Fundamentals of aerial photos and satellite image Interpretation
2. Types of imaging
3. Elements of interpretation
4. Techniques of Visual interpretation
5. Generations of Thematic maps
6. Study of satellite image annotation
7. Demarcation of contours & watershed
8. Remote sensing applications
9. Understanding of spectral response pattern of different landforms
10. Image Interpretation and Analysis

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	**Computer Application in Engineering Lab**	**L**	**T**		**P**	
3. Course Code		0	0		2	
4. Type of Course		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials = 00**	**Practical = 28**			
Brief Syllabus: Explore the world of spatial analysis and cartography with geographic information systems (GIS). In this class you will learn the basics of the industry's leading software tool, ArcGIS, during four week-long modules.						
8. Learning objectives: Basics of ArcGIS						
9. Course Outcomes: On completion of this course, the students will be able to 1) Spatial Analysis and Cartography 2) Will learn about the stereoscopy. 3) Will able to learn about the analytical Photogrammetry						
10. Unit wise detailed content						
1. ArcGIS Enterprise Deployment						
2. ArcGIS Tools						
3. ArcGIS Data						
4. ArcGIS Customization						
5. ArcGIS Drawing						
6. ArcGIS Base map						
7. ArcGIS Levels						
8. ArcGIS Layers						
9. ArcGIS Symbology						
10. ArcGIS Mapping						

Second Semester

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**DIGITAL IMAGE PROCESSING**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem (√)	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			

Brief Syllabus:

Digital image processing includes Introduction Image processing system, Image Analysis and Understanding and Multi temporal Data merging – Change detection procedures & Hyper-spectral Image Analysis and Radar image analysis.

7. Learning objectives:

1 To study and analyze the image processing

2 To analyze the appropriate methods to improve data merging and image analysis

8. Subject Outcomes:

On completion of this course, the students will be able to

1. Students will be able to understand use of image processing in Civil Engineering

2. Students will understand about GIS and image processing techniques

9. Unit wise detailed content

Unit-1	**Number of lectures =10**	**Title of the unit: Introduction**

Image processing system; Satellite data acquisition –Storage and retrieval – Data Formats – Compression – Satellite System – Data products – Image display system – Current Remote Sensing Systems. Preprocessing of remotely sensed data; Radiometric and Geometric distortions and corrections- Geometric correction Radiometric correction – Noise removal. Spectral Rationing – Principal and Canonical Components– Vegetative Components.

Unit - 2	**Number of lectures =10**	**Title of the unit: Image Analysis and Understanding**

Image Rectification and Restoration. Image enhancement- Contrast Manipulation – Gray-Level Thresh holding- Level Slicing Contrast Stretching. Convolution – Edge Enhancement – Spatial feature manipulation. Image transformations; Pattern recognition, Image classification, Image fusion and change detection. Pattern recognition – Shape analysis- Textural and contextual analysis.

Unit – 3	**Number of**	**Title of the unit: Data Merging and GIS Integration**

	lectures =10	
Multi temporal Data merging – Change detection procedures- Multi sensor image merging – Merging of image data with Ancillary data Incorporating GIS Data in automated land cover classification.		
Unit - 4	**Number of lectures = 12**	**Title of the unit: Hyper-spectral Image Analysis and Radar image analysis**
Atmospheric correction – Hyper-spectral image analysis techniques.		

10. Brief Description of self learning / E-learning component

The students will be encouraged to learn using the SGT e-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

Journal papers; Patents in the respective field.

11. Books Recommended

Text books

1. John R Jenson „Introducing Digital Image Processing" Prantice Hall. New Jersy 1986.
2. R. A. Schowengergt, „Techniques for Image Processing and Classification in Remote Sensing'; 1983

Reference Books:-

1. Remote Sensing & Image Interpretation Thomas M. Lillesand, Ralph W.Kiefer,
2. Image Interpretation in Geology Drury S.A.
3. Robert A Schowengergt, „Remote Sensing – Models and Methods for Image Processing Academic Press 1997 Hord R M, Academic Press, 1982

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**GPS & Electronic Surveying**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 00**	**Practical = 00**

Brief Syllabus:

In this course, the students will know the importance of GPS, Factor affecting GPS & Applications of GPS.

7. Learning objectives:

1. To study the different types of GPS and its technical description.
2. To Analyse the data collected and use the application

8. Subject Outcomes:

1. Students will learn how to take observation and collect data from GPS.
2. Students will be able to understand the application of GPS

9. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction**

Maps & their numbering, Map projection and co-ordinate system, Geo referencing and data, Basic concepts of GPS: History and timeline, overview. pseudo range and carrier phase measurements; Signal structure; GPS coordinate systems: WGS-84, GPS time; GPS Errors and biases; GPS orbital Geometry and Navigational solution.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Technical Description and GPS Observables**

System Segmentation – Space segment; control segment, user segment- types of receivers ; GPS satellite signals, GPS data, position and time from GPS, code phase tracking, pseudo range navigation, receiver position, time and velocity, carrier phase tracking, GPS positioning types – absolute positioning, differential positioning; Navigation signals -GPS frequencies; Calculating positions using C/A code using P(Y) code, code phase v/s carrier phase, augmented GPS, local augmentation; Accuracy and error sources – atmospheric effects, multipath effects, ephemeris and clock errors; selective availability, relativity, sagnac distortion

Unit - 3	**Number of lectures = 10**	**Title of the unit: Factor affecting GPS**

Factors that affect GPS - number of satellites, multipath, ionosphere, troposphere, satellite geometry, satellite health, signal strength, distance from the reference receiver, RF interference, loss of radio

transmission; Other satellite based navigational systems: GLONASS, GALILEO. GPS interference and jamming – natural sources, artificial sources; Techniques to improve accuracy- augmentation, precise monitoring, GPS time and data, GPS modernization.

Unit - 4	**Number of lectures = 12**	**Title of the unit: Applications of GPS**

Military – airborne, marine and land based navigation, and civilian –surveying and mapping, control surveys, cadastral surveying, navigation, RS, GIS and Photogrammetry, geodesy, location, navigation, tracking, mapping and timing, Engineering and Monitoring; Special applications of GPS, etc.,

10. Brief Description of self learning / E-learning component

The students will be encouraged to learn using the SGT e-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

Journal papers; Patents in the respective field.

11. Books Recommended

Text Books

1 Understanding GPS: Principles and Applications Elliott Kaplan, Christopher Hearty

2. Introduction to GPS: The Global Positioning System Ahmed El-Rabbany

Reference books

1. Tomlinson, “Foundation Design and Construction”, ELBS, Longman Group Ltd.

2. Integrating GIS and the Global Positioning System Karen Steede-Terry

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Pattern Recognition and Machine Learning**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			

7. Learning objectives:

1.To analyse Kernel methods and space clustering

2. To analyse basic concept of machine learning and artificial neural network

Subject Outcomes: On completion of this course, the students will be able to

1. Kernel methods for SVM classification and apace clustering & model based clustering

2. Apply & use basic concept of machine learning and neural network

8. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Kernel Methods**

Introduction to metric space, vector space, normed space, inner product space; RKHS; Learning theory; SVM for classification & regression; implementation techniques of SVM; kernel ridge regression; kernel density estimation; kernel PCA; kernel online learning. Random forest, Genetic algorithms, ant colony optimization

Unit – 2	**Number of lectures = 10**	**Title of the unit: Spectral Clustering**

Spectral Clustering; model based clustering, Expectation Maximization; Independent Component Analysis; Hidden Markhov models; Factor Analysis; introduction to Graphical models & Sampling Methods.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Basic concepts of machine learning**

Basic concepts of machine learning, inductive learning, decision tree learning, semi-supervised learning, ensemble learning, clustering

Unit – 4	**Number of lectures = 12**	**Title of the unit: Artificial neural networks**

Artificial neural networks, support vector machines, Bayesian learning, deep learning, Convolution

neural network, accuracy assessment

9. Brief Description of self learning / E-learning component

The students will be encouraged to learn using the SGT e-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

Journal papers; Patents in the respective field.

10. Books Recommended (3 Text Books + 2-3 Reference Books)

Text Books

1. Neural Networks and Learning Machines (3rd Ed) by Simon Haykin, McMaster University, Canada,2008
2. Deep learning by Ian Goodfellow, Yoshua Bengio,Aaron Courville, MIT Press, 2016.

Reference Books

1. Pattern Recogonition and Machine learning Christopher M Bishop 2006
2. Machine Learning, Tom Mitchell, McGraw Hill, 1997

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	**Digital Image Processing Lab**	**L**	**T**		**P**	
3. Course Code		0	0		2	
4. Type of Course		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials = 00**	**Practical = 28**			

Brief Syllabus: Digital image processing includes Introduction Image processing system, Image Analysis and Understanding and Multi temporal Data merging – Change detection procedures & Hyper-spectral Image Analysis and Radar image analysis.

8. Learning objectives:

1 To study and analyze the image processing.

2 To analyze the appropriate methods to improve data merging and image analysis.

9. Course Outcomes:

On completion of this course, the students will be able to

1. Students will be able to understand use of image processing in Civil Engineering.
2. Students will understand about GIS and image processing techniques.

10. Unit wise detailed content

1. Familiarization with digital image processing & image processing software
2. Importing raw data
3. Displaying image data
4. Image Rectification & Registration
5. Image Enhancement & Transformation
6. Unsupervised Classification
7. Training site marking & Supervised Classification
8. Accuracy Assessment
9. Map Composition, Image Data Fusion
10. Calculation of area and Accuracy Assessment

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	**GPS Lab**	**L**	**T**		**P**	
3. Course Code		0	0		2	
4. Type of Course		**Core(✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials = 00**	**Practical = 28**			

Brief Syllabus: In this course, the students will know the importance of GPS, Factor affecting GPS & Applications of GPS.

8. Learning objectives:

1. To study the different types of GPS and its technical description.
2. To Analyse the data collected and use the application

9. Course Outcomes:

On completion of this course, the students will be able to

1. Students will learn how to take observation and collect data from GPS
2. Students will be able to understand the application of GPS

10. Unit wise detailed content

1. Familiarization with different types of GPS and software
2. Measurement of location with the help of GPS
3. GPS Survey of Natural and Man-made features
4. Field exercise on GPS data collection in standalone mode
5. GPS & GIS data integration and output preparation
6. DGPS setting up for observation
7. Data collection in differential mode
8. Ground control points, Criteria for Selecting reference station
9. Reference station equipment's, operational procedures, post processing of data
10. Ground control for geometric correction of satellite imagery using DGPS

Third Semester

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	Basics and Digital Cartography	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			
Brief Syllabus: Basic Introduction to Cartography, practical applications in GIS in terms of labeling techniques, colour choice and symbolization. Theoretical and critical views of GIS as a tool, as well as maps as conveyors of information						
8. Learning objectives: 1. To give the students' knowledge about Cartography. 2. To study different concepts of Basic and Digital Cartography.						
9. Course Outcomes: Knowledge and understanding (1) Explain how fonts, coolers and symbols are used in maps to convey information, Competence and skills (2) select and customize labels, colors and symbols based on the purpose and target audience of the map, (3) utilize graphics software for post-processing of map content and design, (4) design map layouts whose appearance and content are well suited to their purpose, and Judgment and approach (5) Assess and relate to maps in terms of their function as conveyors of information.						
10. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Basic Introduction and Understanding**				
Introduction to the basic concepts and techniques for Cartography, the manipulation, analysis, and the graphic representation of spatial information.						
Unit - 2	**Number of lectures = 10**	**Title of the unit: Processing**				
Concept of Processing, compilation and symbolization of spatial data and the application of related statistical techniques.						
Unit - 3	**Number of lectures =10**	**Title of the unit: Mapping**				

Technology of mapping, particularly the Internet, computer mapping, geographic information systems, and remote sensing.

Unit - 4	Number of lectures = 12	Title of the unit: Basics of Computer Cartography

Introduction to image processing: Acquisition of digital images and image formats; Digital image processing operations: Image rectification and restoration, image enhancement, spatial feature manipulation, spectral ratioing, image data fusion, image classification; Image interpretation: elements and techniques; Air- photo interpretation, Satellite imagery interpretation.

11. Brief Description of self-learning / E-learning component

1. https://www.edx.org/learn/cartography
2. https://www.coursera.org/courses?query=cartography
3. https://www.esri.com/training/catalog/596e584bb826875993ba4ebf/cartography./

12. Books Recommended

TEXT BOOKS

1. Monmonier, M.S. (1982): Computer Assisted Cartography: Principles and Prospects, Prentice Hall.
2. Robinson, H. et al (1995): Elements of Cartography, 6th Edition, John Wiley & Sons, New York.
3. Monkhouse, F.J.R. & Wilkinson H.R.(2000):Maps and Diagrams, Methuen &Co. London.
4. Raise, Erwin (1962): Principles of Cartography, McGraw-Hill, New York.

REFERENCE BOOKS

1. Rampal, K.K.(1993): Mapping and Compilation, Concept Publishing Co. New Delhi.
2. Slocum, T.A.et al.(2008): Thematic Cartography and Revisualization, 3rd Edition, Prentice Hall.
3. Mishra, R.P. (1973): Fundamentals of Cartography, Prasaranga, University of Mysore..

1. Name of the Department	CIVIL ENGINEERING					
2. Course Name	Research Methodology and IPR	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core (✓)	PE-()		OE()	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials = 00	Practical = 0			

8.Brief Syllabus:

The aim of the course is to make students understand the importance of Research Paper Writing. Also, it covers all the concepts which involved in writing the Research Paper.

9 Learning objectives:

The objectives of the course are:

1. The students are able to recognize the steps involved in doing research work.
2. The students will be able to collect data using various media and using the best possible sample available.
3. The students would learn to propose their Hypothesis and build models for the problem.
4. The students would be able to correctly document their findings in the form of a report.

10.Course Outcomes:

After completion of this course, the student will be able to:

1. Recognize the various steps involved in research.
2. Collect data from samples, Examine and analyze the data.
3. Develop models for problems.
4. Explain the entire process in the form of a report.

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction**

Research - Types, Research process and steps, Hypothesis, Research Proposal and aspects. Research Design- Need, Problem Definition, Variables, Research Design concepts, Literature survey and review, Research design process, Errors in research. Research Modeling- Types of models, model building and stages, Data consideration.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Sampling**

Sampling and data collection- Techniques of sampling, Random, Stratified, Systematic, Multistage-sampling, Primary and secondary sources of data. Design of questionnaire.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Data Collection and Experiments**
Design of Experiments- Objectives, strategies, Factorial experimental design, designing engineering experiments, basic principles-replication, randomization, blocking, guidelines for design of experiments.		
Unit - 4	**Number of lectures = 12**	**Title of the unit: Models and Hypothesis & Report writing**
Single factor experiment- Hypothesis testing, analysis of Variance component (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effect model, estimation of variance components, Model adequacy checking. Structure and components of Scientific Reports, Types of Report, Technical Reports and Thesis; Different steps in the preparation – Layout, structure and Language of typical reports; Illustrations and tables, Bibliography, Referencing and foot notes.		

12.Brief Description of self learning / E-learning component

https://research-methodology.net/research-methodology/

https://gradcoach.com/what-is-research-methodology/

13.Books Recommended

Text Book:

1. Research Methodology – Methods and Techniques – C.R. Kothari, New Age International, New Delhi, 2004.

Reference Book:

1. Design and Analysis of Experiments – Douglas C. Montgomery, Wiley India, 8th Edition, 2012.

2. Practical Research: Planning Design – Paul D. Leddy, London, 1980.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Research Methodology and IPR Lab**	**L**	**T**		**P**	
3. Subject Code		0	0		2	
4. Type of Subject		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	**Research Methodology and IPR**	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

1. Learning objectives:

The objectives of the course are:

2. The students are able to recognize the steps involved in Identifying research problem.
3. The students will be able to collect data using various media and using the best possible sample available.
4. The students would learn to propose their Hypothesis and build models for the problem.
5. The students would be able to correctly document their findings in the form of a report.

Outcomes:

On completion of this course, the students will be able to

1. Choose the topic for writing research paper.
2. Develop models for problems.
3. The students would learn to write the research paper.

7. Lab Content

Sr. No.	Title	CO covered
1	How to choose topic for research	1,2
2	How to collect data for the particular research problem	1,2
3	Writing Abstract	1,2
4	Writing Literature review	1,2
5	Explaining and writing methodology	1,2
6	How to analyze the data collected	1,2
7	Presentation of analysis and findings	1,2
8	How to write result and conclusion	2,3
9	References in research article	2,3

Departmental Electives

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Advanced Surveying and Cartography**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core ()**	**PE (√)**		**OE()**	
5. Pre-requisite (if any)	nil	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical =00**			

Brief Syllabus:

Students will learn the concept of advanced Surveying

7. Learning objectives:

1. To teach the students about the Triangulation and Trilateration
2. To enable the students to understand the Photogrammetry and Remote Sensing

8. Subject Outcomes:

On completion of this course, the students will be able to

1. Understand the concept of advanced surveying
2. Understanding the concept of field survey and field astronomy.

9. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Triangulation, Trilateration and Adjustment Computations**

Triangulation and Trilateration : Necessity of Control Surveying, Principle of Triangulation and Trilateration classification of Triangulation Systems Station Marks, Towers and Signals, Satellite station, Intersected and Resected points, Reconnaissance, Indivisibility of stations, Angular Measurement, Base line measurement and its extension

Adjustment Computations: Treatment of random errors, Normal law of errors, Most Probable Value, Weight of observations, Propagation of errors and variances, Principle of Least Squares, Observations and correlative Normal Equations, Adjustment of triangulation figures and level nets.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Curves and project survey**

Curves: Classification of curves, Elements of Simple Circular, Transition and Vertical curves, Theory and methods of setting out circular, transition and vertical curves, special field problems.

Project Surveys: General requirements and specifications for Engineering project surveys, Reconnaissance, Preliminary and Location surveys for highways, railways and canals, Correlation of surface and underground surveys in case of culverts, Bridges and Tunnels; Principles and practice of hydrographic surveys, Layout of culverts, canals, bridges and buildings.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Field Astronomy:**

Field Astronomy: Astronomical terms, co-ordinate systems, Spherical trigonometry, Astronomical triangle, Relationship between coordinates.

Unit – 4	**Number of lectures = 12**	**Title of the unit: Photogrammetry ,Remote Sensing, GPS and GIS**

Photogrammetry and Remote Sensing: Photogrammetry-Introduction, Scale of photograph, Tilt and height displacement, Stereoscopic vision and stereoscopes, Techniques of photo-interpretation, Principles of remote sensing, Electro Magnetic Radiation (EMR), energy interaction with atmosphere and earth features, spectral signatures, Remote sensing satellites and their data products, methods of interpretation of remotely sensed data.

GPS and GIS: Global Positioning System (GPS)-Introduction, principle, and applications of GPS in different fields of Surveying, Geographic Information System (GIS) – Introduction, Geographical concepts and terminology, Applications of GIS

10. Brief Description of self learning / E-learning component

The students will be encouraged to learn using the SGT e-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

Journal papers; Patents in the respective field.

11. Books Recommended

Text Books

1 Agor, R., “Surveying”, Vol. II & III, Khanna Publications, Delhi, 1995.
2. Arora, K.R., “Surveying”, Vol. II & III, Standard Book House, Delhi. Bannister, A. And Baker, R., “Solving Problems in 3 Surveying, “Longman Scintific Technical, U.K., 1994.
5. Punmia, B.C., “Surveying”, Vol.II & III Laxmi Publications, New Delhi.

Reference books

1. Duggal S.K., Surveying Vol. I & II TMH Basak, Surveying TMH. Kanetkar, Surveying Chandra, A.M. “Plane Surveying”, New Age International Publisher,

2. Cromley .R. G, “Digital Cartography”. Prentice-Hall of India, New Delhi, 1992.
3. Dent, B. D., “Cartography – Thematic Map Design”,. 5th” Edition, W C B McGraw-Hill, Boston, 1999.
4. Rampal .K.K, “Mapping and Compilation”. Concept Publishing Co., New Delhi, 1993.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Advanced Surveying and Cartography Lab**	**L**	**T**		**P**	
3. Subject Code		0	0		2	
4. Type of Subject (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)	Nil	**5. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials = 00**	**Practical = 28**			

8. Brief Syllabus: This course explores how geographic information systems and related technologies (global positioning systems, remote sensing, etc.) can be used to promote and support the construction and simulation of dynamic models of human and environmental systems.

9. Learning objectives:

1. To teach the students about the Triangulation and Trilateration
2. To enable the students to understand the Photogrammetry and Remote Sensing

10. Subject Outcomes:

On completion of this course, the students will be able to perform/Understand:-

1. Understand the concept of advanced surveying
2. Understanding the concept of field survey and field astronomy.
3. Understanding the concept of Photogrammetry
4. Understanding the concept of Remote Sensing,
5. Understanding the concept of GPS and GIS

11. Unit wise detailed content

Sr. No.	**Title**
1.	Study of Principle of Triangulation and Trilateration
2	Study of Satellite station, Intersected and Resected points, Reconnaissance, Indivisibility of stations
3	Study of Propagation of errors and variances
4	Study of Adjustment of triangulation figures and level nets.
5	Theory and methods of setting out circular, transition and vertical curves,
6	General requirements and specifications for Engineering project surveys
7.	Study of Applications of GIS

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	Application of Remote Sensing in Geosciences	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			

Brief Syllabus: Basic Introduction to Remote Sensing, Basic Spatial Analysis and Urban Mapping, Concept of Urban Planning, Urban Disaster Management.

8. Learning objectives:

1. To give the students an insight about Remote Sensing.
2. To study different concepts of Urban Planning and Urban Mapping.

9. Course Outcomes:

At the end of the syllabus, students will be able to understand the

1. Knowledge about Remote Sensing.
2. Understanding concepts of Urban Planning and Urban Mapping.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Basic Introduction and Understanding**

An overview of - origin of earth, structure of earth, geological time scale, plate tectonics and continental drift, rocks and minerals, different geomorphic processes. Applications of remote sensing and GIS in mineral targeting, geomorphologic studies, engineering geological studies, litho logical and structural mapping. Hydrological cycle, river systems and river dynamics, river morph metric analysis, wetlands mapping and monitoring, watershed concept and its management, behavior of different Remote Sensing sensors in surface water studies.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Urban Mapping and Spatial Analysis**

Urban process, the physical structure and composition of urban areas, Urbanization process, growth trend, problems of urbanization, information requirements for perspective planning, Scale and resolution concepts and interpretation techniques for urban and regional analysis, urban GIS, spatial analytical techniques, statistics and visualization, conceptual modeling of urban processes; Urban Sprawl: Change detection in Land Use Land Cover monitoring physical growth of urban area, trends in urban sprawl and associated problems.

Unit - 3	**Number of lectures =10**	**Title of the unit: Urban Planning**
Plans – planning needs, types of plans, urban and regional planning; LU/LC mapping Urban Planning: Zoning of Land Use, Zonal Land Use Plan, Object oriented GIS data modeling for urban design, landscape architecture, urban infrastructure, Site selection for urban development, site suitability analysis for utilities and civic amenities, interim master plan, Master Plan.		
Unit - 4	**Number of lectures =12**	**Title of the unit: Urban Disaster and Emergencies Management**
Mapping vulnerable zones with respect to earth quake, flood, fire, terrorist attacks, and finding optimum routes for ambulances, and emergency services, GIS modeling for Hazard risk and emergencies management		

11. Brief Description of self-learning / E-learning component

1. https://elearning.iirs.gov.in/
2. https://elearning.iirs.gov.in/e-Learning.html
3. https://gis.e-education.psu.edu/remote_sensing

12. Books Recommended

TEXT BOOKS

1. Remote Sensing of Geology Prof. R.P.Gupta
2. Geomorphological process Savindra Singh
3. Remote Sensing in Geosciences Nitin K. Tripathi & Vishwanath Bajpai
4. Earth Surface System Richard J. Huggett

1. Name of the Department		**CIVIL ENGINEERING**					
2. Subject Name	Application of Remote Sensing in Geosciences Lab	**L**	**T**		**P**		
3. Subject Code		0	0		2		
4. Type of Subject (use tick mark)		**Core ()**	**PE(✓)**		**OE()**		
5. Pre-requisite (if any)	Nil	**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 00		**Tutorials = 00**	**Practical = 28**				

7. Brief Syllabus: Basic Introduction to Remote Sensing, Basic Spatial Analysis and Urban Mapping, Concept of Urban Planning, Urban Disaster Management

8. Learning objectives:

1. To give the students an insight about Remote Sensing.
2. To study different concepts of Urban Planning and Urban Mapping.

9. Subject Outcomes:

At the end of the syllabus, students will be able to understand the

1. Knowledge about Remote Sensing.
2. Understanding concepts of Urban Planning and Urban Mapping.

10. Unit wise detailed content

Sr. No.	**Title**
1.	Study of Applications of remote sensing and GIS in mineral targeting
2	Study of wetlands mapping and monitoring, watershed concept and its management
3	Study of Scale and resolution concepts and interpretation techniques for urban and regional analysis
4	Study of Change detection in Land Use Land Cover monitoring physical growth of urban area
5	LU/LC mapping Urban Planning
6	Mapping vulnerable zones with respect to earth quake
7.	GIS modeling for Hazard risk and emergencies management

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	Non – Topographic Photogrammetry	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			
Brief Syllabus: Basic Introduction to Non – Topographic Photogrammetry						

8. Course Outcomes:

The student will be able to:

1. Understand basic photogrammetric & remote sensing techniques
2. Perform basic photogrammetric office computations
3. Apply Photogrammetry information to professional surveying services
4. Demonstrate an appropriate mastery of the knowledge, techniques, skills and modern tools of Photogrammetry
5. Apply current knowledge and adapt to emerging applications of Photogrammetry and technology
6. Identify, analyze, and solve technical photogrammetric problems
7. Communicate photogrammetric analysis and results effectively

9. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: INTRODUCTION**

Basic Introduction, Potential of Close Range Photogrammetry, Instrumentation of Data Acquisition, Phototheodolite, Analytical Stereo plotters.

Unit - 2	**Number of lectures =10**	**Title of the unit: Architecture**

Applications in Architecture and Archaeology, Photomontage by Inverse Photogrammetry.

Unit - 3	**Number of lectures =12**	**Title of the unit: Industry and Engineering Applications**

Aerospace Industry, Automobile Industry, Measurement of Storage Tanks and Cooling Towers, Model Studies.

Unit - 4	**Number of lectures = 10**	**Title of the unit: Applications Areas**

X – Ray Photogrammetry Systems, Reverse Projection Techniques, Under water Photogrammetry and Case Studies.

10. Brief Description of self-learning / E-learning component

1. https://elearning.iirs.gov.in/e-Learning.html
2. https://gis.e-education.psu.edu/remote_sensing

11. Books Recommended

TEXT BOOKS

1. Juliana Maantay, John Ziegler, John Pickles, GIS for the Urban Environment, Esri Press 2006.
2. Allan Brimicombe, GIS Environmental Modeling and Engineering, CRC; 1 edition 2003.

1. Name of the Department		**CIVIL ENGINEERING**					
2. Subject Name	Non – Topographic Photogrammetry Lab	**L**	**T**	**P**			
3. Subject Code		0	0	2			
4. Type of Subject (use tick mark)		**Core (√)**	**PE(✓)**		**OE()**		
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 00		**Tutorials = 00**	**Practical = 28**				

7. Brief Syllabus: Basic Introduction to Non – Topographic Photogrammetry.

8. Learning objectives:

1. To teach the students about the Triangulation and Trilateration
2. To enable the students to understand the Photogrammetry and Remote Sensing

9. Subject Outcomes:

The student will be able to:

1. Understand basic photogrammetric & remote sensing techniques
2. Perform basic photogrammetric office computations
3. Apply Photogrammetry information to professional surveying services
4. Demonstrate an appropriate mastery of the knowledge, techniques, skills and modern tools of Photogrammetry
5. Apply current knowledge and adapt to emerging applications of Photogrammetry and technology
6. Identify, analyze, and solve technical photogrammetric problems
7. Communicate photogrammetric analysis and results effectively

10. Unit wise detailed content

Sr. No.	**Title**
1.	Study of Potential of Close Range Photogrammetry
2	Study of Analytical Stereo plotters.
3	Study of Photomontage by Inverse Photogrammetry
4	Measurement of Storage Tanks and Cooling Towers
5	Study of Underwater Photogrammetry
6	Study of Analytical Stereo plotters
7.	Study of X – Ray Photogrammetry Systems

SGT University, Chandu-Budhera, Gurugram
Faculty of Engineering & Technology
Department of Civil Engineering

M. Tech. **Water Resource Engineering**

Scheme & Syllabus (2021-22)

Vision of SGT University

"Driven by Research & Innovation, we aspire to be amongst the top ten Universities in the Country by 2022"

Water Resource Engineering
First Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Advanced Fluid Mechanics	3	0	0	3	60	40	100
2		Surface Water Hydrology and Hydrologic Systems	3	0	0	3	60	40	100
3		Flow and Transport in Porous Media	3	0	0	3	60	40	100
4		Water Quality Modeling and Management	3	0	0	3	60	40	100
5		Flow and Transport in Porous Media Laboratory	0	0	2	1	40	60	100
6		QGIS and SAGA GIS Laboratory	0	0	2	1	40	60	100
7		Value Added Courses-I	2	0	0	2	60	40	100
8		Seminar	0	0	2	1	00	100	100
		Total	**14**	**0**	**6**	**17**	**380**	**420**	**800**

Second Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Water Resources systems analysis and design	3	0	0	3	60	40	100
2		Remote sensing applications in water resources engineering	3	0	0	3	60	40	100
3		Computational Hydraulics and Hydrology	3	0	0	3	60	40	100
4		Statistical Methods in Hydrology	3	0	0	3	60	40	100
5		Computational Hydraulics and Hydrology Laboratory	0	0	2	1	40	60	100
6		Water Resources Systems Design Lab	0	0	2	1	40	60	100
7		Seminar	0	0	2	1	00	100	100
		Total	**12**	**0**	**6**	**15**	**320**	**380**	**700**

Third Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Geographical Information Systems and its Applications in Hydrology	3	0	0	3	60	40	100
2		Research Methodology & IPR	3	0	0	3	60	40	100
3		Department Electives-XIII	3	0	0	3	60	40	100
4		Department Electives-XIV	3	0	0	3	60	40	100
5		Department Electives-XV	3	0	0	3	60	40	100
6		Research Methodology & IPR Lab	0	0	2	1	40	60	100
7		Department Electives Lab-XIII	0	0	2	1	40	60	100
8		Department Electives Lab-XIV	0	0	2	1	40	60	100
9		Department Electives Lab-XV	0	0	2	1	40	60	100
10		Value Added Courses-II	2	0	0	2	60	40	100
		Total	**17**	0	**8**	**21**	520	480	1000

Fourth Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Dissertation	-	-	**20 W**	**20**	100	-	100
		Total	-	-	**20 W**	**20**	**100**	-	**100**

Departmental Electives

S. No.	Specialization	Departmental Elective XIII	Departmental Elective XIV	Departmental Elective XV
1	Water Resource Engineering	Hydraulic Modeling 3-0-2 (4)	Hydrogeology and Groundwater Development 3-0-2 (4)	Environmental Impact Assessment of Water 3-0-2 (4)
2		Hydropower 3-0-2 (4)	Watershed Management 3-0-2 (4)	Urban Hydrology and Drainage 3-0-2 (4)

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Advanced Fluid Mechanics**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Fluid Mechanics	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

The course provides the elements to understand the basic tools for the analysis and solution of different types of flows, from the ideal to the viscous flow, contrasting the numerical results with the experiments. The students will be able to understand and assimilate the foundations of fluid mechanics.

9. Course Outcomes (COs):

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

1. Formulate momentum, energy and mass transport models, Analyze Potential Flows, Develop approximate solutions for small and large Reynolds number flows, Apply turbulent flow models, Boundary layer formation and stress acts at the boundary.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**KINEMATICS OF FLUIDS**

Methods of describing fluid motion-Lagrangian and Eulerian methods, Translation, Rotation and rate of deformation. Streamline, Path lines and streak lines, Material Derivative-local and Convective Acceleration, Fluid rotation-Vorticity Vector.

Unit - 2	**Number of lectures = 10**	**STRESSES IN FLUIDS AND RATE OF STRAIN**

Stresses at a point fluids. Stress Tensior-Normal and shear stresses, Nature of strains. Relations between stresses and rates of strains-Stokes law of viscosity. Viscous Contribution to normal stresses.

Unit - 3	**Number of lectures = 10**	**FUNDAMENTAL EQUATIONS OF FLOW OF VISCOUS COMPRESSIBLE FLUIDS:**

Reynold's transport theorem, Equations of Continuity and Momentum in integral form and applications, Differential form of continuity equation and Euler's equation of motion, Navier-Stoke's equations of viscous compressible fluids.

Unit - 4	**Number of lectures = 12**	**TWO AND THREE DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW OF FLUIDS:**

Circulation concept-Stoke's theorem, Kelvin's theorem, Stream function, Irrotational flow and velocity potential function, Integration of Euler's equation-along a stream line for irrotational flows, Momentum theorem and moment of momentum theorem. Laplace equation and Flow nets.

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

1. Fox, R.W., Pitchard, P.J., and Mcdonald, A.T., Fluid Mechanics, Wiley India Pvt. Ltd., 2009
2. Schlichting, H., and Gresten, K., Boundary Layer Theory, Springer Publications, 2004
3. White, F.M., Viscous Fluid Flow, McGraw Hill Pub. Co, New York, 2011
4. Yalin, M.S., Theory of Hydraulic Models, McMillan Co., 1971

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Surface Water hydrology and hydrologic systems**	**L**	**T**	**P**		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**	**OE()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

To address the computational emphasis of advanced hydrology at a post-graduate level, and to provide a balanced approach to important applications in hydrologic engineering and science.

9. Course Outcomes (COs):

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

1) To address the computational emphasis of advanced hydrology at a post-graduate level, and to provide a balanced approach to important applications in hydrologic engineering and science.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: HYDROLOGIC PRINCIPALS**

Hydrologic cycles and weather, weather, hydrologic losses. Philosophy of mathematical models of watershed hydrology.

Unit - 2	**Number of lectures = 10**	**Title of the unit: HYDROLOGIC ANALYSIS**

Watershed concepts, rainfall-runoff, hydrograph analysis, unit hydrograph theory, linear and kinematic wave model, overland flow models

Unit - 3	**Number of lectures = 10**	**Title of the unit: ROUTING**

Lumped flow, distributed flow, dynamic wave routing, Muskingum method, Saint-Venant Equation-Reynolds transport theorem, continuity equation, momentum equation, energy equation.

Unit - 4	Number of lectures = 12	Title of the unit: HYDROLOGIC STATISTICS

Statistical parameter estimation, probability distribution, goodness of fit, concepts of probability weighted moments and L-moments, frequency analysis, Markov chain, reliability analysis.

11. Brief Description of self learning / E-learning component

Quiz/Assignment/ Seminar/Written Examination. The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

1. Bras, R. L., and Rodriguez-Iturbe, 1994, "Random Functions and Hydrology", Dover Publications, New York.
2. Chow, V. T., D. R. Maidment, and L. W. Mays; "Applied Hydrology", McGraw Hill International Editions.
3. Haan, C. T., 2002, "Statistical Methods in Hydrology", 2nd ed., Blackwell Publishing, Ames, IA.
4. Hoskings, J. R. M. and J. R. Wallis, 1997, "Regional Frequency Analysis, An Approach Based on L-Moments", Cambridge University Press, New York.
5. Viessman Jr., W., and G. L. Lewis, "Introduction to Hydrology", 4th ed., Harper-Collins, New York, 1996

1. Name of the Department: Civil Engineering Department						
2. Course Name	**FLOW AND TRANSPORT IN POROUS MEDIA**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. To study the basic principles of flow.
2. To study the different mapping techniques.
3. To control the seepage and to analyze the seepage with various theories and techniques.
4. To impart the knowledge of various de-watering methods and drainage methods for stability of slope.

9. Course Outcomes (COs):

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

1. Students should be able to analyze the seepage with various theories and techniques.
2. Students should be able to utilize basic principles of flow.
3. Students should be able to use different mapping techniques.
4. Students should be able to perform analysis of the seepage by application of seepage theories.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Basic Principles:**

Darcy's Law, Permeability and its field determination, equation of continuity, velocity potential, and stream function Laplace's equation. Solution of Laplace's Equation: Solution by graphical method, flow nets in homogeneous soils, anisotropic soils and layered soils, computation of seepage quantity, seepage pressure, uplift pressure on structures, exit gradient, piping due to subsurface erosion and heave. Two and three dimensioned electrical analogy method, relaxation method.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Seepage through Earth Dams**

Determination of phreatic line, Dupuit's solution, Casagrande's solution, Kozeney parabola, entrance and exit corrections, flow nets for zoned earth dams and earth dams on pervious foundations under steady seepage conditions, flow nets for homogeneous sections under sudden drawn down, introduction to control of seepage, filters -type, selection and design.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Solution by Mapping Techniques:**

Conformal mapping of elementary function, Kozeney's basic parabola, Schwarez-Christoffel transformation, Khosla's solution, Velocity hydrograph, flow characteristics at singular points, examples of velocity hydrograph, solution by complex velocity, solution of triangular dam.

Unit - 4	**Number of lectures = 12**	**Title of the unit: Seepage in Foundations:**

Construction dewatering-Methods of dewatering, Design of dewatering for foundation excavations, foundation improvement by drainage, drainage in retaining structures, influence of seepage on stability of slopes, drainage methods for stability of slopes.

11. Brief Description of self learning / E-learning component

Quiz/Assignment/ Seminar/Written Examination. The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended

1. Harr, M.E. " Ground Water & Seepage"
2. Cedergren "Seepage, Drainage & Flow nets"

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Water Quality Modelling and Management**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. Meaning of important parameters for measuring water quality, water quality criteria and standards, and their relation to public health, environment and urban water cycle.

2. Water quality tests and to determine how the parameters relate to each other.

9. Course Outcomes (COs):

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

1. Principles and the practical approaches and techniques required to effectively monitor the chemical, hydrological, microbiological and aquatic elements of water quality.
2. Water quality tests and to determine how the parameters relate to each other.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title:- Introduction**

Introduction: Quality parameter and classification of natural water, Physico-Chemical and biological water quality classification of aquatic systems. Sources of pollution: characteristics of point and non-point sources of pollution.

Unit - 2	**Number of lectures = 10**	**Title:- Management strategies**

Eutrophication in natural water bodies: causes processes and control Toxic wastes: Sources, transportation and management strategies.

Unit - 3	**Number of lectures = 10**	**Title:- Thermal pollution**

Thermal pollution: causes model and control. Acid rains: Occurrences, impacts and strategies for control.

Unit - 4	Number of lectures = 12	Title:- Water quality monitoring
Water quality monitoring: Objectives, requirements, planning and various techniques. Case studies related to water quality monitoring under various river actions plans including Ganga and Yamuna Action plans.		

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

1. Reckhow and Chapra (1983) Engineering Approaches for Lake Management, Vol. 1, Butterworth, Boston.
2. Thomson and Mueller (1987) Principles of Surface Water Quality Modelling and Control, Harper and Row, NY.
3. Tchobanoglous and Schroeder (1987) Water Quality: characteristics, Modelling and modification, Addition – Wesley Pub. Co., US
4. APHA (1998) Standard Methods for Examination of Water and Wastewater, 20th Edition, Washington, D.C
5. Velz, C.J.(1970) Applied Stream Sanitation, Wiley Interscience, NY

1. Name of the Department: Civil Engineering Department							
2. Course Name	**Flow and Transport in Porous Media Laboratory**	**L**	**T**	**P**			
3. Course Code		0	0	2			
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**	**OE()**			
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 28**				
8. Experiments							
1. To study the basic principles of flow. 2. To study the different mapping techniques. 3. To control the seepage and to analyze the seepage with various theories and techniques. 4. To impart the knowledge of various de-watering methods and drainage methods for stability of slope							
9. Brief Description of self-learning / E-learning component The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.							

1. Name of the Department: Civil Engineering Department							
2. Course Name	QGIS and SAGA GIS Laboratory	**L**		**T**		**P**	
3. Course Code		0		0		2	
4. Type of Course (use tick mark)		**Core (✓)**		**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**		Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**		**Practical = 28**			
8. Content							
1. QGIS is the most popular GIS tool with an impressive trajectory and a vibrant community. It also even has a particular ecosystem of complements called “plugins”. 2. SAGA GIS is a GIS platform oriented to spatial analysis. SAGA GIS is a simple but powerful tool, with a big library focused on spatial analysis and characterization of basins. The interpolation options in SAGA GIS are better implemented than in other free and commercial software.							
9. Brief Description of self learning / E-learning component							
The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.							
10. Books/courses Recommended							
1. Manuals available at http://www.saga-gis.org/ and http://www.qgis.org/ 2. QGIS and SAGA GIS are completely open source alternative that reduces the cost barriers since it does not need a paid license and can be executed in any operative system.							

Second Semester

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Water resources system analysis and design**	**L**	**T**	**P**		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**	**OE()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. Students should be able to apply concepts of systems analysis for planning of water resources systems and minor levels
2. Students can perform basic economic analysis between alternate water resources projects and to evaluate the economic feasibility of water resources engineering projects

9. Course Outcomes (COs):

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

1. Students must in position to formulate and solve deterministic optimization models for design and operation of water resources systems.
2. To develop analytical skills to formulate and solve stochastic problems for decision making under uncertainty.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: INTRODUCTION**

Planning, Meaning and Significance. Need for water resources systems planning, Issues in planning. Planning process.

Unit - 2	**Number of lectures = 10**	**Title of the unit: PLANNING FOR WATER RESOUCES DEVELOPMENT:**

Statement of objectives. Data requirements. Project formulation. Environmental considerations in planning, Systems analysis. Pitfalls in project planning. Conservation and augmentation of water resources. Multipurpose projects. Functional requirements in multi-purpose project. Compatibility of multipurpose uses.

Unit - 3	**Number of lectures = 10**	**Title of the unit: ECONOMIC ANALYSIS:**

Equivalence of kind. Equivalence of time, Value. Cost. Benefit. Discounting factors, Discounting techniques. Measurement of cost and benefit. Benefit-cost analysis. Project evaluation, Benefit-cost variation. Limitations of benefit-cost analysis. Dynamic of project analysis.

Unit - 4	**Number of lectures = 12**	**Title of the unit: FINANACIAL ANALYSIS:**

Role of financial analysis. Distinctions from economic analysis. Financial feasibility, Separable and non-separable costs. Cost allocation, allocation consequences. Water resources pricing.

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended

1. Water Resources Engineering by R.K. Liniley and Franzini, McGraw-Hill Book Co.
2. Water Resources Systems Engineering by Hall and Dracup, McGraw Hill Book Co.
3. Economics of Water Resources Engineering by L. Douglas James. And Robert R. Lee McGraw Hill BookCo.
4. Design of Water Resources Systems by Arther Mass et. Al, Harward Univ. Press Cambridge. 1967
5. Optimization Theory and Applications by S.S.Rao, Willy East. Ltd.

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Remote sensing applications in water resources engineering**	**L**	**T**	**P**		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42	**Tutorials = 0**	**Practical = 0**				

8. Learning objectives:

1. The techniques of Remote Sensing and Geographic Information System (GIS)
2. Different types of remotely sensed images
3. Application of Remote Sensing in water resources engineering
4. Application of GIS in water resources engineering.

9. Course Outcomes (COs):

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

1. To understand the interaction of electromagnetic interaction with matter and working of aerial and satellite remote sensing and radar
2. To learn image interpretation and satellite image processing
3. To learn to make use of aerial and satellite data for applications in hydrology, water resources, agriculture, geology, environment and snow & glacier studies
4. To learn to integrate remote sensing and GIS analysis.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title:- Principles**

Principles of remote sensing, Remote sensing platforms and data acquisition systems, Wavebands, Radiometric quantities, Spectral reflectance and spectral signature. Interaction of electromagnetic radiation with land surface features, hydrosphere and atmosphere, Data capture for simulation of land surface processes.

Unit - 2	**Number of lectures = 10**	**Title:- Photographic and image interpretation**

Photographic and image interpretation, Satellite image processing, Earth surface features inventory, Geomorphology, Land use classification, Land use planning and land cover mapping, Flood plain mapping and flood plain zoning.

Unit - 3	**Number of lectures = 10**	**Title:- Remote sensing applications**

Remote sensing applications in water resources, agriculture, geology and environmental monitoring, Applications in snow and glacier studies, Snow line, Ice cover, Snow-pack properties, Integrated use of remote sensing and GIS, Database preparation and Decision support analysis.

Unit - 4	**Number of lectures = 12**	**Title:- Estimation of damages**

Estimation of damages due to hydrologic extremes and preparation of contingency plans, Case studies.

11. Brief Description of self-learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

(1) Lillesand, T., Kiefer, R. W., Chipman, J., Remote Sensing and Image Interpretation, 6th Ed., Wiley, 2007.
(2) Curran, P.J., Principles of Remote Sensing, ELBS, 1988
(3) Rees, W.G., Physical Principles of Remote Sensing, 2nd Edition, Cambridge University Press, 2001
(4) Keshari, A.K., Satellite Remote Sensing, Ane Books, 2015
(5) Keshari, A.K. and Singh, R.P., Use of microwave radiometry for monitoring the alpine environment. Snow, Hydrology and Forests in High Alpine Areas, IAHS Publ. No. 205, 81-89, International Association of Hydrological Sciences, 1991.
(6) Ambast, S.K., Keshari, A.K. and Gosain, A.K., An operational model for estimating regional evapotranspiration through surface energy partitioning (RESEP). International Journal of Remote Sensing, 23(22): 4917-4930, 2002

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Computational Hydraulics and Hydrology**	**L**	**T**	**P**		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**	**OE()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			
8. Learning objectives: The purpose of this course is to obtain knowledge on various soft computing techniques widely used in water resources engineering.						
9. Course Outcomes (COs):						
At the end of the course, the student will be able to						
1. To forecast the complex systems in water resources engineering using soft computing techniques.						
10. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title:- Introduction**				
Introduction, need for soft computing techniques, components of soft computing. Artificial Neural Networks (ANN), types of ANN and learning algorithms, tasks performed by ANN.						
Unit - 2	**Number of lectures = 10**	**Title:- Basic concepts**				
Basic concepts of feed forward neural networks, perception learning rule, back propagation learning algorithm, application of feed forward ANN for function approximation and prediction. Hebbian learning and hopified networks, pattern association, radial basis function networks, Kohonen networks and self-organization maps, applications of ANN in pattern classification.						
Unit - 3	**Number of lectures = 10**	**Title:- Information and uncertainty**				

Information and uncertainty, chance versus ambiguity, classical sets and fuzzy sets, logic and reasoning. Fuzzy set operations and fuzzy relations, Membership Functions, fuzzy numbers and fuzzy arithmetic. Fuzzy Systems, fuzzy relations, fuzzy interface systems, Decision making with fuzzy information, Fuzzy classification and pattern recognition, Neuro-Fuzzy Systems.

Unit - 4	**Number of lectures = 12**	**Title:- Evolutionary computing**

Evolutionary computing, concepts of genetic algorithm, components of genetic algorithm, Hybrid soft computing techniques, Applications in Hydrology and Water Resources Engineering.

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

1. Neural Networks, A Comprehensive Foundation- Haykin, Prentice Hall India.
2. Neuro-Fuzzy and Soft Computing, A Computational Approach to learning-Jang, J.R., Sun Chuen-tsaiandMizutaniEiji, Prentice Hall.

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Statistical Methods in Hydrology**	**L**	**T**	**P**		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**	**OE()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			
8. Learning objectives: To make the student investigating the causes, consequences and possible solutions to problems associated with degradation of environmental resources and analyses the potential non-sustainability of certain types of economic activities using economic analysis as a tool.						
9. Course Outcomes (COs):						
At the end of the course, the student will be able to						
• Students would be able to apply finite difference and finite element method for analyzing behavior of geotechnical structures. • Students would be able to solve linear and non-linear equations using numerical technique						
10. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title:- Numerical Solution**				
Numerical Solution of Ordinary Differential Equations: Solution by Taylor's Series- Euler's Method – Runge-Kutta Methods – Simultaneous and Higher Order Equations- Boundary Value Problems – Applications						
Unit - 2	**Number of lectures = 10**	**Title:- Economic significance**				
Economic significance and causes of environmental degradation - The concepts of policy failure, externality and market failure - Economic analysis of environmental degradation – Equi. Marginal principle.						

Unit - 3	Number of lectures = 10	Title:- Probability Distribution
Economics of Pollution - Economics of optimal pollution, regulation, monitoring and enforcement - Managing pollution using existing markets: Bargaining solutions - Managing pollution through market intervention: Taxes, subsidies and permits.		
Unit - 4	**Number of lectures = 12**	**Title:- Numerical Solution**
Probability Distribution: Discrete and Continuous probability Distribution Functions – Binomial, Poisson, Normal, Lognormal, Exponential, Gamma Distribution, Extreme Value Distribution - Transformations to Normal Distributions, Selecting a Probability Distribution, Parameter Estimation – Method of Moments, Method of Maximum Likelihood, Probability Weighted Moments and Least Square Method, Joint Probability Distributions. Regression Analysis: Simple Linear Regression, Evaluation of Regression – Confidence Intervals and Tests of Hypotheses – Multiple Linear Regressions – Correlation and Regression Analysis.		
11. Brief Description of self learning / E-learning component The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.		
12. Books Recommended		
1. Applied Numerical Methods for Engineers by Akai 2. Statistical Methods in Hydrology by Haan 3. Computational Methods in Subsurface Flow by Huyorkon, Pinder 4. Numerical Recipes – The Art of Scientific Computing by Press, Flannery, Tenklsky, Vetterling		

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Computational Hydraulics and Hydrology Laboratory**	**L**	**T**	**P**		
3. Course Code		0	0	2		
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**	**OE()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Content

1. Kohonen networks and self-organization maps, applications of ANN in pattern classification.
2. Fuzzy Systems, fuzzy relations, fuzzy interface systems, Decision making with fuzzy information, Fuzzy classification and pattern recognition, Neuro-Fuzzy Systems.
3. Applications in Hydrology and Water Resources Engineering.

9. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

10. Books Recommended

2. Neural Networks, A Comprehensive Foundation- Haykin, Prentice Hall India.
3. Neuro-Fuzzy and Soft Computing, A Computational Approach to learning-Jang, J.R., Sun Chuen-tsaiandMizutaniEiji, Prentice Hall.

1. Name of the Department: Civil Engineering Department						
2. Course Name	Water Resources Systems Design Lab	**L**	**T**	**P**		
3. Course Code		0	0	2		
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**	**OE()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			
8. Content						
1. Using software and analyzing open channel flow over different paths condition. **2.** Design of flow system by software like HEC-RAS Systems. **3.** Applications in Hydrology and Water Resources Engineering.						
9. Brief Description of self learning / E-learning component The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.						
10. Books Recommended						
1. HEC-RAS Manual. 2. E-Learning courses by different portal.						

Third Semester

1. Name of the Department: Civil Engineering Department							
2. Course Name	**Geographical Information Systems and its Applications in Hydrology**	**L**	**T**	**P**			
3. Course Code		3	0	0			
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**	**OE()**			
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 40		**Tutorials = 0**	**Practical = 0**				

8. Learning objectives:

1. Conduct hydrologically related calculations using map algebra on raster grids;
2. Build a geometric network for streams and rivers;
3. Analyze a digital elevation model of land surface terrain to derive watersheds and stream networks.

9. Course Outcomes (COs):

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

1. Principles of Satellite-based Remote Sensing
2. Derivation of surface reflectance, and biophysical variables including vegetation indices
3. Land use Maps, and surface temperature maps.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title :- Course Overview**

Course Overview. Introduction to GIS in Water Resources. Introduction to ArcGIS software, Geodesy, Map projections, Reprojection, and Coordinate systems.

Unit - 2	**Number of lectures = 10**	**Title :- Data source**

Data sources for GIS in water resources, Building a Base Map, Spatial analysis using grids Spatial analysis (Model Builder geo processing capability to program a sequence of ArcGIS functions/Raster Calculator to calculate watershed attributes/Spatial Interpolation).

Unit - 3	Number of lectures = 10	Title :- Concept of Reference
The Concept of Reference Evapotranspiration/ASCE-Standardized Reference Evapotranspiration Equation, Weather data and Quality Assessment and Control of Automated Weather Data.		
Unit - 4	**Number of lectures = 12**	**Title :- Watershed and Stream Net**
Watershed and Stream Network Delineation, Remote Sensing: Principles of Electromagnetic Radiation/ Spectral Characteristics of Vegetation & Water bodies/Creating Color Composites from individual bands Working with Landsat Imagery, NLCD, and DEM, Estimation of Evapotranspiration from Landsat NDVI. Evapotranspiration- Energy Balance Algorithms/EEFLUX (Earth Engine Flux)		
11. Brief Description of self learning / E-learning component The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.		
12. Books Recommended (2 Books+ 4 References)		
(1) Lillesand, T., Kiefer, R. W., Chipman, J., Remote Sensing and Image Interpretation, 6th Ed., Wiley, 2007. (2) Curran, P.J., Principles of Remote Sensing, ELBS, 1988 (3) Rees, W.G., Physical Principles of Remote Sensing, 2nd Edition, Cambridge University Press, 2001 (4) Keshari, A.K., Satellite Remote Sensing, Ane Books, 2015 (5) Keshari, A.K. and Singh, R.P., Use of microwave radiometry for monitoring the alpine environment. Snow, Hydrology and Forests in High Alpine Areas, IAHS Publ. No. 205, 81-89, International Association of Hydrological Sciences, 1991. (6) Ambast, S.K., Keshari, A.K. and Gosain, A.K., An operational model for estimating regional evapotranspiration through surface energy partitioning (RESEP). International Journal of Remote Sensing, 23(22): 4917-4930, 2002		

1. Name of the Department	**CIVIL ENGINEERING**					
2. Course Name	Research Methodology and IPR	L	T	P		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		Core (✓)	PE-()	OE()		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials = 00	Practical = 0			

8.Brief Syllabus:

The aim of the course is to make students understand the importance of Research Paper Writing. Also, it covers all the concepts which involved in writing the Research Paper.

9 Learning objectives:

The objectives of the course are:

1. The students are able to recognize the steps involved in doing research work.
2. The students will be able to collect data using various media and using the best possible sample available.
3. The students would learn to propose their Hypothesis and build models for the problem.
4. The students would be able to correctly document their findings in the form of a report.

10.Course Outcomes:

After completion of this course, the student will be able to:

1. Recognize the various steps involved in research.
2. Collect data from samples, Examine and analyze the data.
3. Develop models for problems.
4. Explain the entire process in the form of a report.

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction**

Research - Types, Research process and steps, Hypothesis, Research Proposal and aspects. Research Design- Need, Problem Definition, Variables, Research Design concepts, Literature survey and review, Research design process, Errors in research. Research Modeling- Types of models, model building and stages, Data consideration.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Sampling**

Sampling and data collection- Techniques of sampling, Random, Stratified, Systematic, Multistage-sampling, Primary and secondary sources of data. Design of questionnaire.

Unit - 3	Number of lectures = 10	Title of the unit: Data Collection and Experiments
Design of Experiments- Objectives, strategies, Factorial experimental design, designing engineering experiments, basic principles-replication, randomization, blocking, guidelines for design of experiments.		
Unit - 4	**Number of lectures = 12**	**Title of the unit: Models and Hypothesis & Report writing**
Single factor experiment- Hypothesis testing, analysis of Variance component (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effect model, estimation of variance components, Model adequacy checking. Structure and components of Scientific Reports, Types of Report, Technical Reports and Thesis; Different steps in the preparation – Layout, structure and Language of typical reports; Illustrations and tables, Bibliography, Referencing and foot notes.		
12.Brief Description of self learning / E-learning component https://research-methodology.net/research-methodology/ https://gradcoach.com/what-is-research-methodology/		
13.Books Recommended **Text Book:** 1. Research Methodology – Methods and Techniques – C.R. Kothari, New Age International, New Delhi, 2004. **Reference Book:** 1. Design and Analysis of Experiments – Douglas C. Montgomery, Wiley India, 8th Edition, 2012. 2. Practical Research: Planning Design – Paul D. Leddy, London, 1980.		

1. Name of the Department		**CIVIL ENGINEERING**				
1. Subject Name	**Research Methodology and IPR Lab**	**L**	**T**		**P**	
2. Subject Code		0	0		2	
3. Type of Subject		**Core (✓)**	**PE()**		**OE()**	
4. Pre-requisite (if any)	**Research Methodology and IPR**	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
5. Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

1. Learning objectives:

The objectives of the course are:

2. The students are able to recognize the steps involved in Identifying research problem.
3. The students will be able to collect data using various media and using the best possible sample available.
4. The students would learn to propose their Hypothesis and build models for the problem.
5. The students would be able to correctly document their findings in the form of a report.

Outcomes:

On completion of this course, the students will be able to

1. Choose the topic for writing research paper.
2. Develop models for problems.
3. The students would learn to write the research paper.

6. Lab Content

Sr. No.	Title	CO covered
1	How to choose topic for research	1,2
2	How to collect data for the particular research problem	1,2
3	Writing Abstract	1,2
4	Writing Literature review	1,2
5	Explaining and writing methodology	1,2
6	How to analyze the data collected	1,2
7	Presentation of analysis and findings	1,2
8	How to write result and conclusion	2,3
9	References in research article	2,3

Departmental Electives

1. Name of the Department: Civil Engineering Department						
2. Course Name	**HYDRAULIC MODELLING**	**L**	**T**	**P**		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**	**OE()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. To able the students to model the domain.
2. To impart the knowledge of establishing the relationship between the model and the constraints.
3. To impart the knowledge to model the dynamic structures.

9. Course Outcomes (COs):

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

1. Students are able to model the domain.
2. Students are able to establish the relationship between the model and the constraints.
3. Students are able to model the dynamic structures

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: MODELLING PROCESS AND PRIMITIVE MODELS**

Taxonomy of model types, Steps in model building; Simulation, Algorithms and Heuristics, Simulation languages. Establishing relationships via physical laws, Establishing relationships via curve fitting, Parameter estimation problems, Elementary state transition models.

Unit - 2	**Number of lectures = 10**	**Title of the unit: FORE CASTING AND PATTERN RECOGNITION**

Nature of data, Statistical attributes of data, Probability distributions and their mechanisms, Generation of random numbers, Time series. Neighborhood and distances, Cluster analysis, Individual and group preference patterns

Unit - 3	**Number of lectures = 10**	**Title of the unit: STATIC EQULLIBRIUM MODELS AND LINEAR DYNAMICAL STRUCTURE**

Graphical models and matrix models, Input-output type models, Decomposition of large systems, Routing problems.
Block diagram, Representation of model structure, Transfer function representation, State space models, Stability, System control.

Unit - 4	**Number of lectures = 12**	**Title of the unit: GROWTH AND DECAY PROCESSES**

Discrete and continuous growths, Limits to growth, Competition among species, Growth process and integral equations, Discrete event approach, Population planning.

11. Brief Description of self learning / E-learning component

Quiz/Assignment/ Seminar/Written Examination. The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended

1. I. R. Haberman, Mathematical Models. Prentice Hall.
2. D.P. Maki and M. Thompson, Mathematical Models and Applications. Prentice Hall.
3. R.E. Shannon, System Simulation: Art and Science Prentice Hall

1. Name of the Department		**CIVIL ENGINEERING**				
7. Subject Name	**Hydraulic Modelling Lab**	**L**	**T**		**P**	
8. Subject Code		0	0		2	
9. Type of Subject		**Core (✓)**	**PE()**		**OE()**	
10. Pre-requisite (if any)		**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
11. Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

6. Learning objectives:

The objectives of the course are:

1. Students are able to model the domain.
2. Students are able to establish the relationship between the model and the constraints.
3. Students are able to model the dynamic structures

Outcomes:

On completion of this course, the students will be able to

1. Students are able to model the domain.
2. Students are able to establish the relationship between the model and the constraints.
3. Students are able to model the dynamic structures

12. Lab Content

Sr. No.	Title	CO covered
1	Steps in model building; Simulation	1,2
2	Elementary state transition models.	1,2
3	Probability distributions and their mechanisms	1,2
4	Individual and group preference patterns	1,2
5	Graphical models and matrix models	1,2
6	Representation of model structure	1,2
7	Discrete and continuous growths	1,2
8	Growth process and integral equations	2,3

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Hydropower**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. The objective of this course is to understand the concept of hydropower projects including investigation, planning and design aspects.

9. Course Outcomes (COs):

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

1. To learn the elements of hydropower scheme.
2. To study the estimation of hydropower potential
3. To gain knowledge on water conveyance system by studying intake structures, power canals, surge tanks and penstocks.
4. To understand the force exerted by a jet on a fixed target, moving target, and by a jet on a series of curved vanes.
5. To gain knowledge on Francis turbine and Miscellaneous hydraulic machines.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: HYDROPOWER PLANT DEVELOPMENT**

Sources and forms of energy Hydropower plants classification Layout and components, Development of hydropower schemes Comparison of Hydro and Thermal power, Survey and Investigation.

Unit - 2	**Number of lectures = 10**	**Title of the unit: POWER POTENTIAL**

Estimation of Hydropower potential Flow duration curve, Firm power, Secondary power, Load and Load duration curves, Load factor, Firm capacity Reservoir capacity, Capacity factor.

Unit - 3	**Number of lectures = 10**	**Title of the unit: WATER CONVEYANCE SYSTEM**

Intake structures: Location function and types of intakes, Energy losses at intake trash rock Power canals , Alignment, Design of power canals Penstocks, Alignment, types of penstock, Economic diameter of penstocks and Anchor blocks Water hammer pressure. Behavior of surge tanks, Types of surge tanks. Hydraulic design of simple surge tank.

Unit - 4	**Number of lectures = 12**	**Title of the unit: IMPACT OF JET ON VANES**

Introduction to Impulse Momentum equation and its applications Force exerted by a Jet on a fixed, Force exerted by a Jet on a moving target, Force exerted by a Jet on a serious of curved vane.

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

1. Modi .P.N. and Seth .S.M, “Hydraulics and Fluid Mechanics”, Standard Book House, 2005.
2. Rajput .R.K, “Fluid Mechanics and Hydraulic Machines”, S.Chand and Company Ltd., 2013.
3. Bansal .R.K, “Fluid Mechanics and Hydraulic Machines”, Laxmi Publications 2010
4. M.M.Dandekar and K.N.Sharma, “Water Power Engineering”, Vikas Publications.

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Hydropower Laboratory**	L	T		P	
3. Course Code		0	0		4	
4. Type of Course (use tick mark)		Core ()	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		Odd ()	Either Sem ()	Odd (✓)	Either Sem ()	**Every Sem ()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 28		**Tutorials =0**	**Practical =0**			

7. Learning objectives:

The objective of this course is to understand the concept of hydropower projects including investigation, planning and design aspects.

8. Course Outcomes (COs):

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

1. To learn the elements of hydropower scheme.
2. To study the estimation of hydropower potential
3. To gain knowledge on water conveyance system by studying intake structures, power canals, surge tanks and penstocks.
4. To understand the force exerted by a jet on a fixed target, moving target, and by a jet on a series of curved vanes.
5. To gain knowledge on Francis turbine and Miscellaneous hydraulic machines.

9. Unit wise detailed content

1. To study the behaviour of centrifugal and axial rotating pump.
2. To study the estimation of hydropower potential
3. To explore intake structures, power canals, surge tanks and penstocks.
4. To study a jet on a series of curved vanes.
5. To work on a Francis turbine and others hydraulic machines.
6. Explore the options of hydro-power plants in the local and nearby cities areas.

1. Name of the Department: Civil Engineering Department						
2. Course Name	**HYDROGEOLOGY AND GROUNDWATER DEVELOPEMENT**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

- To create a simple conceptual model of an area's hydrogeology that can be used to guide a site investigation or engineering design project.
- To compare methods for solving groundwater flow equations under a variety of situations, selecting the most appropriate modeling techniques based on an engineering project's goals and evaluating how their weaknesses may impact the final conclusions.
- To develop a preliminary consulting report for a groundwater development or remediation project.

9. Course Outcomes (COs):

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

1. Model regional groundwater flow and design water wells
2. Formulate and solve conjunctive use of surface water and groundwater resource utilization problems
3. Identify sites for artificial recharge of groundwater and determine the consequences of artificial recharge.
4. Conduct Geophysical exploration studies for groundwater source identification.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: OCCURRENCE AND MOVEMENT OF GROUND WATER:**

Groundwater in hydrological cycle, Properties of rocks and water bearing formations affecting ground water flow, Ground water basins, Vertical distribution of ground water, Ground water potential and its exploitation in India. Darcy's law, Permeability and its determination, Flow rates and directions of flow of ground water, Dispersion of tracers in ground water, Unsaturated flows, General equations governing steady/unsteady flow through confined and unconfined aquifers.

Unit - 2	Number of lectures = 10	Title of the unit: HYDRAULICS OF WATER WELLS:

Flow in confined aquifers towards wells in steady and unsteady state. Flow through leaky or semi confined aquifers into wells, Dupuits assumption for unconfined aquifers, Steady and unsteady flows into wells, Theis, Jacob's and Chow's methods of solution of unsteady flows, Method of superposition in groundwater flow-method of images, Solutions of flow towards wells near a recharge boundary or impermeable boundary, Use of observation wells, Multiple well systems, Partially penetrating wells.

Unit - 3	Number of lectures = 10	Title of the unit: DESIGN AND CONSTRUCTION OF WELLS:

Selection of Aquifer, well depth and well diameter, selection of screen-type and design of well screen, Provision of artificial gravel pack and shrouded wells, Test holes and well logs, Method of construction of shallow and deep wells including drilling, Completion and development of wells, Pumping equipment, resting the wells for yield, Maintenance and protection of wells, Rehabilitation of old and abandoned wells.

Unit - 4	Number of lectures = 12	Title of the unit: SURFACE AND SUBSURFACE INVENSTIGATIONS OF GROUNDWATER

SURFACE: - Geological methods, remote sensing, Geophysical exploration, electrical Resistivity method, Seismic Refraction method, Gravity and magnetic methods, Water Witching.

SUBSURFACE:- Test drilling measurement of water levels, Geophysical logging, Resistivity logging, Spontaneous potential logging, Radiation logging, Temperature logging, Caliper logging, Fluid conductivity logging, Fluid Velocity logging, miscellaneous logging and other subsurface techniques.

11. Brief Description of self learning / E-learning component

Quiz/Assignment/ Seminar/Written Examination, The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 2 References)

1. Karamouz, M, Ahmadi, A, and Akhbari, M, Groundwater Hydrology: Engineering Planning and Management, CRC Press, 2011.
2. Todd, D.K., and Mays, L. W., Groundwater Hydrology, John Wiley & Sons, Singapore, 2011
3. Davis, S.N., and De Weist, R.J.M., Hydrogeology, John Wiley & Sons, New York, 1966.
4. Domenico, Concepts and Models in Groundwater Hydrology, McGraw Hill Inc. New York, 1972.

1. Name of the Department: Civil Engineering Department						
2. Course Name	**HYDROGEOLOGY AND GROUNDWATER DEVELOPEMENT Laboratory**	L	T		P	
3. Course Code		0	0		4	
4. Type of Course (use tick mark)		Core ()	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		Odd ()	Either Sem ()	Odd (✓)	Either Sem ()	**Every Sem ()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 28		**Tutorials =0**	**Practical =0**			

7. Learning objectives:

The objective of this course is to understand the concept of hydropower projects including investigation, planning and design aspects.

8. Course Outcomes (COs):

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

1. To learn the elements of hydropower scheme.
2. To study the estimation of hydropower potential
3. To gain knowledge on water conveyance system by studying intake structures, power canals, surge tanks and penstocks.
4. To understand the force exerted by a jet on a fixed target, moving target, and by a jet on a series of curved vanes.
5. To gain knowledge on Francis turbine and Miscellaneous hydraulic machines.

9. Unit wise detailed content

1. Properties of rocks and water bearing formations affecting ground water flow.
2. General equations governing steady/unsteady flow through confined and unconfined aquifers.
3. Flow in confined aquifers towards wells in steady and unsteady state.
4. Jacob's and Chow's methods of solution of unsteady flows.
5. Type and design of well screen.
6. Maintenance and protection of wells.
7. Electrical Resistivity method.
8. Fluid conductivity logging

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Watershed management**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials = 00**	**Practical = 00**			

7. Learning objectives:

1. Proper use of all available resources of a watershed for optimum production with minimum hazards to natural resources
2. Discuss various aspects of water resources development and management on watershed basis.

9. Subject Outcomes:

On completion of this course, the students will be able to

1. Apply their knowledge of Watershed management practices in various regions; Sustainable watershed approach; Integrated watershed management; Watershed modeling; Use of modern techniques in watershed management;
2. Apply social aspects of watershed management; Management of water quality; Storm water and flood management; Drought management; Water conservation and recycling.

9. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction and Basic Concepts:**

Concept of watershed, introduction to watershed management, different stakeholders and their relative importance, watershed management policies and decision making.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Sustainable Watershed Approach & Watershed Management Practices**

Sustainable integrated watershed management, natural resources management, agricultural practices, integrated farming, Soil erosion and conservation; Watershed Management Practices in Arid and Semiarid Regions, Case studies, short term and long term strategic planning.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Integrated Watershed Management:**

Introduction to integrated approach, Integrated water resources management, conjunctive use of water resources, rainwater harvesting; roof catchment system.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Watershed Modeling:**

Standard modeling approaches and classifications, system concept for watershed modeling, overall description of different hydrologic processes, modeling of rainfall-runoff process, subsurface flows and groundwater flow.

10. Brief Description of self learning / E-learning component

The students will be encouraged to learn using the SGT e-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

Journal papers; Patents in the respective field.

11. Books Recommended

Text Books

1.Murty, J.V.S. "Watershed Management", New Age Intl., New Delhi 1998

2. Purandare, A.P., Jaiswal A.K., Waterhed Development in India, NIRD, Hyderabad, 1995.

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Watershed management Laboratory**	L	T		P	
3. Course Code		0	0		4	
4. Type of Course (use tick mark)		Core ()	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		Odd ()	Either Sem ()	Odd (✓)	Either Sem ()	**Every Sem ()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials =0**	**Practical =28**			

7. Learning objectives:

1. Proper use of all available resources of a watershed for optimum production with minimum hazards to natural resources
2. Discuss various aspects of water resources development and management on watershed basis.

7. Subject Outcomes:

On completion of this course, the students will be able to

1. Apply their knowledge of Watershed management practices in various regions; Sustainable watershed approach; Integrated watershed management; Watershed modeling; Use of modern techniques in watershed management;
2. Apply social aspects of watershed management; Management of water quality; Storm water and flood management; Drought management; Water conservation and recycling.

9. Unit wise detailed content

1. Examine various stakeholders in watershed management.
2. Explore nearby natural resources for their effects in watershed.
3. Study the nearby arid and semi-arid areas for watershed management.
4. Explore the possibility of building a rainwater harvesting plants in nearby areas.
5. Examine the role of integrated watershed management.
6. Study various steps in watershed modelling.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Environmental Impact Assessment of water**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical						
Lectures =42		**Tutorials = 00**	**Practical = 00**			

7. Learning objectives:

1. Identify the need to assess and evaluate the impact on environment.
2. Major principles of environmental impact assessment
3. Understand the different steps within environmental impact assessment

8. Subject Outcomes: On completion of this course, the students will be able to

1) Overview of assessing risks posing threats to the environment

2) Be able to access different case studies/examples of EIA in practice

3) Able to liaise with and the importance of stakeholders in the EIA process

9. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title:- Initial environmental Examination**

Initial environmental Examination, Elements of EIA, - factors affecting E-I-A Impact evaluation and analysis, preparation of Environmental Base map, Classification of environmental parameters. E I A Methodologies: introduction, Criteria for the selection of EIA Methodology, E I A methods, Ad-hoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods, cost/benefit Analysis.

Unit – 2	**Number of lectures = 10**	**Title:- Assessment of Impact**

Assessment of Impact of development Activities on Vegetation and wildlife, environmental Impact of Deforestation – Causes and effects of deforestation.

Unit – 3	**Number of lectures = 10**	**Title:- Procurement of relevant**

Procurement of relevant soil quality, Impact prediction, Assessment of Impact significance, Identification and Incorporation of mitigation measures.

Unit – 4	**Number of lectures = 10**	**Title:- Environmental Audit**

Environmental Audit & Environmental legislation objectives of Environmental Audit, Types of environmental Audit, Audit protocol, stages of Environmental Audit, onsite activities, evaluation of Audit data and preparation of Audit report, Post Audit activities.

10. Brief Description of self learning / E-learning component

The students will be encouraged to learn using the SGT e-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

Journal papers; Patents in the respective field.

11. Books Recommended

Text Books

1. Larry Canter – Environmental Impact Assessment, McGraw-Hill Publications.
2. Environmental Impact Assessment, Barthwal, R. R. New Age International Publications.

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Environmental Impact Assessment of water laboratory**	L	T		P	
3. Course Code		0	0		4	
4. Type of Course (use tick mark)		Core ()	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		Odd ()	Either Sem ()	Odd (✓)	Either Sem ()	**Every Sem ()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials =0**	**Practical =28**			

7. Learning objectives:

1. Identify the need to assess and evaluate the impact on environment.
2. Major principles of environmental impact assessment
3. Understand the different steps within environmental impact assessment.

8. Subject Outcomes: On completion of this course, the students will be able to

1) Overview of assessing risks posing threats to the environment

2) Be able to access different case studies/examples of EIA in practice

3) Able to liaise with and the importance of stakeholders in the EIA process

9. Unit wise detailed content

1. Study the initial environment examination before implementation of EIA.
2. Explore the method of matrix and ad-hoc for the purpose of EIA methodology selection.
3. Calculate the cost requirements for the purpose of benefits analysis.
4. Explore nearby wildlife and vegetation that are in verge of extinction.
5. Conduct a social awareness for stopping deforestation and enhance the plantation drive.
6. Study nearby water resources for the purpose of Pollution control.

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Urban Hydrology and Drainage**	**L**	**T**	**P**		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**	**OE()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. To learn urban water management practices and its effect on urban water infrastructure, hydrology and groundwater regime.

9. Course Outcomes (COs):

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

1. To understand urban water cycle and its role in the designs of urban water infrastructures water supply, storm water drainage, sanitation, sewerage and wastewater conveyance infrastructures and its rehabilitation and augmentation
2. To understand sustainability concepts and how to carry out sustainable urban designs.
3. To learn about emerging sustainable materials and its hydraulic, structural strength and resilience properties, and design procedures for water supply and sewer pipelines.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title:- Urban water cycle**

Urban water cycle, Urban water infrastructures - water supply, storm water drainage, sanitation, sewerage and wastewater conveyance infrastructures.

Unit - 2	**Number of lectures = 10**	**Title:- Water supply and sewerage network**

Water supply and sewerage network hydraulics, SCADA systems, Sustainable urban designs, Methodologies for assessing sustainability of urban water infrastructures, Emerging sustainable materials and design procedures for water supply and sewerage pipelines.

Unit - 3	**Number of lectures = 10**	**Title:- Hydraulic performance**

Hydraulic performance and structural strength, chemical resistance and resilience characteristics of emerging materials based water and sewer pipelines, Rehabilitation and augmentation technologies for water supply and sewerage networks, Analytic hierarchy process and optimization techniques for arriving at the best appropriate rehabilitation/ augmentation technology.

Unit - 4	**Number of lectures = 12**	**Title:- Urban water management**

Urban water management, Rain water harvesting, Managed aquifer recharge, Constructed/engineered wetlands, Sprinkler and drip irrigation, Water use efficiencies, Effect of water management practices on urban water infrastructure, hydrology and groundwater regime, Surface and subsurface mapping of water supply and sewerage networks, Structural safety and mitigating plans against natural and human caused threats.

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

(1) Grigg, N.S., Water, Wastewater, and Storm water Infrastructure Management, Second Edition, CRC Press, 2012
(2) Lazaro, T.R., Urban Hydrology, CRC Press, 1990
(3) WEF and ASCE, Existing Sewer Evaluation and Rehabilitation, McGraw-Hill, 2009
(4) Keshari, A.K., Rainwater Harvesting. Water Digest, 1(2): 46-50, 2006.
(5) Smith, S.W., Landscape Irrigation: Design and Management, 1st Edition, Wiley, 1996
(6) Mays, L.W., Hydraulic Design Handbook, McGraw-Hill, 1999

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Urban Hydrology and Drainage Laboratory**	L	T		P	
3. Course Code		0	0		4	
4. Type of Course (use tick mark)		Core ()	**PE(✓**		**OE()**	
5. Pre-requisite (if any)		Odd ()	Either Sem ()	Odd (✓)	Either Sem ()	**Every Sem ()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 28		**Tutorials =0**	**Practical =0**			

7. Learning objectives:

1. To learn urban water management practices and its effect on urban water infrastructure, hydrology and groundwater regime.

8. Course Outcomes (COs):

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

1. To understand urban water cycle and its role in the designs of urban water infrastructures water supply, storm water drainage, sanitation, sewerage and wastewater conveyance infrastructures and its rehabilitation and augmentation
2. To understand sustainability concepts and how to carry out sustainable urban designs.
3. To learn about emerging sustainable materials and its hydraulic, structural strength and resilience properties, and design procedures for water supply and sewer pipelines.

10. Unit wise detailed content

1. To determine mean rainfall of an area by isohyetal method.
2. The determine mannings rogosity coefficient.
3. To determine the velocity of a running of a stream in a canal by current meter and Calculate the approximate discharge of the canal.
4. To design a regime channel by Lacey's theory for a given .pattern of crops and area to be Irrigated.
5. To determine the yield of an open well by recuperation test.
6. To determine the yield of an open well by constant level pumping test.
7. To visit a Multipurpose River valley, project and to prepare a report of the solid project.

Curriculum
(Scheme of Examination)
&
Syllabus for

M.Tech
Environmental Engineering

Batch 2021 onwards

SGT University Gurgaon

Credit Based Scheme w.e.f. 2021-2022

Scheme of Examination for M.Tech– Environmental Engineering Program

SEMESTER WISE COURSE STRUCTURE

First Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Atmospheric Processes & Climate Change	3	0	0	3	60	40	100
2		Physico-chemical, Biological Principles and Processes	3	0	0	3	60	40	100
3		Environmental Quality Modeling	3	0	0	3	60	40	100
4		Solid Waste Management	3	0	0	3	60	40	100
5		Environmental system design lab	0	0	2	1	40	60	100
6		Environmental Quality Modeling Lab	0	0	2	1	40	60	100
7		Value Added Courses-I	2	0	0	2	60	40	100
8		Seminar	0	0	2	1	00	100	100
		Total	**14**		**6**	**17**	**380**	**420**	**800**

Second Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Energy, Instrumentation, Measurement &Control	3	0	0	3	60	40	100
2		Environmental Audit & Impact Assessment	3	0	0	3	60	40	100
3		Design of Water & Wastewater Treatment Systems	3	0	0	3	60	40	100
4		Air Pollution & Its Control	3	0	0	3	60	40	100
5		Design of Water & Wastewater Treatment Systems Lab	0	0	2	1	40	60	100
6		Environmental Engineering Lab	0	0	2	1	40	60	100
7		Seminar	0	0	2	1	00	100	100
		Total	**12**	**0**	**6**	**15**	**320**	**380**	**700**

Scheme of Examination for M.Tech– Environmental Engineering Program

SEMESTER WISE COURSE STRUCTURE

Third Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Energy Auditing, Conservation & Management	3	0	0	3	60	40	100
2		Research Methodology & IPR	3	0	0	3	60	40	100
3		Department Electives-XIII	3	0	0	3	60	40	100
4		Department Electives-XIV	3	0	0	3	60	40	100
5		Department Electives-XV	3	0	0	3	60	40	100
6		Research Methodology & IPR Lab	0	0	2	1	40	60	100
7		Department Electives Lab-XIII	0	0	2	1	40	60	100
8		Department Electives Lab-XIV	0	0	2	1	40	60	100
9		Department Electives Lab-XV	0	0	2	1	40	60	100
10		Value Added Courses-II	2	0	0	2	60	40	100
		Total	**17**	**-**	**8**	**21**	520	480	1000

Fourth Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Dissertation	0	0	20	20	100	0	100
		Total	**0**	**0**	**20**	**20**	100	0	100

Departmental Elective

S. No.	Specialization	Departmental Elective XIII	Departmental Elective XIV	Departmental Elective XV
2	**Environmental Engineering**	Emerging Trends in Waste Treatment 3-0-2 (4)	Urban Environmental Quality Management 3-0-2 (4)	Environmental Quality Monitoring 3-0-2 (4)

First Semester

1. Name of the Department: Civil Engineering						
2. Course Name	Atmospheric Processes and Climate Change	**L**	**T**	**P**		
3. Course Code		3	0	4		
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical =0**			

8. Brief Syllabus

This course will help learners to understand the key characteristics of natural and anthropogenic perturbations to the climate system (such as greenhouse gases, aerosols, land use, volcanoes and solar radiation), and to elucidate the mechanisms through which these perturbations influence global and regional climate. Since atmospheric processes play important roles in shaping the Earth's energy and water cycles.

9. Learning objectives:

1. The evolution of the earth's atmosphere
2. Characteristics of the terrestrial atmosphere
3. Homogeneous and heterogeneous processes in the atmosphere
4. A basic understanding of the recent advances made in the understanding of the atmospheric processes leading to climate change

10. Course Outcomes (COs):

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

1. First acquire a basic understanding of the evolution of the earth's atmosphere.
2. Thereafter, learn about the structure and composition of the various atmospheric layers.
3. Gain a basic grounding on atmospheric chemical cycles.
4. Understand how atmospheric chemical processes are linked to the dynamics.
5. Finally, gain an insightful understanding of the Physico-chemical processes leading to climate change.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction to Atmosphere & Radiation**

Origins of the Earth's Atmosphere. Layers of the Atmosphere. Earth–Atmosphere System. Solar and Terrestrial Radiation. Absorption of Radiation by gases. Solar variability and the Earth's Energy Balance. A simple model to estimate Green House Effect.

Unit - 2	**Number of lectures =**	**Title of the unit: Conceptual Models**

	10	
The ideal Gas law, Atmospheric Composition, Hydrostatic balance, Derivation of the Potential Temperature, States of stability of the Atmosphere, Parcel Concepts. General Circulation and Geotropic flows. Quantification of dry and moist adiabatic Lapse Rates. Cloud Formation.		
Unit - 3	**Number of lectures = 10**	**Title of the unit: Environmental Phenomenon & Global Activities**
Atmospheric Chemical Reactions, Chemical Kinetics, Bimolecular Reactions, Photo-dissociation. Stratospheric Ozone, Chapman Chemistry, Pathways for Ozone destruction. The Antarctic Ozone Hole. Global Climate Change: Global Temperature Record and Solar Variability. Possible Effects of Global Warming. Aerosol direct, in-direct and semi-direct effects. Climate Response to Anthropogenic Aerosols.		
Unit - 4	**Number of lectures = 12**	**Title of the unit: Analytics of Pollutants-Aerosols**
Atmospheric Aerosol: Aerosol size distributions. Continental and Maritime Aerosol. Homogeneous and heterogeneous nucleation. Condensation, Coagulation, Evaporation. Sedimentation and dry deposition. Formation of Cloud droplets. Auto-conversion and Precipitation. Exposure to applications based on current industrial trends.		
12. Books Recommended (1 Books+ 2 References)		
1. Introduction to Environmental Engineering and Science. Gilbert M. Masters. Prentice-Hall of India. 2005.		
2. Inter-governmental Panel on Climate Change: The Third Assessment Report (2007). Cambridge University Press.		
3. A Treatise on Atmospheric Phenomena, by Edward Joseph Lowe, Nabu Press (24 July 2011).		
4. The World Axis as an Atmospheric Phenomenon, by Marinus Anthony Van Der Sluijs, All-Round Publications (28 September 2007)		
5. Atmospheric Phenomena: Readings from "Scientific American", by David K. Lynch, W. H. Freeman & Co Ltd; Illustrated edition (1 July 1980).		

1. Name of the Department: Civil Engineering						
2. Course Name	Physico-chemical, Biological Principles and Processes	**L**	**T**		**P**	
3. Course Code		3	0		4	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Basic of physics, chemistry and biology	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Brief Syllabus

This course touches on some of the fundamentals of Physico-chemical, Biological Principles and Processes field. Starting from basic elements in biochemistry, the course covers other aspects like commonly used to study structure and properties of water, ecosystems & applications of microbiological principles to environmental engineering. Hence this subject aims to give knowledge to the students regarding advanced Physico-chemical, Biological Principles and Processes at large.

9. Learning objectives:

1. To study about the solid- liquid- gas interactions
2. To understand about process kinetics.
3. To deal with the microbial applications in environmental engineering.
4. To let aware students about the Ecosystem at large.
5. To gain insight into the basics of Biochemistry for application in day-to-day activities.

10. Course Outcomes (COs):

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

1. Apply the concepts of different Equilibrium
2. Apply the basic of mass transfer and transport of impurities in current system
3. Able to function as a member of an interdisciplinary problem-solving team.
4. Study and applying practically about microbial kinetics
5. Able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Structure and Properties of Water**

Chemical Structure and Properties of Water- their significance in environmental engineering, Sources of Water impurities, Abiotic reactions, biological metabolism. Solid-Liquid-Gas interactions, Mass transfer and transport of impurities in water, diffusion, dispersion. Physical and Chemical interactions due to various forces, suspensions and dispersions.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Chemical reactions**
Chemical Reactions, Chemical Equilibrium and Laws of thermodynamics, Acid-base Equilibrium, Solubility equilibria, Oxidation-reduction equilibria. Process kinetics, reaction rates and catalysis, Surface and colloidal chemistry, Adsorption Phenomenon and Characteristics.		
Unit - 3	**Number of lectures = 10**	**Title of the unit: Ecosystems & Applications of Microbiological Principles to Environmental Engineering**
Introduction to Ecosystems: biotic and abiotic components, biogeochemical cycles, Ecological niche, Mortality and Survivorship, Natural and artificial ecosystems. Applications of microbiological principles to environmental engineering; Assimilation of wastes, Concepts and Principles of Carbon Oxidation, Nitrification, Denitrification, Methanogenesis, etc.		
Unit - 4	**Number of lectures = 12**	**Title of the unit: Biochemistry**
Introduction to Biochemistry; Biological compounds– enzymes, coenzymes and amino acids, Microbiological concepts; Cells, Classification and Characteristics of living organisms, Reproduction, Metabolism, Microbial Growth Kinetics. Exposure to applications based on current industrial trends.		
11. Books Recommended (3 Text Books + 2-3 Reference Books)		
1. Benefield, L.D. Judkins J.F. and Weaned B.L. (1982). Process Chemistry for Water and Wastewater Treatment, End ed., Prentice-Hall, Inc, New Jersey, USA		
2. Metcalf and Eddy, M.C., “Wastewater Engineering: Treatment, Disposal and Reuse”, Tata McGraw-Hill Publications, New Delhi, 2003		
3. Pelczar, M.J., Chan ECS and Krieg NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India		
4. Talaro K., Talaro A Cassida Pelzar and Reid, (1993) Foundations in Microbiology, W.C. Brown Publishers		
5. Sawyer, McCarty, and Parkin, 2003.Chemistry for Environmental Engineers, 5th” McGraw Hill		

1. Name of the Department: Civil Engineering						
2. Subject Name	Water Quality Modeling	**L**	**T**		**P**	
3. Subject Code		3	0		4	
4. Type of Subject (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 00**			

7. Brief Syllabus:

This course will discuss a wide variety of waters and factors and processes affecting the microbial water quality. We will also discuss the approaches that may be taken to improve the quality of water. At the end of this course, students will learn how intentional, incidental or unintentional misuse of water resources can have a detrimental consequence on human health. The course will also cover water remediation and safeguard techniques for the improvement of water quality.

8. Learning objectives:

1. Sources of microbial water contamination and its impact of human health globally.
2. Understand the relationship between human behavior and water quality.
3. Develop remediation strategies for several types of microbial water quality contamination.
4. Understand epidemiological studies related to water quality and public health.
5. Understand various water sources and transmission mechanisms of infectious agents.

9. Course Outcomes:

On completion of this course, the students will be able to

1. Apply the basics of water quality in day-to-day life.
2. Understand the significance of Management practices for maintaining water quality.
3. Apply the understanding of water treatment methods in water conservation.
4. Apply the skills in developing proper waste disposal for water quality maintenance.
5. Apply the dynamics of water in conservation strategies.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Overview of Water Quality**

Water quality: sources and impacts of impurities, classification of water quality parameter Standards: drinking water quality standards, effluent disposal standards, Surface water, And pollution: sources, Effects of Surface water pollution: physico-chemical, biological, toxic and pathological, Ground water pollution: sources & effects, Consequences of overusing of surface water & ground water.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Water Management Practices**

Non-point source pollution-Agricultural runoff, TMDLs, Best management practices (BMPs), Numeric vs narrative standards, Water quality dynamics and human impacts on water quality. Human

population growth-Modern lifestyle effects on the water and human health.		
Unit - 3	**Number of lectures = 12**	**Title of the unit: Water Treatment Methods**
Water treatment in developed and developing countries -Primary, secondary, and tertiary treatments, Land application of sewage, Improving the quality of drinking water at the source: Education and proper hygiene, Proper waste disposal, Water chlorination, Improving surveillance.		
Unit - 4	**Number of lectures = 8**	**Title of the unit: Dynamics of Water Quality**
Water quality and health linkage; Understanding the significance of the environment for human health, Human population pressures and pollution dynamics, Common terms and definitions in water quality, Aquatic resources of the world & Sources of drinking water, Common contaminants of drinking, water and linkages to disease. Exposure to applications based on current industrial trends.		
11. Books Recommended (3 Text Books + 2-3 Reference Books)		
1. Hall, W.A. and Dracup, J.A., Water resources systems engineering, Mc Graw Hill, 1970.		
2. Hexem, R.W. and Heady E.O., Water production functions for irrigated agriculture, Iowa State University Press, 1978.		
3. James, L.D. & Robert, R. L., Economics of Water Resources Planning, 1970, 5th edition.		
4. Lee, S.M., Linear optimization for management, Petrocelli/ Charter, New York, 1976. Isobel W Heathcote. 1998. Integrated Watershed Management: Principles and Practice. Wiley Publ.		
5. Kenneth N Brooks, Peter F Folliott, Hans M Gregersen, Leonard F DeBano. 1991. Hydrology and the Management of Watersheds. Wiley-Blackwell.		

1. Name of the Department: Civil Engineering						
2. Course Name	Solid Waste Management	**L**	**T**	**P**		
3. Course Code		3	0	4		
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 00**			

8. Brief Syllabus

This course is based on Solid-waste management techniques, the collecting, treating, and disposing of solid material that is discarded because it has served its purpose or is no longer useful. Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions in turn can lead to pollution of the environment and to outbreaks of vector-borne disease—that is, diseases spread by rodents and insects. The tasks of solid-waste management present complex technical challenges. They also pose a wide variety of administrative, economic, and social problems that must be managed and solved.

9. Learning Objectives:

1. To gain insight into collection, transfer and transport of municipal solid waste.
2. Understand the design and operation of municipal solid waste landfill.
3. Understand the design and operation of resource recovery facility.
4. Understand the design and operation of waste to energy facility.

10. Course Outcomes (COs):

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

1. Understand solid waste and its composition
2. Understand various processes involved in solid waste collection, segregation and transportation.
3. Design solid waste disposal facility
4. Able to handle leachate in preventing ground water pollution.
5. Apply the understanding in disposal of Solid Wastes.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Municipal Solid Waste Management**

Definition of solid waste–waste generation, major legislation, monitoring responsibilities, sources and types of solid waste, sampling and characterization, Determination of composition of MSW–storage and handling of solid waste. Future changes in waste composition.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Collection and Transportation of Solid Waste**

Waste collection systems, analysis of collection system–alternative techniques for collection system. Need for transfer operation, transport means and methods, transfer station types and design requirements.

Unit - 3	**Number of lectures = 12**	**Title of the unit: Process of Solid Waste and Energy recovery**

Unit Operations for separation and processing, Materials Recovery facilities, Waste transformation through combustion and aerobic composting, anaerobic methods for materials recovery and treatment, Energy Recovery-Incinerators

Unit - 4	**Number of lectures = 8**	**Title of the unit: Landfills & Disposal of Solid Wastes**

Landfills: Site selection, Engineered Sites, liners and covers, leachate control and treatment, gas recovery and control, including utilization of recovered gas (energy). Landfill monitoring and reclamation.

Definition and identification of hazardous wastes-sources and characteristics, hazardous wastes in Municipal Waste, Hazardous waste regulations – minimization of Hazardous Waste-compatibility, handling, storage and disposal of hazardous waste-collection and transport. Exposure to applications based on current industrial trends.

11. Books Recommended (3 Text Books + 2-3 Reference Books)

1. Hand book of Solid Waste Management by Frank Kreith, McGraw Hill Publication.
2. Bagchi, A., Design, Construction, and Monitoring of Landfills, (2ndEd). Wiley Interscience, 1994.
3. Sharma, H. D., and Lewis, S. P., Waste Containment Systems, Waste Stabilization and Landfill. Design and Evaluation. Wiley Interscience, 1994. ISBN: 0471575364.
4. George Techobanoglous et al," Integrated Solid Waste Management ", McGraw-Hill Publication, 1993.
5. Charles A. Wentz; "Hazardous Waste Management ", McGraw-Hill Publication, 1995

1. Name of the Department: Civil Engineering						
2. Course Name	Environmental system Design Lab	L	T		P	
3. Course Code		0	0		4	
4. Type of Course (use tick mark)		Core (✓)	**PE()**		**OE()**	
5. Pre-requisite (if any)		Odd ()	Either Sem ()	Odd (✓)	Either Sem ()	Every Sem **()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

7. Brief Syllabus:

This laboratory course work emphasis on development of basic knowledge of the learner toward environment system. In addition to that, this course will inculcate the understanding about parameters involved in the environment monitoring.

8. Learning objectives:

1. Understand the processes for determination of environment system.
2. To gain insight into basic concept of environment quality management.
3. Understand the parameter involved in determination of environment quality management variables.

7. Course Outcomes (COs):

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

1. Apply the methodologies involved in the determination of environment quality monitoring.

2. Apply the understanding of analytical techniques toward parameters that influences environment monitoring.

8. Unit wise detailed content

1. Environmental Engineering includes specialized software.
2. Determination of land remediation.
3. To determine the air quality management.
4. To determine the pollution control of noise.
5. To determine the air and water Pollution.
6. Determination of environmental and pollution management.

1. Name of the Department: Civil Engineering						
2. Course Name	Water Quality Modeling Lab	L	T		P	
3. Course Code		0	0		4	
4. Type of Course (use tick mark)		Core (✓)	**PE()**		**OE()**	
5. Pre-requisite (if any)		Odd ()	Either Sem ()	Odd (✓)	Either Sem ()	Every Sem **()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

7. Brief Syllabus:

This laboratory course work emphasis on development of basic knowledge of the learner toward water system. In addition to that, this course will inculcate the understanding about parameters involved in the water modeling.

8. Learning objectives:

1. Understand the processes for determination of water modeling.
2. To gain insight into basic concept of water modeling.
3. Understand the parameter involved in determination of water modeling variables.

7. Course Outcomes (COs):

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

1. Apply the methodologies involved in the determination of water modeling.
2. Apply the understanding of analytical techniques toward parameters that influences water modeling.

8. Unit wise detailed content

1. Determination of Optimum Coagulant dosage
2. Determination of residual chlorine in bleaching powder
3. Determination of available chlorine in bleaching powder
4. Determination of Oil and Grease
5. Determination of suspended, settleable, volatile and fixed solids.
6. Determination of pH, Turbidity and conductivity
7. Determination of Hardness
8. Determination of Alkalinity and Acidity
9. Determination of Chlorides
10. Determination of Phosphates and Sulphates

Second Semester

1. Name of the Department: Civil Engineering						
2. Course Name	Energy Instrumentation, Measurement and Control	**L**	**T**	**P**		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		**Core (✔)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem (✔)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 00**			

8. Brief Syllabus

Provides an introduction to the field of instrumentation and covers process variables and the various instruments used to determine the energy and fluid flow. The course concludes with a study of instrumentation drawings and diagram. The process variables used in determination fluid flow are expressed in details to enhance learner knowledge in this field.

9. Learning objectives:

1. To understand the basics of instrumentation involved in energy metering.
2. To understand the flow detection devices employed in the fluid metering.
3. To understand the working principles of different flow meters.

10. Course Outcomes (COs):

At the end of course, the student will be able to:

1. Apply the basic understanding of metering devices in the field of energy analysis.
2. Apply the understanding of flow meters in controlling of the fluid/ gas flow at different fields.
3. Apply the understanding of Energy Metering Device in daily life.
4. Apply the understanding of Thermal Energy Meter at various sites.
5. Apply the understanding of Air & Fluid Flow meters in different sites.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Electrical Energy Metering**

Electrical energy meter, One Phase energy meters, Three Phase Energy meters, Working principle, Automatic meter reading systems

Unit - 2	**Number of lectures = 12**	**Title of the unit: Thermal Energy Metering**

Combustion Analyser, Fuel Efficiency Monitor, Flue Gas Analyzer, Thermocouples & RTDs, Potentiometric & Paperless Recorders, I/P Converters, Temperature Transmitters, Optical Pyrometer, Digital Indicators, PID Controllers, Loop Powered Indicators & Isolators, BTU meters, Thermistors, Heat Flux sensor.

Unit - 3	**Number of lectures = 12**	**Title of the unit: Air Flow Metering & Velocity Metering**

Air flow meters: vane (flap) type air flow meters and “hot wire" and "hot film" air mass meters. Anemometer, types and its classification, working principle. Types and its basic working principle, Odometer

Unit - 4	**Number of lectures = 8**	**Title of the unit: Fluid Flow Metering**
Classification of fluid flow meters based on the operating principle- Differential Pressure Flow meters, Velocity Flow meters, Positive Displacement Flow meters, Mass Flow meters, Open Channel Flow meters, Types: Orifices, Venturies, Nozzles, Rota meters, Pitot Tubes, Calorimetric, Turbine, Vortex, Electromagnetic, Doppler, Ultrasonic, Thermal, and Coriolis. Exposure to applications based on current industrial trends.		
12. Books Recommended (3 Text Books + 2 Reference Books)		
1. Measurement and Control Basics, ISA; 4th edition (30 June 2007), by Thomas A. Hughes		
2. Electrical Measurements and Measuring Instruments, I K International Publishing House Pvt. Ltd (30 December 2013) by S. Kamakshaiah, J. Amarnath, Pannala Krishna Murthy.		
3. Flow Measurement, CRC Press; 1st edition (15 September 1993), by Bela G. Liptak.		
4. A Course in Electronic Measurements and Instrumentation, Dhanpat Rai & Co. (P) Limited (1 January 2015), by A.K. Sawhney		
5. Flow Measurement Handbook: Industrial Designs, Operating Principles, Performance, and Applications, Cambridge University Press; 1st edition (29 May 2000), by Roger C. Baker		

1. Name of the Department: Civil Engineering						
2. Course Name	Environmental Audit and Impact Assessment	**L**	**T**	**P**		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**	**OE ()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical =00**			

8. Brief Syllabus

This subject provides an introduction to environmental impact assessment (EIA) and environmental auditing. This includes the environmental impact assessment process, State based environmental planning as well as methodologies associated with impact prediction, environmental assessment, and environmental auditing. On completion, students are able to develop the appropriate documentation for an environmental impact statement and respond appropriately to an environment audit or environmental management system.

9. Learning objectives:

1. To develop relationship between EIA content and the preparation of environmental impact Statements
2. Familiarize with environmental auditing and Environmental management systems responsibilities.
3. Decipher the benefits of environmental auditing and impacts for the EIS.

10. Course Outcomes (COs):

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

1. Have an in-depth understanding of the processes associated with EIA, environmental auditing, and environmental management systems
2. Have an in-depth understanding of the current legislative requirements of environmental impact assessment and environmental auditing.
3. Have an ability to develop the appropriate documentation for an environmental impact statement.
4. Have an ability to develop an appropriate response to an environmental audit.
5. Have an ability to develop an appropriate environmental management system.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: General Aspects**

Introduction to EIA & Audit, Environment & Industries, Input information, Plant operation, Environmental Management planning, Waste Streams impact on water bodies.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Procedures and Regulations**

Environmental Impact Assessment planning. Activities, Methodology for Environmental Impact Assessment, Role of Environmental Engineering firm, Role of Regulatory agencies & control boards, Role of the Public.

Unit - 3	**Number of lectures = 12**	**Title of the unit: Approach to Environmental Audit & Reports**

Environmental Audit: Introduction, Environmental information Purpose & advantage of studies, General approach of environmental Auditing Environmental Audit, Audit programs in India, Auditing program in major polluting Industries.

Unit - 4	**Number of lectures = 8**	**Title of the unit: Environmental Laws & Acts**

Pollution prevention and control laws & acts: Constitution of India & environment, Constitution protection to Environment laws, Administrative & legislative arrangement for Environmental production, Indian Standards, Pollution control acts in India, critical appraisal, fiscal incentives for environmental protection. Exposure to applications based on current industrial trends.

11. Books Recommended (3 Text Books + 2-3 Reference Books)

1. O P Gupta, "Elements of Environmental pollution & Control Khanna Publishing house.
2. Environmental Impact Assessment by Canter, McGraw Hills.
3. Environmental Chemistry by Stanley E. Manahan, VIth Ed. Lewis Publishers, London
4. Dying Wisdom: Rise, Fall, and potential of India's Traditional rain water harvesting systems by Anil Agarwal & Sunita Narayan, CSE Publication. New Delhi.
5. Environmental Impact Assessment (Theory and Practice) by Peter Wathern, Routledge (Taylor and Frances Group), London and New York.

1. Name of the Department: Civil Engineering						
2. Course Name	Design of Wastewater Treatment & Disposal System	**L**	**T**	**P**		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		**Core (✔)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Environmental Quality Monitoring	**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem (✔)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 28**			

8. Brief Syllabus

The objective of wastewater treatment course is familiarizing the learner with the water quality parameters. Beside this learner will be able to understand the conventional methods used in water treatment. Moreover, different levels of water treatments will be elaborated in this syllabus and also decipher the characteristics of the waste water.

9. Learning objectives:

1. To expose the student to various technologies in waste water treatment in order to make water safe to drink.
2. To familiarize the learner to various treatment options available in treatment of waste water for recycle and safe disposal.
3. To inculcate the basic understanding about treatment plants and its methodologies.
4. To develop knowledge about disinfections methods followed in treatment plants at municipal levels.

10. Course Outcomes (COs):

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

1. Able to evaluate the water quality standards and apply in day-to-day activities.
2. Able to work in water treatment operations at municipal levels.
3. Able to characterize the waste water in various prospects.
4. Able to develop mechanism for disposal of waste water.
5. Able to design various water treatment units required

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Municipal Water Supply, Sources Quantity and Quality**

Objectives of water treatment, Raw water sources and quality, Drinking Water Quality Standards, Regulations, Per capita water demand, Population Estimates-Guide to Selection of Water Treatment Processes, Water distribution networks.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Conventional Unit Operations used in Water Treatment**

Aeration, Types of settling, Principal of Sedimentation, Design of Sedimentation Tanks, Coagulation,

Flocculation, Filtration, Rapid gravity sand filter, disinfection methods, mechanism of disinfection, chlorine, other disinfectants.		
Unit - 3	**Number of lectures = 12**	**Title of the unit: Wastewater Characterization and Disposal**
Philosophy of wastewater treatment, characteristics of wastewater, discharge standards for aquatic and land disposal, Wastewater Disposal; disposal to inland waters such as lakes reservoirs, rivers and streams, disposal to sea, disposal on Land.		
Unit - 4	**Number of lectures = 8**	**Title of the unit: Pre, Primary and Secondary Wastewater Treatment**
Sources of Wastewater Generation, Collection of waste-water, Flow variation, Design of stabilization plant, Preliminary treatment methods. Design of trickling filters and, activated sludge process (ASP). Variations of ASP, Wastewater treatment pond, Requirements of Tertiary treatment, Different types of advanced wastewater treatments. Exposure to applications based on current industrial trends.		
12. Books Recommended (3 Text Books + 2-3 Reference Books)		
1. Water and Wastewater Engineering: Design Principles and Practice' authored by Mackenzie L. Davis, McGraw-Hill Education (India) Private Ltd., 2015.		
2. Water Treatment: Principles and Design authored by John C. Crittenden, R. Rhodes Trussell, David W. Hand, Kerry J. Howe and George. T, 3rd Edition, John Willey and Sons, 2012		
3. Handbook of Water and Wastewater Treatment Plants Operations, authored by Frank R. Spellman, 3rd Edition, CRC Press, 2014		
4. Water Works Engineering: Planning, Design and Operation' authored by Syed R. Qasim, Edward M. Motley and Guang Zhu, Pearson Prentice Hall, 2011.		
5. Design Manual Onsite Wastewater Treatment and Disposal Systems, by U S Environmental Protection Agency, Scholar's Choice (16 February 2015)		

1. Name of the Department: Civil Engineering						
2. Course Name	Air Pollution and its Control	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	Basics of Environment Quality Measures	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 00**			

8. Brief Syllabus

This will enhance the learner basics about Air Pollution, its prevention methods, the techniques employed to reduce or eliminate the emission into the atmosphere of substances that can harm the environment or human health. These include adverse effects on human health, property, and atmospheric visibility.

9. Learning objectives:

The course is intended

1. To understand the basics of Air Pollution.
2. To enhance learner skills for control and remedial measures against Air Pollution.
3. To teach measures and technologies required to prevent air pollution.

10. Course Outcomes (COs):

At the end of the course, the student will be able to:

1. Identify the type the source of pollutant.
2. Monitor the Air pollution and analyse the samples.
3. Control air pollution using different ECS.
4. To apply methods to control Air Pollution
5. To disseminate knowledge in society to prevent Air Pollution.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Air Pollution & its Classification**

Definition of Air Pollution, Causes, Air Quality Monitoring Methods, Classification of Air Pollutants.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Effects & Prevention of Air pollution**

Effects of Air pollution on human, plant and animal. Preventive measures against Air Pollution. Air Pollution Hazardous level causing -Factors and control measures.

Unit - 3	**Number of lectures = 12**	**Title of the unit: Air Pollution Monitoring & Emission Control Systems**

Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Measurement of SO_2, NO_x,

CO. Basics of Ozone and its applications.
Air pollution control technologies for particulates and gaseous contaminants. Introduction to Gravity settlers, Electrostatic precipitators, Bag Filters, Scrubbers and Cyclone Control Systems.

Unit - 4	**Number of lectures = 8**	**Title of the unit: Meteorology & Dispersion of pollutants**

Introduction to Wind Circulation phenomenon, Lapse Rate, Stability Conditions, Maximum Mixing Depths, Plume Rise & dispersion. Exposure to applications based on current industrial trends.

12. Books Recommended (3 Text Books + 2-3 Reference Books)

i) M. N. Rao& H V N Rao (2000), Air pollution, Tata McGraw Hill Publishing Ltd

ii) 'Fundamentals of Air Pollution' authored by Daniel Vallero, 4th Edition, Elsevier's Science & Technology, 2008 (ISBN: 978-0-12-373615-4).

iii) 'Air Pollution Control Technology Handbook' authored by Karl B. Schnelle, Jr. and Charles A. Brown, CRC Press, 2002 (ISBN 0-8493-9588-7).

iv) 'Air Pollution Control Engineering' Edited by Lawrence K. Wang, Norman C. Pereira and Yung Tse Hung, Humana Press Inc, 2004 (ISBN: 1-58829-161-8).

v) 'Advanced Air and Noise Pollution Control' Edited by Lawrence K. Wang, Norman C. Pereira and Yung-Tse Hung, Humana Press Inc, 2005 (ISBN: 1-58829-359-9).

1. Name of the Department: Civil Engineering						
2. Course Name	Design of waste Water treatment and Disposal System Lab	L	T	P		
3. Course Code		0	0	4		
4. Type of Course (use tick mark)		Core (✓)	**PE ()**		**OE ()**	
5. Pre-requisite (if any)		Even (✓)	Either Sem ()	Odd ()	Either Sem ()	Every Sem **()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

7. Brief Syllabus:

This laboratory course work emphasis on development of basic knowledge of the learner toward waste water system. In addition to that, this course will inculcate the understanding about parameters involved in the determination of water quality.

8. Learning objectives:

1. Understand the analytical processes for determination of waste water variables.
2. To gain insight into basic concept of waste water properties.
3. Understand the parameter involved in determination of waste water quality.

7. Course Outcomes (COs):

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

1. Apply the methodologies involved in the determination of variables of waste water.
2. Apply the understanding of analytical techniques toward parameters that control the water quality.

8. Unit wise detailed content

1. To determine the BOD of a sample.
2. To determine the pH and Turbidity of waste water sample.
3. To determine the suspended, settle able, volatile and fixed solids in a sample.
4. To determine the COD of a sample.
5. To determine the Dissolved Oxygen by Winkler Titration Method.
6. Determination of Iron and Manganese in Water
7. Determination of Sulphate and Sulphide in Water
8. Jar Test for Determining Optimum Coagulant Dosage
9. Determination of Available Chlorine in Bleaching Powder
10. Test for Residual Chlorine

1. Name of the Department: Civil Engineering						
2. Course Name	**Environmental Engineering Laboratory**	**L**	**T**	**P**		
3. Course Code		**0**	**0**	**2**		
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**	**OE ()**		
5. Pre-requisite (if any)	**Environmental Engineering**	**6. Frequency (use tick marks)**	**Even (✓)**	**Odd ()**	**Either Sem ()**	**Every Sem ()**
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =00		**Tutorials =0**	**Practical =28**			

1. Brief Syllabus

Environmental engineering uses the principles of engineering, soil science, biology, and chemistry to develop solutions to environmental problems. They are involved in efforts to improve recycling, waste disposal, public health, and water and air pollution control.

2. Learning objectives:

i) To Ability to identify air pollution problems and interpret air quality data on chemical characteristic.
b. Ability to recognize various biotic and abiotic environmental transformation processes of pollutants.

3. Course Outcomes (COs):

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

1. Ability to identify air pollution problems and interpret air quality data on chemical characteristic.

2. Ability to recognize various biotic and biotic environmental transformation processes of pollutant.

Sr. No.	Title	CO covered
1	To determine the chlorine demand and residual chlorine in water.	1
2	To determine the sludge volume index (SVI) of the given sludge sample	1
3	2. To estimate the hardness of the given water sample.	2
4	3. To estimate the total solids, total dissolved solids and volatile solids of the given water sample.	2
5	4. To determine cations (Na, K, Li) and anions (sulfate, nitrate, fluoride).	1
6	5. To determine MPN count - total and fecal.	1
7	6. To estimate the chloride concentration of the given water sample	2

Third Semester

1. Name of the Department: Civil Engineering							
2. Course Name	Energy Auditing Conservation and Management	**L**	**T**	**P**			
3. Course Code		3	0	4			
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 42		**Tutorials = 0**	**Practical = 00**				

8. Brief Syllabus

To institute the correct energy efficiency programs, we have to know first which areas in our installation unnecessarily consume too much energy, which is the most cost-effective load. To enable the students to acquire the knowledge of energy conservation measures in thermal and electrical energy systems. To familiarize the students about energy conservation and energy audit. To familiarize the students with the concept of energy conservation and management.

9. Learning objectives:

1. To teach the basic concepts of energy audit and management.
2. The energy auditing procedures, techniques, policy planning, implementation and energy audit instrument.
3. To facilitate the students to achieve a clear conceptual understanding of technical and commercial aspects of energy conservation and energy auditing.
4. To enable the students to develop managerial skills to assess feasibility of alternative approaches and drive strategies regarding energy conservation and energy auditing.

10. Course Outcomes (COs):

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

6. Understand the general aspect of energy auditing and management
7. Understand the energy auditing procedures, techniques, policy planning and implementation.
8. Conceptual knowledge of the technology, economics and regulation related issues associated with energy conservation and energy auditing
9. Ability to analyze the viability of energy conservation projects
10. Capability to integrate various options and assess the business and policy environment regarding energy conservation and energy auditing

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: General Aspects**

General Philosophy and Need of Energy Audit and Management. Definition, Principle and Objectives of Energy Management, Energy Management Approach, Strategy & Skills, Energy Audit: Need, Types, Methodology and Approach. Understanding Energy Costs, Matching energy usage to requirements, Maximizing System Efficiency, Optimizing the Input energy requirements.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Procedures and Techniques**

Data gathering: Level of responsibilities, Energy Sources, Control of energy and uses of energy, Past and Present Operating data, Questionnaire for data gathering.

Analytical Techniques: Incremental cost concept, mass and energy balancing techniques, Inventory of

Energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process and energy system simulation.		
Unit - 3	**Number of lectures = 12**	**Title of the unit: Energy Policy Planning and Implementation**
Role and responsibilities of Energy Manager, Top Management Support, Managerial Functions, Accountability. Motivating-Motivation of Employees, Requirements for Energy Action Planning. Information Systems: Design and Barriers, Marketing Strategies, Training and Planning.		
Unit - 4	**Number of lectures = 8**	**Title of the unit: Energy Balance, MIS & Energy Audit Instruments**
First and Second law of Efficiency, Methods for Preparing Process flow, Energy Balance Diagram, Identification of Losses in Energy System. Energy Balance sheet and Management Information System (MIS), Energy Modeling and Optimization. Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy. Exposure to applications based on current industrial trends.		
12. Books Recommended (3 Text Books + 2-3 Reference Books)		
1. Energy Management: W. R. Murphy, G. McKay (Butterworths).		
2. Energy Management Principles: C.B. Smith (Pergamon Press).		
3. Efficient Use of Energy: I. G. C. Dryden (Butterworth Scientific)		
4. Energy Economics -A.V. Desai (Wiley Eastern)		
5. Industrial Energy Conservation: D.A. Reay (Pergamon Press)		

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	Research Methodology and IPR	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core (✓)	PE-()		OE()	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	Tutorials = 00	Practical = 0

8.Brief Syllabus:

The aim of the course is to make students understand the importance of Research Paper Writing. Also, it covers all the concepts which involved in writing the Research Paper.

9 Learning objectives:

The objectives of the course are:

1. The students are able to recognize the steps involved in doing research work.
2. The students will be able to collect data using various media and using the best possible sample available.
3. The students would learn to propose their Hypothesis and build models for the problem.
4. The students would be able to correctly document their findings in the form of a report.

10.Course Outcomes:

After completion of this course, the student will be able to:

1. Recognize the various steps involved in research.
2. Collect data from samples, Examine and analyze the data.
3. Develop models for problems.
4. Explain the entire process in the form of a report.

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction**

Research - Types, Research process and steps, Hypothesis, Research Proposal and aspects. Research Design- Need, Problem Definition, Variables, Research Design concepts, Literature survey and review, Research design process, Errors in research. Research Modeling- Types of models, model building and stages, Data consideration.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Sampling**

Sampling and data collection- Techniques of sampling, Random, Stratified, Systematic, Multistage-sampling, Primary and secondary sources of data. Design of questionnaire.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Data Collection and Experiments**
Design of Experiments- Objectives, strategies, Factorial experimental design, designing engineering experiments, basic principles-replication, randomization, blocking, guidelines for design of experiments.		
Unit - 4	**Number of lectures = 12**	**Title of the unit: Models and Hypothesis & Report writing**
Single factor experiment- Hypothesis testing, analysis of Variance component (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effect model, estimation of variance components, Model adequacy checking. Structure and components of Scientific Reports, Types of Report, Technical Reports and Thesis; Different steps in the preparation – Layout, structure and Language of typical reports; Illustrations and tables, Bibliography, Referencing and foot notes.		

12.Brief Description of self learning / E-learning component

https://research-methodology.net/research-methodology/

https://gradcoach.com/what-is-research-methodology/

13.Books Recommended

Text Book:

1. Research Methodology – Methods and Techniques – C.R. Kothari, New Age International, New Delhi, 2004.

Reference Book:

1. Design and Analysis of Experiments – Douglas C. Montgomery, Wiley India, 8th Edition, 2012.

2. Practical Research: Planning Design – Paul D. Leddy, London, 1980.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Research Methodology and IPR Lab**	**L**	**T**		**P**	
3. Subject Code		0	0		2	
4. Type of Subject		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	**Research Methodology and IPR**	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

1. Learning objectives:

The objectives of the course are:

2. The students are able to recognize the steps involved in Identifying research problem.
3. The students will be able to collect data using various media and using the best possible sample available.
4. The students would learn to propose their Hypothesis and build models for the problem.
5. The students would be able to correctly document their findings in the form of a report.

Outcomes:

On completion of this course, the students will be able to

1. Choose the topic for writing research paper.
2. Develop models for problems.
3. The students would learn to write the research paper.

7. Lab Content

Sr. No.	Title	CO covered
1	How to choose topic for research	1,2
2	How to collect data for the particular research problem	1,2
3	Writing Abstract	1,2
4	Writing Literature review	1,2
5	Explaining and writing methodology	1,2
6	How to analyze the data collected	1,2
7	Presentation of analysis and findings	1,2
8	How to write result and conclusion	2,3
9	References in research article	2,3

Departmental Electives

1. Name of the Department: Civil Engineering						
2. Course Name	Emerging Trends in Waste Treatment	**L**	**T**	**P**		
3. Course Code		3	0	4		
4. Type of Course (use tick mark)		**Core (✔)**	**PE()**	**OE()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem (✔)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 00**			

8. Brief Syllabus

This course deals in the latest techniques involved in the treatment of hazardous waste. Also, deals in the disposal ways of waste. Waste Characterization and Source Reduction, Storage, Collection and Transport of Wastes are the part of it to gain insight the waste treatment. This will aware the learner about the remedial measures and waste processing technologies as well.

9. Learning objectives:

1. To impart knowledge and skills in the collection, storage, transport, treatment, disposal and recycling options for solid wastes including the related engineering principles, design criteria, methods and equipment's.
2. To impart understanding about the landfills and leachates, at dumping sites.
3. To decipher the storage and transport mechanisms involve in solid wastes management.
4. To aware the learner about the waste processing technologies.
5. To aware the student about the Regulatory frame works for solid waste handling.

10. Course Outcomes (COs):

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

1. Understand the characteristics of different types of solid and hazardous wastes and the factors affecting variation.
2. Define and explain important concepts in the field of solid waste management and suggest suitable technical solutions for treatment of municipal and industrial waste.
3. Understand the role legislation and policy drivers play in stakeholders' response to the waste and apply the basic scientific principles for solving practical waste management challenges.
4. Able to apply the basics of solid waste management strategies in everyday life.
5. Able to work at municipal waste processing sites and provide input for efficient management of solid wastes.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Sources, Classification and Regulatory Framework**

Introduction to Sources of Solid and hazardous wastes, with types as, biomedical wastes, nuclear wastes, lead acid batteries, electronic wastes, plastics and fly ash. Need for solid and hazardous waste management, Salient features of Indian legislations on management and handling of municipal waste. Elements of integrated waste management, Public Private Participation for waste management.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Waste Characterization, Source Reduction and Waste Disposal**

Waste composition: physical, chemical and biological properties of solid wastes, Hazardous waste characteristics, TCLP tests, Waste sampling and characterization, Reduction of wastes, Recycling and reuse. Waste disposal options: Disposal in landfills, Landfill Classification and types, Aspects of sanitary landfills, secure landfills and landfill bioreactors, Leachate and landfill gas management. Landfill remediation.

Unit - 3	**Number of lectures = 12**	**Title of the unit: Storage, Collection and Transport of Wastes**

Handling and Segregation of wastes at source, Storage and collection of municipal solid wastes, Analysis of Collection systems, Need for transfer and transport, Transfer stations, Optimizing waste allocation: compatibility, storage, labeling and handling of hazardous wastes, hazardous waste transportation methods.

Unit - 4	**Number of lectures = 8**	**Title of the unit: Waste Processing Technologies**

Objectives of Waste processing, Processing technologies: biological and chemical conversion technologies, Methods and controls of Composting, Thermal conversion technologies and energy recovery incineration, Solidification and stabilization of hazardous wastes, Treatment of biomedical wastes. Exposure to applications based on current industrial trends.

11. Books Recommended (5 References)

1. George T., Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management, Mc-Graw Hill International edition, New York, 1993.

2. Michael D. La Grega, Philip L Buckingham, Jeffrey C. E vans and "Environmental Resources Management, Hazardous waste Management", Mc-Graw Hill International edition, New York, 2001.

3. CPHEEO, “Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000.

4. Vesilind P. A., Worrell W and Reinhart, "Solid waste Engineering", Thomson Learning Inc., Singapore, 2002.

5. Paul T Williams, "Waste Treatment and Disposal", Wiley, 2005

1. Name of the Department: Civil Engineering							
2. Course Name	Emerging Trend in Waste Treatment Lab	L	T	P			
3. Course Code		0	0	4			
4. Type of Course (use tick mark)		Core ()	**PE(√)**		**OE()**		
5. Pre-requisite (if any)		Odd ()	Either Sem ()	Odd (√)	Either Sem ()	Every Sem **()**	
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 28**				

7. Brief Syllabus:

This laboratory course work emphasis on development of basic knowledge of the learner toward waste management system. In addition to that, this course will inculcate the understanding about parameters involved in the waste management.

8. Learning objectives:

1. Understand the processes for determination of waste management variables.
2. To gain insight into basic concept of waste management.
3. Understand the parameter involved in determination of waste management variables.

7. Course Outcomes (COs):

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

1. Apply the methodologies involved in the determination of waste management.

2. Apply the understanding of analytical techniques toward parameters that a waste management processes.

8. Unit wise detailed content

1. To demonstrate the waste management practices.

2. To demonstrate the chemical properties of solid waste.

3. To demonstrate the methods for treatment of biomedical wastes.

4. To demonstrate the recycling and reuse methodologies of solid waste.

5. To demonstrate the methods and controls for Composting.

6. Determination of suspended, settleable, volatile and fixed solids

7. To demonstrate the solid waste sources at different sites.

8. To demonstrate the solid waste at river sites.

9. To demonstrate the solid waste at land sites.

10. To demonstrate the solid waste at mountain sites.

1. Name of the Department: Civil Engineering							
2. Course Name	Urban Environmental Quality Management	**L**	**T**		**P**		
3. Course Code		3	0		4		
4. Type of Course (use tick mark)		**Core (✔)**	**PE()**		**OE()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem (✔)	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 42		**Tutorials = 0**	**Practical = 28**				

8. Brief Syllabus

Students learn procedures to establish environmental quality monitoring. They are able to choose the appropriate type of environmental monitoring, both in terms of choice of sampling locations and measured parameters, as well as in terms of choice of medium. Based on practical examples, they realize the importance of proper sampling, data quality assurance and learn about the basic equipment for monitoring. Also, students are able to explain differences in the planning and implementation of environmental monitoring at local, national and international level.

9. Learning objectives:

1. To teach students the general procedure for collection and preservation of samples of water and wastewater.
2. To provide standard methodologies for sampling and analysis of environment at whole and its constituents like water, wastewater, air and soil.
3. To teach advance analytical methods for environmental quality monitoring

10. Course Outcomes (COs):

At the end of the course, the student will be able to undergo

1. Schedule field studies and other data acquisition activities to be considered for compliance
2. Use a monitoring approach consisting of rapid assessment or screening studies at site.
3. Supervise monitoring techniques of various environmental parameters.
4. Generate monitoring data relevant to decision making process.
5. Manage and report environmental quality data in a way that is meaningful and understandable to intended audience.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit:** THEORY OF ENVIRONMENTAL PLANNING

Concepts of Environmental Planning, History of Environmental Planning, Development of habitat patterns, settlement structure and form in response to environmental challenges, Concepts of Ecology and Ecosystem, Resource analysis for various ecosystems and development imperatives (land, geology, soil, climate, water, vegetation) characteristics, exploitation, causative factors for degradation, analytical techniques, Urban Ecosystem.

Unit - 2	**Number of lectures = 12**	**Title of the unit:** ENVIRONMENTAL DESIGN

Design as a determinant of Environmental quality, Evolution of Environmental design, theories and practice of design, Criteria of Urban Environmental design issues-pedestrian-vehicular conflict, City Centre Environment, Housing areas, dereliction, environmental upgradation programmes , Urban climatology, effects of thermal pollution, factors causing heat sink effects, direct radiation, climatic effects on Urban areas, control techniques, Climate Change and City Planning.

Unit - 3	**Number of lectures = 12**	**Title of the unit:** ENVIRONMENTAL MONITORING AND ASSESSMENT
Air Pollution-sources, causes/pollutants and their effects, emission sources, vehicular emissions, techniques of monitoring of emissions, emission standards, and ambient air quality. Concepts of relevant meteorological parameters, and interpolation of data, wind system measurement, turbulence; mixing height, plume use, dispersion and dispersion models, Water Pollution – sources, water quality tests, minimum standards of disposal (for different uses), performance criteria		
Unit - 4	**Number of lectures = 8**	**Title of the unit: Advanced Analytical Methods**
Working principles of Spectrophotometric methods, Nephelometric methods; Basics & Applications of Atomic Absorption Spectroscopy, Ion Chromatography, High performance liquid chromatography, CHNO/S Analyzer, TOC analyzer, Flame Photometer. Exposure to applications based on current industrial trends.		
12. Books Recommended (3 Text Books + 2-3 Reference Books)		
i) Metcalf and Eddy, (2003), Wastewater Engineering Treatment and Reuse, 4th edition, Tata McGraw Hill Education Private Limited, ISBN:978		
ii) S. K. Garg (2010), Sewage Disposal and Air Pollution Engineering, Khanna Publishers, ISBN:978		
iii) M. N. Rao, H. V. N. Rao, (2007), Air Pollution, Tata McGraw Hill Publishing Company Limited, ISBN:978		
iv) Stanley E. Manahan (2005), Environmental Chemistry, 8th Edition, CRC Press, ISBN: 978		
v) Clair N Sawyer, Perry L. McCarty and Gene F. Parkin (2002), Chemistry for Environmental Engineering and Science, McGraw		

1. Name of the Department: Civil Engineering							
2. Course Name	Urban Environmental Quality Management Lab	L	T		P		
3. Course Code		0	0		4		
4. Type of Course (use tick mark)		Core ()	**PE(√)**		**OE()**		
5. Pre-requisite (if any)		Odd ()	Either Sem ()	Odd (√)	Either Sem ()	Every Sem **()**	
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 28**				

7. Brief Syllabus:

This laboratory course work emphasis on development of basic knowledge of the learner toward environment system. In addition to that, this course will inculcate the understanding about parameters involved in the environment monitoring.

8. Learning objectives:

1. Understand the processes for determination of environment system.
2. To gain insight into basic concept of environment quality management.
3. Understand the parameter involved in determination of environment quality management variables.

7. Course Outcomes (COs):

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

1. Apply the methodologies involved in the determination of environment quality monitoring.

2. Apply the understanding of analytical techniques toward parameters that influences environment monitoring.

8. Unit wise detailed content

1. Familiarization with relevant instruments/equipments and procedures (High Volume Sampler, Handy Sampler, Noise Meter, Spectrophotometer etc)

2. TSPM, RSPM, SO2, NOX, Stack Monitoring, Noise Level Measurements etc.

3. Familiarization with relevant instruments/equipments and procedures (Flame Photometer, Water Testing Kit, Digital pH meter, BOD Incubator, Dissolved Oxygen Meter)

4. Alkalinity, Amonical Nitrogen, BOD, COD, DO, Coliform, Fluoride, Nitrate-Nitrogen, pH, SAR, etc

5. Familiarization with relevant instruments/equipments and procedures (Soil Testing Kit) pH, EC, Soil Moisture, Phosphate, Potassium, Sodium, etc.

7. Familiarization with relevant instruments/equipments and procedures (Electronic Weather Station)

8. Temperature, Relative Humidity, Rainfall, Wind Direction and Speed, etc.

11. Name of the Department: Civil Engineering						
12. Course Name	Environmental Quality Monitoring	**L**	**T**		**P**	
13. Course Code		3	0		4	
14. Type of Course (use tick mark)		**Core (✔)**	**PE()**		**OE()**	
15. Pre-requisite (if any)		**16. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem (✔)	Every Sem ()
17. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 28**			

18. Brief Syllabus

Students learn procedures to establish environmental quality monitoring. They are able to choose the appropriate type of environmental monitoring, both in terms of choice of sampling locations and measured parameters, as well as in terms of choice of medium. Based on practical examples, they realize the importance of proper sampling, data quality assurance and learn about the basic equipment for monitoring. Also, students are able to explain differences in the planning and implementation of environmental monitoring at local, national and international level.

19. Learning objectives:

4. To teach students the general procedure for collection and preservation of samples of water and wastewater.
5. To provide standard methodologies for sampling and analysis of environment at whole and its constituents like water, wastewater, air and soil.
6. To teach advance analytical methods for environmental quality monitoring

20. Course Outcomes (COs):

At the end of the course, the student will be able to undergo

6. Schedule field studies and other data acquisition activities to be considered for compliance
7. Use a monitoring approach consisting of rapid assessment or screening studies at site.
8. Supervise monitoring techniques of various environmental parameters.
9. Generate monitoring data relevant to decision making process.
10. Manage and report environmental quality data in a way that is meaningful and understandable to intended audience.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: General Sampling and Analytical Techniques**

General principles for collection of representative samples, frequency of sampling, validation, interpretation and analysis of data, various statistical techniques, quality control, assessment and management techniques.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Methods for Physicochemical Analysis of Water/ Wastewater**

Gravimetric methods for solids analysis in water and wastewater, Determination of acidity, alkalinity and turbidity of samples and nitrogen, phosphorus content. Analysis of common cations and anions in water/wastewater through various chemical techniques, Determination of Basics of Precipitation titrations, Complexometric titrations. Working principles of Electrodes and Different types of

electrodes.		
Unit - 3	**Number of lectures = 12**	**Title of the unit: Biological Methods, Microbiology & Air Pollution Measurements**
Sampling techniques for air pollution measurements; analysis of particulates and common chemical air pollutants, Analysis methods of oxides of nitrogen, Sulphur, carbon monoxide, hydrocarbon and poly-aromatic hydro carbons. BOD & COD, MPN test for microbial pollution, plate counts; confirmatory tests for various microbiological agents.		
Unit - 4	**Number of lectures = 8**	**Title of the unit: Advanced Analytical Methods**
Working principles of Spectrophotometric methods, Nephelometric methods; Basics & Applications of Atomic Absorption Spectroscopy, Ion Chromatography, High performance liquid chromatography, CHNO/S Analyzer, TOC analyzer, Flame Photometer. Exposure to applications based on current industrial trends.		
12. Books Recommended (3 Text Books + 2-3 Reference Books)		
i) Metcalf and Eddy, (2003), Wastewater Engineering Treatment and Reuse, 4th edition, Tata McGraw Hill Education Private Limited, ISBN:978		
ii) S. K. Garg (2010), Sewage Disposal and Air Pollution Engineering, Khanna Publishers, ISBN:978		
iii) M. N. Rao, H. V. N. Rao, (2007), Air Pollution, Tata McGraw Hill Publishing Company Limited, ISBN:978		
iv) Stanley E. Manahan (2005), Environmental Chemistry, 8th Edition, CRC Press, ISBN: 978		
v) Clair N Sawyer, Perry L. McCarty and Gene F. Parkin (2002), Chemistry for Environmental Engineering and Science, McGraw		

9. Name of the Department: Civil Engineering						
10. Course Name	Environment Quality Monitoring Lab	L	T	P		
11. Course Code		0	0	4		
12. Type of Course (use tick mark)		Core ()	**PE(√)**		**OE()**	
13. Pre-requisite (if any)		Odd ()	Either Sem ()	Odd (√)	Either Sem ()	Every Sem **()**
14. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

7. Brief Syllabus:

This laboratory course work emphasis on development of basic knowledge of the learner toward environment system. In addition to that, this course will inculcate the understanding about parameters involved in the environment monitoring.

8. Learning objectives:

1. Understand the processes for determination of environment system.
2. To gain insight into basic concept of environment quality management.
3. Understand the parameter involved in determination of environment quality management variables.

15. Course Outcomes (COs):

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

1. Apply the methodologies involved in the determination of environment quality monitoring.
2. Apply the understanding of analytical techniques toward parameters that influences environment monitoring.

16. Unit wise detailed content

1. Determination of pH & Alkalinity.
2. Determination of Hardness of water.
3. To determine the phosphate level in water sample.
4. To determine the Sulphates level in water sample.
5. To determine the Chloride Content in Water
6. Determination of Phosphates and Sulphates
7. Determination of Iron and Fluoride
8. Determination of Optimum Coagulant dosage
9. Determination of residual chlorine and available chlorine in bleaching powder
10. Determination of Oil and Grease

SGT University, Chandu-Budhera, Gurugram
Faculty of Engineering & Technology
Department of Civil Engineering

M. Tech. **Structural Engineering**

Scheme & Syllabus (2021-22)

Vision of SGT University

"Driven by Research & Innovation, we aspire to be amongst the top ten Universities in the Country by 2022"

Structural Engineering
First Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Advance Pre-Stressed Concrete Design	3	0	0	3	60	40	100
2		Structural Dynamics	3	0	0	3	60	40	100
3		Matrix Methods of Structural Analysis	3	0	0	3	60	40	100
4		Design of Concrete Structural Systems	3	0	0	3	60	40	100
5		Matrix methods of Structural Analysis Lab (STAAD PRO)	0	0	2	1	40	60	100
6		Design of Concrete and Structural Systems Lab (STAAD PRO)	0	0	2	1	40	60	100
7		Value Added Courses-I	2	0	0	2	60	40	100
8		Seminar	0	0	2	1	00	100	100
		Total	**14**	**0**	**6**	**17**	**380**	**420**	**800**

Second Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Finite Element Analysis	3	0	0	3	60	40	100
2		Theory of Elasticity and Plasticity	3	0	0	3	60	40	100
3		Limit State Design of Steel Structures	3	0	0	3	60	40	100
4		Earthquake Resistant Design	3	0	0	3	60	40	100
5		Structural Engineering lab (CASTING)	0	0	2	1	40	60	100
6		Finite Element Analysis Lab (STAAD PRO)	0	0	2	1	40	60	100
7		Seminar	0	0	2	1	00	100	100
		Total	**12**	**0**	**6**	**15**	**320**	**380**	**700**

Third Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Theory & Design of Plate and Shell	3	0	0	3	60	40	100
2		Research Methodology & IPR	3	0	0	3	60	40	100
3		Department Electives-XIII	3	0	0	3	60	40	100
4		Department Electives-XIV	3	0	0	3	60	40	100
5		Department Electives-XV	3	0	0	3	60	40	100
6		Research Methodology & IPR Lab	0	0	2	1	40	60	100
7		Department Electives Lab-XIII	0	0	2	1	40	60	100
8		Department Electives Lab-XIV	0	0	2	1	40	60	100
9		Department Electives Lab-XV	0	0	2	1	40	60	100
10		Value Added Courses-II	2	0	0	2	60	40	100
		Total	**17**	0	**8**	**21**	520	480	1000

Fourth Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Dissertation	-	-	**20 W**	**20**	100	-	100
		Total	-	-	**20 W**	**20**	**100**	-	**100**

Departmental Electives

S. No.	Specialization	Departmental Elective XIII	Departmental Elective XIV	Departmental Elective XV
1	**Structural Engineering**	Pre-Fabricated Structures 3-0-2 (4) / Design of Industrial Structures 3-0-2 (4)	Maintenance & Rehabilitation of Structures 3-0-2 (4) / Design of Bridges 3-0-2 (4)	Composite Structures 3-0-2 (4) / Design of Tall Buildings 3-0-2 (4)

1.Name of the Department	CIVIL ENGINEERING					
2.Course Name	Advanced Pre-stressed Concrete Structures	L	T		P	
3.Course Code		3	0		0	
4.Type of Course (use tick mark)		Core (✓)	PE-()		OE()	
5.Pre-requisite (if any)	RCC, PSC	**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem()
7.Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials = 00	Practical=00			

8.Brief Syllabus:

In this course, student will learn about Pre-stressed concrete. Its advantages, different methods and its application. Different types of losses in pre-stressed concrete structure and design.

9.Learning objectives:

1. This subject is taught to give the concepts of pre-stress.

2. This subject is taught to give the concepts of design the pre-stressed concrete members.

10.Course Outcomes

On completion of this course, the students will be able to

1. Know the concepts, methods and materials of pre-stressing systems.
2. Design the pre-stressed concrete members.
3. Calculate the deflections in pre-stressed concrete members.
4. Design anchorage zones and composite pre-stressed concrete members.

11.Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Materials and losses in pre stress**

Difference between reinforced and pre-stressed concrete – Principles of pre-stressing – Methods and systems of pre-stressing – Principles of pre-stressing – Classification of pre-stressed concrete structures – Materials – High strength concrete and High strength steel – Stress-strain diagram - Losses in pre-stress.

Unit - 2	**Number of lectures = 11**	**Design of pre-stressed concrete beams**

Design of prismatic pre-stressed concrete members for bending at service load.

Unit - 3	**Number of lectures = 11**	**Deflections**

Simple cable profiles – Calculation of deflections – Design of beams for shear and torsion at working and ultimate loads.

Unit - 4	**Number of lectures = 08**	**Anchorage design**

Design of Anchorage zone by Guyon's method – Concept of Magnel's method – IS: 1343 recommendations.

13.Books Recommended

TEXT BOOKS

1. Krishna Raju.N, (2010), Problems & Solutions Pre-stressed Concrete, Second Edition, CBS Publishers, ISBN-13: 9788123907154.

REFERENCE BOOKS

1. Dayarathnam P, (1996), Pre-stressed Concrete Structures, Fifth Edition, Oxford & IBH – Pubs Company, ISBN-13: 9788120400450.
2. Sinha N. C and Roy S. K., Fundamentals of Pre-stressed Concrete, Third Edition, S.Chand & Company, ISBN-13: 9788121924276.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	Structural Dynamics	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical(assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			

Brief Syllabus: Study of Single degree of freedom system (SDOF Systems) **,** Study of structure under Harmonic and Impulse Loading**,** Vibration Analysis**,** Study of multi degree of freedom system (MDOF Continuous Systems).

8. Learning objectives:

1. To find the behaviour of structures subjected to dynamic loads such as wind, earthquake And blast loads.
2. To study different dynamic analysis procedures for calculating response of structures.
3. To study different mode shapes of structures.

9. Course Outcomes:

1. Solve the problems on single degree of freedom system.
2. Understanding concepts of harmonic loading and impulse loading and related analysis.
3. Understanding the concepts of multi degree of freedom system.
4. Evaluate the mode shapes for different structures.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: SDOF Systems**

Single Degree of Freedom System - Introduction - Alembert's principle - Mathematical models for SDOF systems - Free vibration - Damped and undamped - Critical damping - Logarithmic decrement.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Harmonic and Impulse Loading**

Response to Harmonic Loading and Impulse Loading - Analysis of undamped system - damped system - general dynamic loading.

Unit - 3	**Number of lectures =10**	**Title of the unit: Vibration Analysis**

Vibration Analysis - Rayleigh's method - Approximate Analysis - Improved Rayleigh method.

Unit - 4	**Number of lectures = 12**	**Title of the unit: MDOF Systems**

Multi degree of Freedom System - Evaluation of structural property matrices - Mode shape - Orthogonality conditions - Undamped and damped system - Mode superposition method.

11. Brief Description of self learning / E-learning component

1. https://swayam.gov.in/course/3697-structural-dynamics
2. https://onlinecourses.nptel.ac.in/noc16_ce08/course
3. https://www.iitk.ac.in/nicee/wcee/article/WCEE2012_3202.pdf

12. Books Recommended

TEXT BOOKS

1. Mario Paz, (2004), Structural Dynamics - Theory and Computation, Second Edition, CBS Publishers, ISBN-13: 9788123909783.

REFERENCE BOOKS

1. J. Humar, (2012), Dynamics of Structures, Third Edition, CRC Press, ISBN-13: 9780415620864.
2. Anil K. Chopra, (2003), Dynamics of Structures - Theory and Applications to Earthquake Engineering, Third Edition, Pearson India, ISBN-13: 9788131713297.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	**Matrix Methods of Structural Analysis**	**L**	**T**		**P**	
3. Course Code		3	0		2	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Structural Analysis	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials = 00**	**Practical =**			

Brief Syllabus:

This course mainly deals with matrix analysis of structures. It begins with a review of the basic concepts of structural analysis and matrix algebra, and shows how the latter provides an excellent mathematical framework for the former. This is followed by detailed descriptions, and demonstrations through many examples, of how matrix methods can be applied to linear static analysis of skeletal structures (plane and space trusses; beams and grids; plane and space frames) by the stiffness method, and also the flexibility method.

8. Learning objectives:

1. The course is intended to teach the basic concepts of indeterminate structures, static indeterminacy and kinematic indeterminacy.
2. Different matrix methods will be taught and their uses will be explained in the class.

9. Course Outcomes:

1. Solve different structures by flexibility matrix method and stiffness matrix method.
2. Visualize and analyze space trusses and space frames.
3. Understand the effect of settlement of supports.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction to flexibility matrix and stiffness matrix**

Concept of static indeterminacy and kinematic indeterminacy - concept of flexibility matrix and stiffness matrix - properties of matrices - coordinate system - solution of simple problems - derivation of stiffness matrix of beam element from strain energy.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Analysis of plane structures by flexibility matrix method**

Analysis of continuous beam, plane truss and plane frame by flexibility matrix method - Internal forces due to thermal expansion and lack of fit – effect of settlement of supports.

Unit - 3	Number of lectures = 10	Title of the unit: Analysis of plane structures by stiffness matrix method
Analysis of continuous beam, plane truss and plane frame by stiffness matrix method - Internal forces due to thermal expansion and lack of fit – effect of settlement of supports.		
Unit - 4	**Number of lectures = 12**	**Title of the unit: Space truss**
Analysis of space truss by flexibility matrix method and stiffness matrix method.		

11. Books Recommended

TEXT BOOKS

1. Pundit G.S. & Gupta S.P., (2008), Structural Analysis (A matrix approach), Second Edition, Tata McGraw Hill Education, ISBN-13: 9780070667358.

REFERENCE BOOKS

1. J. S. Przemieniecki, (1985), Theory of Matrix Structural Analysis, New Edition, Dover Publication, ISBN-13: 97804866494.
2. Richard B. Nelson, Lewis P. Felton, (1997), Matrix Structural Analysis, John Wiley & Sons, Imported Edition, ISBN-13: 9780471123248.

1. Name of the Department		**Civil Engineering**				
2. Course Name	**Design of Concrete Structural Systems**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 00**			

8. Brief Syllabus : Student will study about limit state design method, Deep Beams, Flat Slab, Columns and shear walls and framed buildings

9. Learning objectives:

1. This subject is intended to teach the concept of advanced concrete design.
2. The practical aspects of various designs of structure will be explained in the classes

10. Course Outcomes (COs): On completion of this course, the students will be able to

On completion of this course, the students will be able to

1. Analyse and design the deep beams.
2. Design shears wall buildings and flat slabs.
3. Design slender columns.

11. Unit wise detailed content

Unit-1	**Number of lectures =11**	**Title of the unit: Limit state design of beams**

Limit state analysis and design of beams in flexure - Behaviour of reinforced concrete members in bending - Plastic hinge – Rotation capacity – Factors affecting rotation capacity of a section – Plastic moment – Moment curvature relationship – Redistribution of moments.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Deep Beams**

Limit state design of deep beams

Unit – 3	**Number of lectures = 11**	**Title of the unit: Flat Slab**

Design of Flat Slabs using BIS 456

Unit – 4	**Number of lectures = 10**	**Title of the unit: Columns and shear wall buildings**

Design of slender column subjected to combined bending moment & axial force using SP: 16

12. Brief Description of self learning / E-learning component

The students will be encouraged to learn using the SGT ELearning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

Journal papers; Patents in the respective field.

13. Books Recommended

TEXT BOOKS

1. Krishnaraju N., (2013), Advanced Reinforced Concrete Design, Second Edition, CBS Publisher, ISBN-13: 9788123912257.

REFERENCE BOOKS

1. P. C. Varghese, (2009), Advanced Reinforced Concrete Design, Second Edition, Phi Learning Pvt. Ltd., ISBN-13: 9788120327870.
2. M. L. Gambhir, (2009), Design of Reinforced Concrete Structures, First Edition, Phi Learning Pvt. Ltd., ISBN-13: 9788120331938.
3. P. Dayaratnam, (2011), Design of Reinforced Concrete Structures, Fourth Edition, Oxford & IBH – Pubs Company, ISBN-13: 9788120414198.
4. B. C. Punmia, Ashok Kr. Jain, Arun Kr. Jain, (2006), R. C. C. Designs, Laxmi Publication (P) Ltd., ISBN-13: 9788131809426.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	Matrix methods of Structural Analysis Lab (STAAD PRO)	**L**	**T**		**P**	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Structural Analysis	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =00		**Tutorials = 00**	**Practical = 28**			

Brief Syllabus:

This course mainly deals with matrix analysis of structures. It begins with a review of the basic concepts of structural analysis and matrix algebra, and shows how the latter provides an excellent mathematical framework for the former. This is followed by detailed descriptions, and demonstrations through many examples, of how matrix methods can be applied to linear static analysis of skeletal structures (plane and space trusses; beams and grids; plane and space frames) by the stiffness method, and also the flexibility method.

8. Learning objectives:

1. The course is intended to teach the basic concepts of indeterminate structures, static Indeterminacy and kinematic indeterminacy.
2. Different matrix methods will be taught and their uses will be explained in the class**.**

9. Course Outcomes:

1. Solve different structures by flexibility matrix method and stiffness matrix method.
2. Visualize and analyze space trusses and space frames.
3. Understand the effect of settlement of supports.

10. Unit wise detailed content

1. Analysis of propped cantilever beam
2. Analysis of two span continuous beams
3. Analysis of statically determinate plane truss
4. Analysis of statically indeterminate plane truss
5. Analysis of kinematically indeterminate plane truss
6. Analysis of one bay – one storey plane frame
7. Analysis of multi bay – multi storied plane frame
8. Analysis of space truss
9. Analysis of space frame

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Design of Concrete and Structural Systems Lab (STAAD PRO)**	**L**	**T**		**P**	
3. Subject Code		0	0		2	
4. Type of Subject		**Core (✓)**	**PE()**		**OE()**	
Pre-requisite (if any)	**Design of Concrete Structural Systems**	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical, Assuming 14 weeks in semester						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

7. Brief Syllabus :

Student will study about limit state design method, Beams, Slab, Columns and framed buildings & design of these by using STAAD Pro.

8. Learning objectives:

1. This subject is intended to teach the concept of advanced concrete design.
2. The practical aspects of various designs of structure will be explained in the classes.

9. Outcomes:

On completion of this course, the students will be able to

1. Analyse and design the beams.
2. Design shears wall buildings and slabs.
3. Design of slender columns.

10. Lab Content

Sr. No.	**Title**
1	Design of propped cantilever RCC beam
2	Design of two span continuous RCC beams
3	Analysis and design one bay – one storey plane frame
4	Analysis and design of multi bay – multi storied plane frame
5	Analysis and design of space frame
6	Case study

Second Semester

1. Name of the Department – Civil Engineering						
2. Course Name	**Finite Element Analysis**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			

8. Brief Syllabus

Basics of finite element analysis, study of different methods linear equations and matrix method, study by displacement models, analysis of structure such as frame and truss by finite element analysis, Basic study of Iso-parametric elements.

9. Learning objectives:

1. The course is intended to teach the basic concepts of finite element analysis.
2. The practical application of finite element method and their advantages and disadvantages Will be explained in the class.

10. Course Outcomes (COs):

On completion of this course, the students will be able to

1. Calculate strain-displacement matrix and stress-strain matrix.
2. Know the analysis procedure and the matrix operations.
3. Know the concepts of isoperimetric elements.

11. Unit wise detailed content

Unit-1	**Number of lectures =10**	**Introduction to FEM**

Introduction - Background - General description of the method – Analysis procedure - Stress and strain vectors – Stain displacement equations – Linear constitutive equations – Overall stiffness matrix – Overall load matrix - Analysis of beams.

Unit – 2	**Number of lectures = 10**	**Displacement models**

Theory of Finite Element - Concept of an element - Various elements shapes - Displacement polynomials - Convergence requirements - Shape functions - Element strains and stresses - Direct formulation of element stiffness matrix for beam element and plane truss element

Unit – 3	**Number of lectures = 10**	**Analysis of structures by FEM**

Overall Problems - Discretization of a body or structure - Minimization of band width - Construction of stiffness matrix and loads for the assemblage - Boundary conditions - Analysis of plane truss, space truss, plane frame.

Unit – 4	Number of lectures = 12	Plane stress and plane strain
Plane stress - Plane strain - CST, LST & QST elements – Rectangular element - solutions of problems		

12. Books Recommended

TEXT BOOKS

1. C. S. Krishnamoorthy, (2008), Finite Element Analysis, Second Edition, Tata McGraw Hill Education Pvt. Ltd., ISBN-13: 978007462100.

REFERENCE BOOKS

1. Cook R. D., Malkas D. S. & Plesha M. E, (2008), Concepts and applications of Finite Element analysis, Fourth Edition, Wiley India Pvt. Ltd., ISBN-13: 9788126513369.
2. Reddy, (2005), An Intro. To The Finite Element Methods, Third Edition, Tata McGraw Hill Education Pvt. Ltd., ISBN-13: 9780070607415.
3. Singiresu S. Rao, (2010), The Finite Element Method in Engineering, Fifth Edition, Elsevier Science, ISBN-13: 9780080952048.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	**Theory of Elasticity and Plasticity**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Strength of Materials, Engg. Mechanics	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical =00**			

8. Brief Syllabus: Structural analysis is the determination of the effects of loads on physical structures and their components. Structures subject to this type of analysis include all that must withstand loads, such as buildings, bridges, vehicles, machinery, furniture, attire, soil strata, prostheses and biological tissue.

Learning objectives:

1. This subject is taught to impart knowledge on theory of elasticity and plasticity.
2. To impart knowledge on Equilibrium equations.
3. To impart knowledge on Plasticity.

Course Outcomes:

On completion of this course, the students will be able to

1. Analyse the stresses and strains for two dimensional and three dimensional elements.
2. Understand the equilibrium and compatibility conditions.
3. Solve the problems on Torsion for different shaped bars.
4. Understand the concept of plasticity.

9. Unit wise detailed content

Unit-1	**Number of lectures = 11**	**Stresses and strains**

Analysis of Stress and Strain - Elasticity approach – Definition and notation of stress – Components of stress and strain – Generalized Hooke's law -Two dimensional Problems in Cartesian Coordinates - Plane stress and plain strain problems with practical examples - Equations of equilibrium and compatibility conditions in Cartesian coordinates – Airy's stress function - Bending of simply supported beams.

Unit - 2	**Number of lectures = 11**	**Axi-symmetric problems**

Two dimensional Problems in Polar Coordinates - Equations of equilibrium and compatibility conditions in polar coordinates – Axi-symmetrical problems - Thick cylinder under uniform pressure - Circular arc beams subjected to pure bending.

Unit - 3	**Number of**	**Prandle's membrane analogy**

	lectures = 10	
Torsion of circular shafts, St. Venant's Approach , torsion of non-circular sections, membrane analogy, narrow rectangular cross-section		
Unit - 4	**Number of lectures = 10**	**Introduction to plasticity**
Introduction to plasticity – Stress – Strain diagram – Plastic analysis – Yield criteria – St. Venant's theory – Von Mises criterion – Plastic work – Strain hardening.		

10. Books Recommended

TEXT BOOKS

1. Timoshenko and Goodier, (1970), Theory of Elasticity, Third Edition, McGraw Hill Professional, ISBN-13: 9780070858053.

REFERENCE BOOKS

1. Srinath, (2002), Advanced Mechanics of Solids, Third Edition, Tata McGraw Hill Pvt. Ltd., ISBN-13: 9780070139886.
2. D. Peric, E. A. de Souza Neto & D. R. J. Owen, (2011), Computational Methods for Plasticity, Wiley, ISBN-13: 9781119964544.

Name of the Department		CIVIL ENGINEERING				
1. Course Name	**Limit State Design of Steel Structures**	**L**	**T**		**P**	
2. Course Code		3	0		0	
3. Type of Course		**Core (✓)**	**PE()**		**OE()**	
4. Pre-requisite (if any)	Design of Steel Structure	**5. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			

7. Brief Syllabus:

Many civil engineering structures are made up of steel. Knowledge of designing and detailing of steel structures is very important for civil engineers in order to make structures safe and serviceable during its life span. Limit State design philosophy is currently used worldwide for design of steel structures and its various components. Also precise and correct detailing of structural drawing is necessary in order to get the correct behavior of structures and leads to smooth construction of structures. This course will provide detailed knowledge of design and detailing of steel structures as per Indian standards.

8. Learning objectives:

1. To know how to design and use the different types of steel structural elements.
2. To know about the plastic analysis of structures.
3. To know about design of light gauge steel structures.

Course Outcomes:

On completion of this course, the students will be able to

1. Design compression members.
2. Design light gauge steel structures.
3. Analyse the beams and portal frames.
4. Design joints and connections using riveted and welded connections.

9. Unit wise detailed content

Unit – 1	**Number of lectures = 10**	**Compression members**
Design of compression members – Axially – Uniaxial and biaxial bending - Design of base slab.		

Unit – 2	**Number of lectures = 12**	**Plastic Analysis**
Plastic Analysis of Structures – Introduction - Shape factors – Mechanisms - Plastic hinge - Analysis of beams and portal frames - Design of continuous beams.		

Unit – 3	**Number of lectures = 10**	**Light gauge sections**
Design of Light Gauge Steel Structures - Types of cross sections - Local buckling and lateral buckling		

- Design of compression and tension members – Beams - Deflection of beams.

Unit – 4	**Number of lectures = 10**	**Chimney**

Design of Chimney, Design of foundation of chimney.

10. Books Recommended

TEXT BOOKS

1. Dayarathnam. P., (1996), Design of Steel Structures, Second Edition, S. Chand and Publishers, ISBN-13: 0788121923200.

REFERENCE BOOKS

1. Duggal S. K., (2014), Limit State Design of Steel Structures, Second Edition, McGraw Hill, ISBN-13: 9789351343509.
2. Ramchandra, Virendra Gehlot, (2010), Limit State Design of Steel Structures: Based on IS: 800-2007 IN S. I. Units, Scientific Publishers, ISBN-13: 9788172336141.

1. Name of the Department	CIVIL ENGINEERING					
2. Course Name	Earthquake Resistant Design	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core (✓)	PE-()		OE()	
5. Pre-requisite (if any)	RCC	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials = 00	Practical = 10			

8.Brief Syllabus:

The aim of the course is to present to the students fundamental concepts of current seismic codes and technical seismology as well as the technical skills for the seismic design of structures and the evaluation of their seismic response.

9Learning objectives:

1. To impart the knowledge about the earthquake and its occurrence.
2. To know about the mathematical modeling of structures subjected to earthquakes and their behavior.

10.Course Outcomes:

On completion of this course, the students will be able to

1. Evaluate the behaviour of structures under dynamic loadings.
2. Know methodology for earthquake resistant design.
3. Design the buildings using capacity design concept.
4. Design the multi storied building using computer.

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Basic of Seismology**

Elements of Seismology - Definitions of magnitude – Intensity - Epicenter etc - General features of tectonics of seismic regions - Seismographs.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Design Philosophy**

Philosophy of earthquake resistant design, earthquake proof v/s earthquake resistant design, four virtues of earthquake resistant structures (strength, stiffness, ductility and configuration), seismic structural configuration, Introduction to IS: 1893 (Part I), IS: 875 (Part V). Seismic load: Seismic Coefficient Method – base shear and its distribution along height. Introduction to Response spectrum, IS code provisions.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Ductile Detailing**

Concepts of Ductile Detailing of various structural components as per IS: 13920 provisions, Strong Column weak beam concept.

Unit - 4	**Number of lectures = 12**	**Title of the unit: Capacity Based Design**

Capacity Based design-an approach for earthquake resistant design of soft storey RC Building, Earthquake resistant design of shear wall.

12.Brief Description of self learning / E-learning component

http://retrofit.teipir.gr/?course=earthquakeresistant-design-of-structures&lang=en

13.Books Recommended

TEXT BOOKS

1. Anil K. Chopra, (2011), Dynamics of Structures - Theory and Applications to Earthquake Engineering, Second Edition, Ingram International Inc., ISBN-13: 9780132858038.

REFERENCE BOOKS

1. PankajAgarwal and Manish Shrikhande, (2007), Earthquake Resistant Design of Structures, First Edition, Prentice-Hall India Pvt Ltd, ISBN-13: 9788120328921.
2. Gupta B. L., (2010), Principles of Earthquake Resistant Design of Structures & Tsunami, Standard Publishers & Distributors, ISBN-13: 9788180141485.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	**Structural Engineering Laboratory**	**L**	**T**		**P**	
3. Course Code		0	0		2	
4. Type of Course		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	None	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials = 00**	**Practical = 28**			

Brief Syllabus: The aim of the course is to present to the students fundamental concepts of current seismic codes and technical seismology as well as the technical skills for the seismic design of structures and the evaluation of their seismic response.

Learning objectives:

1. To teach students different types of testing of concrete structures.
2. To enable the students to know the behaviour of RCC structures.

Course Outcomes:

On completion of this course, the students will be able to

1. Design concrete mix for particular grade of concrete
2. Test concrete beams for various loading conditions
3. Perform non-destructive testing.

8. Books Recommended (3 Text Books + 2-3 Reference Books)

TEXT BOOKS

1. Krishnaraju N., (2013), Advanced Reinforced Concrete Design, Second Edition, CBS Publisher, ISBN-13: 9788123912257.

REFERENCE BOOKS

1. P. C. Varghese, (2009), Advanced Reinforced Concrete Design, Second Edition, Phi Learning Pvt. Ltd., ISBN-13: 9788120327870.
2. M. L. Gambhir, (2009), Design of Reinforced Concrete Structures, First Edition, Phi Learning Pvt. Ltd., ISBN-13: 9788120331938.
3. P. Dayaratnam, (2011), Design of Reinforced Concrete Structures, Fourth Edition, Oxford & IBH – Pubs Company, ISBN-13: 9788120414198.
4. B. C. Punmia, Ashok Kr. Jain, Arun Kr. Jain, (2006), R. C. C. Designs, Laxmi Publication (P) Ltd., ISBN-13: 9788131809426.

Lab component components

Sr. No.	Title	CO covered
1	To determine the compressive strength of fibre reinforced concrete by testing cubes specimen.	1,2,3
2	Casting and testing of simply supported RCC beams for flexural failure.	2

3	Casting and testing of simply supported RCC beams for shear failure.	2
4	To determine tensile strength on a steel reinforcement bar.	2
5	To determine shear strength of steel bar under double shear.	2,
6	To conduct bending test of I-section steel beam.	3
7	To conduct bending test of steel channel section.	3
8	To study rebound hammer test on concrete blocks.	2,
9	To study ultra sonic pulse velocity test	2

1. Name of the Department – Civil Engineering						
2. Course Name	**Finite Element Analysis Lab (STAAD PRO)**	**L**	**T**		**P**	
3. Course Code		00	00		2	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials = 00**	**Practical = 28**			

8. Brief Syllabus

Basics of finite element analysis, study of different methods linear equations and matrix method, study by displacement models, analysis of structure such as frame and truss by finite element analysis, Basic study of Iso-parametric elements.

9. Learning objectives:

1. The course is intended to teach the basic concepts of finite element analysis.
2. The practical application of finite element method and their advantages and disadvantages Will be explained in the class.

10. Course Outcomes (COs):

On completion of this course, the students will be able to

1. Calculate strain-displacement matrix and stress-strain matrix.
2. Know the analysis procedure and the matrix operations.
3. Know the concepts of isoperimetric elements.
4. Know the analysis procedure by Staad Pro

11. Unit wise detailed content

1. Analysis of three span continuous beams.
2. Analysis of propped cantilever beam.
3. Analysis of statically determinate plane truss.
4. Analysis of statically indeterminate plane truss.
5. Analysis of one bay – one storey plane frame.

Third Semester

1.Name of the Department	CIVIL ENGINEERING					
2.Course Name	Theory and Design of Plates & Shells	L	T		P	
3.Course Code		3	0		0	
4.Type of Course (use tick mark)		Core (✓)	PE-()		OE()	
5.Pre-requisite (if any)	Fluid Mechanics	**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem()
7.Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials =	Practical			

8.Brief Syllabus:

In this course, student will learn about Thin plates its equation and boundary condition, Plate bending and design of shells, curve shell etc. design and detailing of folded plate structure.

9.Learning objectives:

1. This subject is taught to impart knowledge about the behavior of plates and shells.

10.Course Outcomes

On completion of this course, the students will be able to

1. Analyze the plates using Navier's and Levy's method.
2. Analyze the circular, rectangular and square plates by finite difference method.
3. Design the curved shells and roofs.
4. Design the various folded plate structures

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Thin plates**

Laterally loaded thin plates – Differential equation – Boundary conditions.

Unit - 2	**Number of lectures = 11**	**Title of the unit: Plate bending**

Bending of plates – Simply supported rectangular plates – Navier's solution and Levy's method – Rectangular plates with various edge conditions - Symmetrical bending of circular plates – Finite difference method for analysis of square and rectangular plates.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Design of shells**

Types of shells – Structural action – Membrane theory – Limitations – Beam method of analysis.

Unit - 4	**Number of lectures = 05**	**Title of the unit: Curved shell**

Analysis and design of doubly curved shells – Elliptic parabolic - Conoid and hyperbolic paraboloid roofs.

13.Books Recommended

TEXT BOOKS

1. G. S. Ramaswamy, (1996), Design and Construction of Concrete Shell Roofs, First Edition, CBS Publishers and distributors. ISBN-13: 9780812390995.

REFERENCE BOOKS

1. Timoshenko and Krieger, (2010), Theory of Plates and Shells, Second Edition, Tata McGraw Hill Education Pvt. Ltd., ISBN-13: 9780070701250.
2. K. Bhaskar, (2013), Plates: Theories and Applications, First Edition, Ane Books Pvt. Ltd., ISBN-13: 9789382127024. .

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	Research Methodology and IPR	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		Core (✓)	PE-()		OE()	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials = 00	Practical = 0			

8.Brief Syllabus:

The aim of the course is to make students understand the importance of Research Paper Writing. Also, it covers all the concepts which involved in writing the Research Paper.

9 Learning objectives:

The objectives of the course are:

1. The students are able to recognize the steps involved in doing research work.
2. The students will be able to collect data using various media and using the best possible sample available.
3. The students would learn to propose their Hypothesis and build models for the problem.
4. The students would be able to correctly document their findings in the form of a report.

10.Course Outcomes:

After completion of this course, the student will be able to:

1. Recognize the various steps involved in research.
2. Collect data from samples, Examine and analyze the data.
3. Develop models for problems.
4. Explain the entire process in the form of a report.

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction**

Research - Types, Research process and steps, Hypothesis, Research Proposal and aspects. Research Design- Need, Problem Definition, Variables, Research Design concepts, Literature survey and review, Research design process, Errors in research. Research Modeling- Types of models, model building and stages, Data consideration.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Sampling**

Sampling and data collection- Techniques of sampling, Random, Stratified, Systematic, Multistage-sampling, Primary and secondary sources of data. Design of questionnaire.

Unit - 3	Number of lectures = 10	Title of the unit: Data Collection and Experiments
Design of Experiments- Objectives, strategies, Factorial experimental design, designing engineering experiments, basic principles-replication, randomization, blocking, guidelines for design of experiments.		
Unit - 4	**Number of lectures = 12**	**Title of the unit: Models and Hypothesis & Report writing**
Single factor experiment- Hypothesis testing, analysis of Variance component (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effect model, estimation of variance components, Model adequacy checking. Structure and components of Scientific Reports, Types of Report, Technical Reports and Thesis; Different steps in the preparation – Layout, structure and Language of typical reports; Illustrations and tables, Bibliography, Referencing and foot notes.		

12.Brief Description of self learning / E-learning component

https://research-methodology.net/research-methodology/

https://gradcoach.com/what-is-research-methodology/

13.Books Recommended

Text Book:

1. Research Methodology – Methods and Techniques – C.R. Kothari, New Age International, New Delhi, 2004.

Reference Book:

1. Design and Analysis of Experiments – Douglas C. Montgomery, Wiley India, 8th Edition, 2012.
2. Practical Research: Planning Design – Paul D. Leddy, London, 1980.

1. Name of the Department		**CIVIL ENGINEERING**				
1. Subject Name	**Research Methodology and IPR Lab**	**L**	**T**		**P**	
2. Subject Code		0	0		2	
3. Type of Subject		**Core (✓)**	**PE()**		**OE()**	
4. Pre-requisite (if any)	**Research Methodology and IPR**	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
5. Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

1. Learning objectives:

The objectives of the course are:

2. The students are able to recognize the steps involved in Identifying research problem.
3. The students will be able to collect data using various media and using the best possible sample available.
4. The students would learn to propose their Hypothesis and build models for the problem.
5. The students would be able to correctly document their findings in the form of a report.

Outcomes:

On completion of this course, the students will be able to

1. Choose the topic for writing research paper.
2. Develop models for problems.
3. The students would learn to write the research paper.

6. Lab Content

Sr. No.	Title	CO covered
1	How to choose topic for research	1,2
2	How to collect data for the particular research problem	1,2
3	Writing Abstract	1,2
4	Writing Literature review	1,2
5	Explaining and writing methodology	1,2
6	How to analyze the data collected	1,2
7	Presentation of analysis and findings	1,2
8	How to write result and conclusion	2,3
9	References in research article	2,3

Departmental Electives

1.Name of the Department		CIVIL ENGINEERING				
2.Course Name	Prefabricated Structures	L	T		P	
3.Course Code		3	0		0	
4.Type of Course (use tick mark)		Core ()	PE (✓)		OE()	
5.Pre-requisite (if any)		**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem()
7.Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials =	Practical			

8.Brief Syllabus:

In this course, student will learn about types of foundation, Prefabrication systems and structural schemes, Handling and erection stresses, Dimensioning and detailing of joints, Design of pre fabricated Modules.

9.Learning objectives:

1. This subject is taught to impart the knowledge in the area of prefabricated structures.

10.Course Outcomes

On completion of this course, the students will be able to

1. Know the types of prefabrication systems.
2. Understand the behaviour of shell structures.
3. Design pre fabricated Modules.
4. Do the detailing of pre fabricated Modules.

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Introduction**

Types of foundation - Modular co-ordination – Components - Prefabrication systems and structural schemes - Design considerations - Economy of prefabrication - Prefabrication of load-carrying members - DisModuleing of structures - Structural behaviour of pre cast structure.

Unit - 2	**Number of lectures = 12**	**Handling and erection stresses**

Handling and erection stresses - Application of pre stressing of roof members - Floor systems - Two way load bearing slabs - Wall panels.

Unit - 3	**Number of lectures = 10**	**Dimensioning and detailing of joints**

Dimensioning and detailing of joints for different structural connections - Construction and expansion joints.

Unit - 4	**Number of lectures = 10**	**Erection of structures**

Production - Transportation and Erection - Organizing of production - Storing and erection equipment - Shuttering and mould design - Dimensional tolerances, Erection of R.C. structures, Total prefabricated buildings.

13.Books Recommended

TEXT BOOKS

1. Hass, A. M., Precast Concrete Design and Applications, Taylor & Francis Publishers, ISBN-13: 9780853341970.

REFERENCE BOOKS

1. A. S. G. Bruggeling & G. F. Huyghe, (1991), Prefabrications with Concrete, CRC Press, ISBN-13: 9789061911838.
Second Edition, Applied Science Publishers Ltd., ISBN-13: 9780415268462.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Prefabricated Structures Lab**	**L**	**T**		**P**	
3. Subject Code		0	0		2	
4. Type of Subject		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

6. Learning objectives:

This subject is taught to impart the knowledge in the area of prefabricated structures.

7. **Outcomes:**

On completion of this course, the students will be able to

1. Know the types of prefabrication systems.
2. Understand the behaviour of shell structures.
3. Design pre fabricated Modules.
4. Do the detailing of pre fabricated Modules.

7. Lab Content

Sr. No.	**Title**	**CO covered**
1	Prefabrication systems and structural schemes	1,2
2	Prefabrication of load-carrying members	1,2,4
3	Structural behaviour of pre cast structure	1,2
4	Application of pre stressing of roof members	1,2,4
5	Two way load bearing slabs	1,2
6	Dimensioning and detailing of joints for different structural connections	1,2
7	Organizing of production - Storing and erection equipment	1,2
8	Total prefabricated buildings.	2,3

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	Design of Industrial Structures	L	T		P	
3. Course Code		3	0		0	
4. Type of Course :		Core ()	PE(✓)		OE()	
5. Pre-requisite (if any)	Construction Technology	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 42		Tutorials = 00	Practical = 00			

8.Brief Syllabus

The purpose of this course is to develop an in-depth knowledge in the area of design of industrial structure with the latest code of practice as per the Indian Standard. On completion of this course student gain good confidence in designing major industrial structures like bridge plate girders, industrial structures like gantry girders, water tanks, support structures, high rise chimneys and pre-engineered thin walled structures.

9. **Learning objectives**:

1. This subject is taught to impart a broad knowledge in the area of industrial structures.

10. Course Outcomes:

On completion of this course, the students will be able to

1. Know the requirements of various industries.
2. Get an idea about the materials used and planning.
3. Know the construction techniques.
4. Understand the functional requirements

11. Unit wise detailed content

Unit-1	**Number of lectures =10**	**Title of the unit: Industrial requirements & Planning**

General - Specific requirements for industries like textile, sugar, cement, chemical, etc - Site layout and external facilities. Planning of Building Work – Standards - Structural materials including plastics – Polymers - Fiber glass - Pressed card boards, etc - Multi-storey buildings - Steel skeletal structures - Reinforced concrete frames – Workshops - Ware houses - Single storey buildings - Sheds in steel and reinforced concrete - North-lights - Single span spherical and other special constructions - Cooling towers and chimneys - Bunkers and silos' prefabrication - Construction.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Construction techniques**

Construction Techniques - Expansion joints - Machine foundations - Other foundations - Water proofing - Roofs and roofing - Roof drainage - Floors and flooring joists - Curtain walling - Outer wall facing - Sound and shock proof mountings - Use of modern hoisting and other construction

equipments.

Unit – 3	Number of lectures = 10	Title of the unit: Circulation

Circulation - Communication and Transport - Fixed points (central cores) – Staircases - Grid floor sections - Lifts refuse disposals - Utilization of waste materials – Cranes - Continuous conveyors - Mobile cranes – Transporters – Doors - Sliding gates.

Unit – 4	Number of lectures =12	Title of the unit: Functional Requirements

Functional Requirements – Lighting: Natural lighting - Protection from the sun - sly lights - window cleaning installations -Services: Layout – wiring – fixtures - cable and pipe bridges - electrical installations - lighting substation - Effluent. Ventilation and fire protection: Ventilation - Air-conditioning - Fire escapes and chutes - Fire alarms - Hydrants.

12. Brief Description of self learning / E-learning component:
https://nptel.ac.in/courses/105106113/3

13. Books Recommended

TEXT BOOKS

1. El Reedy, (2010), Construction Management and Design of Industrial Concrete and Steel Structures, Taylor & Francis Group, ISBN-13: 9781439815991.

REFERENCE BOOKS

1. Nelson G. L., (1988), Light Agricultural and Industrial Structures: Analysis and Design Kluwer Academic Publisher, ISBN-13: 9780442267773.
2. Dr. Raja Rizwan Hussain, (2011), Pre-Cast Concrete for Multi-Storey Structures, Createspace Publisher, ISBN: 9781467918220.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Design of Industrial Structures Lab**	**L**	**T**		**P**	
3. Subject Code		0	0		2	
4. Type of Subject		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

8. Learning objectives:

This subject is taught to impart a broad knowledge in the area of industrial structures

9. **Outcomes:**

On completion of this course, the students will be able to

1. Know the requirements of various industries.
2. Get an idea about the materials used and planning.
3. Know the construction techniques.
4. Understand the functional requirements

7. Lab Content

Sr. No.	Title	CO covered
1	Site layout and external facilities	1,2
2	Planning of Building Work	1,2,4
3	Construction Techniques - Expansion joints	1,2
4	Use of modern hoisting and other construction equipments.	1,2,4
5	Communication and Transport - Fixed points	1,2
6	Functional Requirements – Lighting: Natural lighting	1,2
7	Organizing of production - Storing and erection equipment	1,2
8	Ventilation and fire protection	2,3

1.Name of the Department		**CIVIL ENGINEERING**				
2.Course Name	**Maintenance & Rehabilitation of Structures**	L	T		P	
3.Course Code		3	0		0	
4.Type of Course (use tick mark)		Core ()	PE-(✓)		OE()	
5.Pre-requisite (if any)		**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem()
7.Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials = 0	Practical =0			

8.Brief Syllabus:

In this course, student will learn Maintenance & Rehabilitation of Structures by learning different properties of concrete, repairing materials and different repairing techniques.

9.Learning objectives:

1. This subject imparts a broad knowledge in the area of repair and rehabilitation of structures.

10.Course Outcomes

On completion of this course, the students will be able to

1. Understand the properties of fresh and hardened concrete.
2. Know the strategies of maintenance and repairing.
3. Get an idea of repairing techniques.
4. Understand the properties of repairing materials.

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Properties of concrete**

Serviceability and Durability of Structures - Quality Assurance for concrete construction - Fresh concrete properties – Strength – Permeability - Cracking - Effects due to climate – Temperature – chemicals - Wear and erosion - Design and construction errors - Corrosion mechanism - Effects of cover thickness and cracking - Methods of corrosion protection – Inhibitors - Resistant steels – Coatings - Catholic protection

Unit - 2	**Number of lectures = 10**	**Repairing materials**

Diagnosis and Assessment of Distress - Visual inspection – Non destructive tests –Ultrasonic pulse velocity method – Rebound hammer technique – ASTM classifications – Pullout tests – Core test

Unit - 3	**Number of lectures = 10**	**Repairing techniques**

Materials for Repairing - Special concretes and mortar - Concrete chemicals - Special elements for accelerated strength gain - Expansive cement - Polymer concrete – Ferro cement, Fibre reinforced concrete - Fibre reinforced plastics.

Unit - 4	**Number of lectures = 12**	**Repairs to structures**

Techniques for Repair - Rust eliminators and polymers coatings for rebars during repair - Foamed concrete - Mortar and dry pack - Vacuum concrete - GModulee and shotcrete - Epoxy injection - Mortar repair for cracks - Shoring and underpinning.

13.Books Recommended

1. Shetty M. S., (2008), Concrete Technology, Seventh Edition, S. Chand & Company Ltd. ISBN-13: 9788121900034.

REFERENCE BOOKS

1. Ravindra K. Dhir, M. Roderick Jones & Li Zheng, (2005), Repair and Renovation of Concrete Structures, American Society of Civil Engineers, ISBN-13: 9780727734051.
2. A. R. Santha Kumar, (2006), Concrete Technology, First Edition, Oxford University Press, ISBN-13: 9780195671537.

1. Name of the Department		**CIVIL ENGINEERING**				
2. **Subject Name**	**Maintenance & Rehabilitation of Structures Lab**	**L**	**T**		**P**	
3. **Subject Code**		0	0		2	
4. **Type of Subject**		**Core ()**	**PE(✓)**		**OE()**	
5. **Pre-requisite (if any)**		**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. **Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)**						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

7. Learning objectives:

This subject imparts a broad knowledge in the area of repair and rehabilitation of structures.

8. **Outcomes:**

On completion of this course, the students will be able to

1. Understand the properties of fresh and hardened concrete.
2. Know the strategies of maintenance and repairing.
3. Get an idea of repairing techniques.
4. Understand the properties of repairing materials.

7. **Lab Content**

Sr. No.	**Title**	**CO covered**
1	Quality Assurance for concrete construction	1,2
2	Methods of corrosion protection	1,2,4
3	Diagnosis and Assessment of Distress	1,2
4	Non destructive tests –Ultrasonic pulse velocity method – Rebound hammer technique.	1,2,4
5	Techniques for Repair - Rust eliminators and polymers coatings for rebars	1,2
6	Polymer concrete – Ferro cement, Fibre reinforced concrete - Fibre reinforced plastics.	1,2
7	Materials for Repairing - Special concretes and mortar	1,2
8	Epoxy injection - Mortar repair for cracks - Shoring and underpinning.	2,3

1. **Name of the Department**	CIVIL ENGINEERING					
2. Course Name	Design of Bridges	L	T		P	
3. Course Code		3	0		0	
4. Type of Course		Core ()	PE(✓)		OE()	
5. Pre-requisite (if any)	Reinforced Concrete Structures	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials =00	Practical = 00			

8. Brief Syllabus:

Design of reinforced concrete bridges is normally done on the basis of a structural analysis. The purpose of the analysis is to find a distribution of sectional forces which fulfils equilibrium and is suitable for design.

9. Learning objectives:

This subject is taught to impart the knowledge in the analysis and design of concrete bridges.

10.Course Outcomes:

On completion of this course, the students will be able to

1. Understand the load distribution and IRC standards
2. Design the slab bridges
3. Design the Arch bridges
4. Design the bridge bearings, hinges and expansion joints.

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: IRC loading and other methods**

Load Distribution Theory - I.R.C. loading standards – Bridge slabs – Effective width method as per I.R.C. – Pigeaud's method – Bridge girders – Courbon's method – Assumptions and analysis of a typical bridge floor – Hendry-Jaeger method – Morice – Little version of Guyon and Massonet method (principles only) .

Unit – 2	**Number of lectures = 10**	**Title of the unit: Slab bridges**

Slab Bridges - Straight and skew slab bridges – T beam bridges – Balanced cantilever bridges – Design of articulation – Continuous girder bridges.

Unit – 3	**Number of lectures = 12**	**Title of the unit: Arch bridges**

Arch Bridges - Single span closed and open spandrel symmetrical type (structural arrangements and functions only) – Design of bow string girder bridges.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Miscellaneous bridges & Substructures**

Other Bridges - Box culvert (Single vent only) – Single span rigid frame bridges (Barrel of solid slab type only) – Pre-stressed composite T beam bridges (structural arrangements only) Design of slab base and gusset base and grillage foundation along with its connection with column. Substructures - Design principles of Piers and abutments – Bridge bearings - Hinges and expansion joints.

12.Brief Description of self learning / E-learning component

https://onlinecourses.nptel.ac.in/noc17_ce24/preview

13.Books Recommended

TEXT BOOKS

1. Johnson Victor, (2007), Essentials of Bridge Engineering, Sixth Edition, Oxford & IBH Publishing Co. Ltd., ISBN-13: 9788120417175.

REFERENCE BOOKS

1. Wilbur Jay Watson, (2910), General Specifications for Concrete Bridges, Nabu Press, ISBN-13: 9781177206587.
2. Portland Cement Association, (2010), Continuous Concrete Bridges, Cambridge Scholars Publishing, ISBN-13: 978115337241.

1. Name of the Department		**CIVIL ENGINEERING**					
2. **Subject Name**	**Design of Bridges Lab**	**L**	**T**		**P**		
3. **Subject Code**		0	0		2		
4. **Type of Subject**		**Core ()**	**PE(✓)**		**OE()**		
5. **Pre-requisite (if any)**		**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
6. **Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)**							
Lectures = 00		**Tutorials = 00**	**Practical =28**				

7. Learning objectives:

This subject is taught to impart the knowledge in the analysis and design of concrete bridges

8. **Outcomes:**

On completion of this course, the students will be able to

1. Understand the load distribution and IRC standards
2. Design the slab bridges
3. Design the Arch bridges
4. Design the bridge bearings, hinges and expansion joints.

7. **Lab Content**

Sr. No.	**Title**	**CO covered**
1	I.R.C. loading standards	1,2
2	Little version of Guyon and Massonet method.	1,2,4
3	Straight and skew slab bridges	1,2
4	Balanced cantilever bridges	1,2,4
5	Single span closed and open spandrel symmetrical type	1,2
6	Design of bow string girder bridges.	1,2
7	Pre-stressed composite T beam bridges	1,2
8	Design of slab base and gusset base and grillage foundation along with its connection with column.	2,3

1.Name of the Department		CIVIL ENGINEERING				
2.Course Name	Composite Structures	L	T		P	
3.Course Code		3	0		0	
4.Type of Course (use tick mark)		Core ()	PE-(✓)		OE()	
5.Pre-requisite (if any)		**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem()
7.Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials = 0	Practical =0			

8.Brief Syllabus:

In this course, student will learn about open channel hydraulics: Pipe Flow and Free Surface Flow, Continuity Equation, Energy in Free Surface Flow, Basic Momentum Equation, Velocity Distribution, Occurrence, Critical Depth in Trapezoidal & Circular Channels, Hydraulic Exponent for Critical Flow, Critical Flow Depth Computations, Derivation of Uniform Flow Equations, Resistance in Open Channel Hydraulics, History of Uniform Flow Velocity and Resistance Factor, Integration of Differential Equation, Improved Euler Method.

9.Learning objectives:

1. To know the types of composites
2. To understand the need for stress strain relation
3. To understand the fabrication methods
4. To understand the laminated plates
5. To study and understand the different methods & analysis of composite materials.

10.Course Outcomes

On completion of this course, the students will be able to

1. Analyze composite structures
2. Do microscopic and macroscopic analysis
3. Analyze sandwich and laminated plates
4. Understand the failure criteria for composites.
5. Know the fabrication techniques

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Stress Strain Relationship**

Introduction - advantages and application of composite materials, reinforcements and matrices - Generalized Hooke's Law - Elastic constants for anisotropic, orthotropic and isotropic materials.

Unit - 2	**Number of lectures = 12**	**Finite Element Analysis of Plates**

Introduction - concept of mesh - Displacement function - Stress-Strain Matrix – Stiffness matrix of plate element – Solution of problem.

Unit - 3	Number of lectures = 10	Methods of Analysis
Micro mechanics - Mechanics of materials approach, elasticity approach to determine material properties - Macro Mechanics - Stress-strain relations with respect to natural axis, arbitrary axis - Determination of material properties - Experimental characterization of lamina.		
Unit - 4	**Number of lectures = 10**	**Laminated Plates**
Governing differential equation for a general laminate, angle ply and cross ply laminates - Failure criteria for composites.		

13.Books Recommended

TEXT BOOKS

1. Madhujit Mukhopadhyay, (2010), Mechanics of Composite Materials and Structures, First Edition, Orient Blackswan Pvt. Ltd., ISBN-13: 9788173714771.

REFERENCE BOOKS

1. Jones, R.M., (1998), Mechanics of Composite Materials, Second Edition, Taylor and Francis Publisher, Isbn-13: 9781560327127.
2. Atul K. Kaw, (2005), Mechanics of Composite Materials, Second Edition, CRC Press, ISBN-13: 9780849313431.

1. Name of the Department		**CIVIL ENGINEERING**					
2. **Subject Name**	**Composite Structures Lab**	**L**	**T**		**P**		
3. **Subject Code**		0	0		2		
4. **Type of Subject**		**Core ()**	**PE(✓)**		**OE()**		
5. **Pre-requisite (if any)**		**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
6. **Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)**							
Lectures = 00		**Tutorials = 00**	**Practical =28**				

7. Learning objectives:

To know the types of composites

2. To understand the need for stress strain relation
3. To understand the fabrication methods
4. To understand the laminated plates
5. To study and understand the different methods & analysis of composite materials.

8. **Outcomes:**

On completion of this course, the students will be able to

1. Analyze composite structures
2. Do microscopic and macroscopic analysis
3. Analyze sandwich and laminated plates
4. Understand the failure criteria for composites.
5. Know the fabrication techniques

7. **Lab Content**

Sr. No.	**Title**	**CO covered**
1	Reinforcements and matrices	1,2
2	Elastic constants for anisotropic	1,2,4
3	Displacement function	1,2
4	Stiffness matrix of plate element	1,2,4
5	Mechanics of materials approach	1,2
6	Determination of material properties	1,2
7	Governing differential equation for a general laminate	1,2
8	Failure criteria for composites.	2,3

1. Name of the Department	CIVIL ENGINEERING					
2. Course Name	Design of Tall Buildings	L	T		P	
3. Course Code		3	0		0	
4. Type of Course		Core ()	PE(✓)		OE()	
5. Pre-requisite (if any)	Design of Steel Structures, Structural analysis	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials = 00	Practical =00			

8. Brief Syllabus:

Classification of buildings, Three dimensional analysis, Shear wall system ,In-filled frame system, Plane frame system.

9.Learning objectives:

1. This course is intended to teach the concept of tall structures.
2. Various methods to analyze the tall structure will be explained in the classes.

10.Course Outcomes:

On completion of this course, the students will be able to

1. Know the types of tall buildings.
2. Analyze the plane frame systems by different methods.
3. Design the shear wall systems and in filled frame systems.

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Classification of buildings**

Introduction - Classification of buildings according to NBC – Types of loads – wind load – Seismic load – Quasi static approach.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Plane frame systems**

Plane Frame System - Calculation of wind load – Approximate method – Portal - Cantilever and factor methods – Kani's method – Substitute frame method for dead load and live loads.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Shear wall system**

Shear Wall System - Rosman's analysis – Design aspect – RC frame and shear wall interaction – Equivalent frame method.

Unit - 4	**Number of lectures = 12**	**Title of the unit: In-filled frame system**

In-filled Frame Systems - Importance – Methods of analysis – Equivalent truss and frame method – Force-displacement method – Effect of perforation in the in-filled frame.

12.Books Recommended

TEXT BOOKS

1. Bryan Stafford Smith and Alex Coull, (2011), Tall Building Structures: Analysis and Design, Wiley India, ISBN-13: 9788126529896.

REFERENCE BOOKS

1. SarwarAlamRaz, (2002), Structural Design in Steel, Second Edition, New Age International, ISBN-13: 9788122432282.

2. Name of the Department		**CIVIL ENGINEERING**				
8. **Subject Name**	**Design of Tall Buildings Lab**	**L**	**T**		**P**	
9. **Subject Code**		0	0		2	
10. **Type of Subject**		**Core ()**	**PE(✓)**		**OE()**	
11. **Pre-requisite (if any)**		**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
12. **Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)**						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

9. Learning objectives:

Classification of buildings, Three dimensional analysis, Shear wall system ,In-filled frame system, Plane frame system.

10. **Outcomes:**

On completion of this course, the students will be able to

1. Know the types of tall buildings.
2. Analyze the plane frame systems by different methods.
3. Design the shear wall systems and in filled frame systems.

13. **Lab Content**

Sr. No.	**Title**	**CO covered**
1	Classification of buildings according to N	1,2
2	Seismic load – Quasi static approach.	1,2,
3	Calculation of wind load	1,2
4	Substitute frame method for dead load and live loads.	1,2,
5	RC frame and shear wall interaction.	1,2
6	Equivalent frame method.	1,2
7	Methods of analysis	1,2
8	Effect of perforation in the in-filled frame	2,3

SGT University, Chandu-Budhera, Gurugram
Faculty of Engineering & Technology
Department of Civil Engineering

M. Tech. **Transportation Engineering**

Scheme & Syllabus (2021-22)

Vision of SGT University

"Driven by Research & Innovation, we aspire to be amongst the top ten Universities in the Country by 2022

Transportation Engineering
First Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1.		Pavement Materials	3	0	0	3	60	40	100
2.		Urban Transportation System Planning	3	0	0	3	60	40	100
3.		Geometric Design of Transportation Facilities	3	0	0	3	60	40	100
4.		Ground Improvement	3	0	0	3	60	40	100
5.		Pavement Materials Lab	0	0	2	1	40	60	100
6.		Geometric design Lab	0	0	2	1	40	60	100
7.		Value Added Courses-I	2	0	0	2	60	40	100
8.		Seminar	0	0	2	1	00	100	100
		Total	**14**	**0**	**6**	**17**	**380**	**420**	**800**

Second Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Analysis and Design of Pavement	3	0	0	3	60	40	100
2		Transport Economics	3	0	0	3	60	40	100
3		Traffic Engineering and Management	3	0	0	3	60	40	100
4		Airport Infrastructure, Planning and Design	3	0	0	3	60	40	100
5		Pavement Design Lab	0	0	2	1	40	60	100
6		Traffic Lab	0	0	2	1	40	60	100
7		Seminar	0	0	2	1	00	100	100
		Total	**12**	**0**	**6**	**15**	**320**	**380**	**700**

Third Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Sustainable Built Environment	3	0	0	3	60	40	100
2		Research Methodology & IPR	3	0	0	3	60	40	100
3		Department Electives-XIII	3	0	0	3	60	40	100
4		Department Electives-XIV	3	0	0	3	60	40	100
5		Department Electives-XV	3	0	0	3	60	40	100
6		Research Methodology & IPR Lab	0	0	2	1	40	60	100
7		Department Electives Lab-XIII	0	0	2	1	40	60	100
8		Department Electives Lab-XIV	0	0	2	1	40	60	100
9		Department Electives Lab-XV	0	0	2	1	40	60	100
10		Value Added Courses-II	2	0	0	2	60	40	100
		Total	**17**	0	**8**	**21**	520	480	1000

Fourth Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Dissertation	0	0	**20 W**	**20**	100	0	100
		Total	0	0	**20 W**	**20**	**100**	0	**100**

Departmental Electives

S. No.	Specialization	Departmental Elective XIII	Departmental Elective XIV	Departmental Elective XV
1	Transportation Engineering	Construction Project Management & BOT 3-0-2 (4)	Highway Construction Practices 3-0-2 (4)	Environment Impact Assessment 3-0-2 (4)
2		Intelligent Transportation Systems 3-0-2 (4)	Highway Traffic Analysis and Design 3-0-2 (4)	Bridge Engineering 3-0-2 (4)

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Pavement Materials	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	Soil Mechanics	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6 .Total Number of Lectures, Tutorials, Practical (assuming 14weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical =0**			

7. Brief Syllabus:

Soil composition and structure, Properties and test on road aggregate, Bitumen materials.

8. Learning objectives:

1. Understanding the strength characteristics of various road materials.
2. Understanding the temperature dependency of bitumen.
3. Understand the rheological properties of bitumen.

9. Subject Outcomes:

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

1. Strength characteristics of various road materials,
2. Behaviour of road binding materials.
3. Scope for the new road materials

10. Unit wise detailed content

Unit-1	**Number of lectures =10**	**Title of the unit: Sub grade soil**

Soil composition and structure - Soil classification for engineering purposes - Origin, Classification, requirements.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Aggregates**

Properties and tests on road aggregates, Aggregate classification, Volumetric analysis of aggregate.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Bituminous materials**

Origin, preparation, properties and tests, constituent of bituminous (road binders), Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests.

Unit - 4	Number of lectures = 12	Title of the unit: Bituminous Mix
Mechanical properties - Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes. Weathering and Durability of Bituminous Materials and Mixes - Performance based Bitumen Specifications – Super pave mix design method.		

11. Books Recommended

Text Books

(i) S.K. Khanna & C.E.G. Justo, Highway Engineering, Namechand & Bros. publication.

(ii) S.K. Khanna & C.E.G. Justo, Highway Materials and Pavement Testing, Namechand & Bros. publication

Reference Books

(i) Martin Rogers and Bernard Enright, Highway Engineering, Wiley publication

(ii) IRC, “Steel Fiber Reinforced Concrete for Pavements”, IRC: SP – 46, 1997, Indian Road Congress.

(iii) Westergaard, H.M. “Stress in Concrete Pavements Computed by Theoretical Analysis”

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Urban Transportation System Planning	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6 .Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical =00**			

7. Brief Syllabus:

Understanding the travel pattern of urban users, learn to forecast the various traffic and to understand the necessity of mass transit system in urban areas, learn to calculate the efficiency of various mass transit system.

8. Learning objectives:

1. Understanding the travel behavior of road users.
2. Planning proper Origin- Destination survey
3. Evaluation of transit mode and its efficiency.
4. Analysis of survey data.

9. Subject Outcomes:

At the end of the course ,the student will be able to:-

1. Understand how to perform O-D survey.
2. Evaluate the efficiency of various routes
3. Evaluate the capacity of various transit system

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction**

Mass transit systems, Elements / components of transit systems; Urban Mass Transit systems-types, characteristics, suitability and adaptability of these systems; Evolution of urban transportation.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Transit System Planning**

Planning needs; Short-range and long-range planning; Planning procedures and methodology, Data collection; Medium performance transit systems and high performance transit systems; trends in transit planning.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Transit Demand Estimation and Evaluation**

Transit demand forecasting; transit mode evaluation; comparison and selection of most suitable transit mode.

Unit - 4	**Number of lectures = 12**	**Title of the unit: Transit System Operations**

Basic operational elements; transit travel characteristics; transit scheduling; transit line analysis – planning objectives, geometry, types and their characteristics, capacity of transit lines, system procedures for improving transit line capacity.

11. Books Recommended

Text Books

(i) C A O'Flaherty, 'Transport Planning and Traffic Engineering', Butter worth Heinemann, Burlington

(ii) John W. Dickey and others, "Metropolitan Transportation Planning", Tata McGraw-Hill Book Company Ltd., New Delhi

References

1. C Jotin Khisty and B Kent Lall, "Transportation Engineering" Prentice Hall of India Pvt. Ltd., New Delhi

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Geometric Design of Transportation Facilities	**L**	**T**		**P**	
3. Subject Code		3	0		3	
4. Type of Subject (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical=0**			

7. Brief Syllabus:

Understanding the various government guidelines for the geometric design, importance of cross-sectional elements and sight distances and curve, learn about the intersection design.

8. Learning objectives:

1. Learn about the various road design elements.
2. Students will be able to understand the importance of sight distances.
3. Curves and the various intersection design.

9. Subject Outcomes:

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

1. Understanding the basic road design elements
2. Importance of sight distance and curves
3. Various intersection design

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Cross sectional elements of highway**

Pavements surface characteristics, camber, carriageway width, median, kerbs, road margins, guard rail

Unit - 2	**Number of lectures = 10**	**Title of the unit: Sight distances**

Stopping sight distance, Passing signt distance, overtaking sight distance, headlight sight distance, sight triangle

Unit - 3	**Number of lectures = 10**	**Title of the unit: Curve design**

Horizontal curve, super elevation, transition curve, vertical curves (summit & valley curve)

Unit - 4	**Number of lectures = 12**	**Title of the unit: Un-signalized intersection at grade**

Sight distance consideration and principles of design, channelization, mini roundabouts, layout of roundabouts, Inter-changes: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes

11. Books Recommended

Text Books

i) Relevant IS and IRC codes

ii) Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Materials and Pavement

Reference Books

i) AASHTO Green Book, 2001

ii) AASHO, A policy on Geometric Design of Rural Highway, American Association of State highway Officials; Washington.

iii) Matson, T.M., Smith, W.S., Hurd, H.W. Traffic Engineering, McGraw Hill Book Co. Inc., New York.

1. Name of the Department			**CIVIL ENGINEERING**			
2. Subject Name	**Ground Improvement**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Soil Mechanics, Rock Mechanics	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

6 .Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 0**	**Practical = 0**

7. Brief Syllabus:

Understanding the mechanical behavior of various soils, soil stabilization techniques and deep exploration.

8. Learning objectives:

1. Properties of various soil deposit.
2. Students will be able to understand that how these stabilization techniques work.
3. Understand about the deep exploration.

9. Subject Outcomes:

At the end of the course ,the student will be able to:-

1. Understanding the sub grade soil behavior by using various test like CBR, Tri-axial test etc.
2. Various techniques for the soil stabilization/improvement like mechanical, hydraulic etc.
3. Deep exploration.

10. Unit wise detailed content

Unit-1	**Number of lectures=10**	**Title of the unit: Properties of various soil deposit**

Engineering properties of soft – weak and compressible deposits – problems associated with weak deposit – Requirements of ground improvements – introduction to engineering ground modification, need and objectives.

Unit - 2	**Number of lectures =10**	**Title of the unit: Soil Stabilization**

Science of soil stabilization – Mechanical modification – Hydraulic modification – Dewatering systems – Chemical modification – Modification by admixtures like lime, Cement, Bitumen etc. – Grouting – Deep jet mixing methods.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Ground improvements techniques**

Recent Ground improvement techniques: stabilization using industrial waste – modification by inclusion and confinement – soil nailing – stone column – compaction piles – dynamic compaction – prefabricated vertical drains – preloading – electro – osmosis – soil freezing vacuum consolidation – deep explosion – dry powdered polymers – enzymes.

Unit - 4	Number of lectures = 12	Title of the unit: Soil reinforcement

Historical background, RCC – concept of reinforced earth – Mechanisms – Types of reinforcements – Soil – Reinforcement – Interaction studies – Internal & External stability criteria – Design Principles of steep reinforced soil slops – pavements – Embankments on soft soils.

11. Books Recommended

Text Books

2. Hausmann, M.R., Engineering Principles of Ground Modification, McGraw – Hill International Editions, 1990.
3. Purushotham Raj, Ground Improvement Techniques, Laxmi Publications, New Delhi.

Reference Books

1. Jones C. J. F. P, Earth Reinforcement and Soil Structures, Butterworths, London.
2. PCA, Soil-cement Laboratory Hand Book, Portland cement association, Chicago.
3. Moreland, H. and Mitchell, H. “Lime Soil Mixture” Highway Research Board Bulletin 304, 1961.

1. Name of the Department: Civil Engineering Department						
2. Course Name	Pavement Materials lab	L	T		P	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		Core (✓)	PE()		OE()	
5. Pre-requisite (if any)	Highway Engineering lab	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials =0**	**Practical = 28**			

7. Brief Syllabus:

Tests on aggregate to determine the mechanical properties, Test on bitumen material and test on soil.

8. Learning objectives:

1. Students will learn about the various material used in road construction.
2. Students able to understand that how to determine the various material characteristics
3. Understand the importance of quality of materials.

9. Course Outcomes (COs):

1. At the end of the course, the student will be able to
2. Differentiate good and poor material for road construction
3. Understand material behavior under loading
4. Aggregate grading importance

10. Unit wise detailed content

1. Aggregate grading importance
2. Compaction test
3. CBR test
4. Shape tests - Elongation, Flakiness Index & Combined Index
5. Aggregate impact value test
6. Los Angeles abrasion value test
7. Specific gravity determination
8. Striping value test
9. Ductility test
10. Penetration test
11. Viscosity test

1. Name of the Department: Civil Engineering Department						
2. Course Name	CAD in Transportation Engineering	**L**	**T**	**P**		
3. Course Code		0	0	2		
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**	**OE()**		
5. Pre-requisite (if any)	Geometric design, Survey	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Learning objectives:

1. MX Road is an excellent string-based modeling tool that enables the rapid and accurate design of all types of roads.
2. MX Road contributes to improving the quality of designs by combining traditional engineering workflow profile and cross sections with 3D modeling technology.

9. Course Outcomes (COs):

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

1. Understand the input data required for road design
2. Understand the surface and excavation work design
3. Understand the curve design and how to use known theory in the design

10. Lab Components

Sr. No.	Topic	CO covered
1	Basic concepts and view control	1
2	Survey input and validation	1
3	String name and drawing style	1
4	Surface checker, string creation and edition	1
5	Surface analysis and earth work calculation	2
6	Alignment creation (horizontal and vertical curve)	3
7	Carriage way design	3
8	Junction design	3

Second Semester

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Analysis and Design of Pavement	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 0**	**Practical =0**

7. Brief Syllabus:

Understanding the effect of various environmental factors effecting the pavement design, Traffic load calculation, Design, and analysis of flexible and rigid pavement.

8. Learning objectives:

1. Students will learn about the behaviour of various materials under various environmental conditions.
2. Design philosophy of flexible pavement
3. Design philosophy of rigid pavement
4. Analysis of flexible and rigid pavement.

9. Subject Outcomes:

At the end of the course, the student will be able to:

1. Ability to analyses of the pavement.
2. Ability to design flexible pavement by various methods.
3. Ability to design rigid pavement by various methods.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Factors effecting the pavement**

Types and component of pavements, Factors affecting design and performance of pavements. Highway and airport pavements, functions of pavement components

Unit - 2	**Number of lectures = 10**	**Title of the unit: Load calculation for pavement design**

Design wheel load, strength characteristics of pavement materials, climatic variations, traffic - load equivalence factors and equivalent wheel loads, aircraft loading, gear configuration and tyre pressure. Drainage – Estimation of flow, surface drainage, sub-surface drainage systems, design of sub-surface drainage structures.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Flexible Pavement Design**

Empirical, semi-empirical and theoretical approaches, design of highway and airport pavements by IRC, AASHTO Methods, applications of pavement design software

Unit - 4	**Number of lectures = 12**	**Title of the unit: Software use in Pavement Design & Analysis**

Types of joints and their functions, joint spacing; design of CC pavement for roads, highways and airports as per IRC, AASHTO, design of joints. Design of continuously reinforced concrete pavements. Reliability; Use of software for rigid pavement design.

11. Books Recommended

Text Books

(iii) Yoder and Witczak, Principles of Pavement Design, John Wiley and Sons

(iv) Yang. H. Huang, Pavement Analysis and Design, Second Edition, Prentice Hall Inc.

Reference Books

(i) Rajib B. Mallick and Tahar El-Korchi, Pavement Engineering – Principles and Practice, CRC Press (Taylor and Francis Group)

(ii) W.Ronald Hudson, Ralph Haas and Zeniswki , Modern Pavement Management, McGraw Hill and Co

(iii) Relevant IRC Codes

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Transport Economics**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
6 .Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

7. Brief Syllabus:

Understanding the supply, demand and surplus, determinant of elasticity, Transportation cost calculation and economic analysis of project.

8. Learning objectives:

1. Students will be able to understand the economics of road projects.
2. Students will learn about the concept of elasticity and how it affects the supply demand.
3. Students will understand the governing factors for the choice of travel mode.

9. Subject Outcomes:

At the end of the course ,the student will be able to:-

1. Understanding the basic economics term like elasticity, supply, demand etc.
2. Understanding the surplus.
3. Travel behavior analysis.
4. Economic and financial analysis of highway project.

10. Unit wise detailed content

Unit-1	**Number of lectures=10**	**Title of the unit: Demand**

Transportation economics, Transportation demand, Demand classification, Determinants of demand, Demand function curve, shift in demand curve, Temporal variation of transportation demand and peak problem and measures to mitigate, Price elasticity of demand, Price elasticity of linear demand curve, CRAFT model, Direct and cross elasticity.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Demand, Supply and Equilibrium**

Supply curve, Determinant of supply, Price elasticity of supply, Determinant of price elasticity of supply, Constant elasticity supply function, Demand supply equilibrium and in-equilibrium.

Unit - 3	**Number of lectures = 06**	**Title of the unit: Surplus**

Consumer surplus, Change in consumer surplus, Latent demand, Producer surplus, Change in producer surplus, Income elasticity.

Unit - 4	**Number of lectures = 16**	**Title of the unit: Travel behavior analysis**

Behavior analysis, its objective and application. Travel Behavior Analysis (TBA), Application of TBA, Basic steps of TBA, Design of survey instrument, Data types in behavior analysis, Preference elicitation techniques, Discrete choice experiment, Identification of attributes and its levels, Generation of alternatives, Factorial design.

11. Books Recommended

Text Books

4. Winfrey, Economic analysis for Highways, International Textbook Company, Pennsylvania, 1969.
5. CRRI, Road User Cost Study in India, New Delhi, 1982.

Reference Books

6. IRC, Manual on Economic Evaluation of Highway Projects in India, SP30, 2007.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Traffic Engineering and Management**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
6 .Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials =**	**Practical**			

7. Brief Syllabus:

Elements of traffic engineering, Road user facilities, Elements of road design, Traffic regulation & controls, Grade separated intersection design.

8. Learning objectives:

1. Students will learn about the traffic studies, traffic forecasting and interpretation.
2. Students will learn about the speed study.
3. Students will learn about the various kind of traffic control system.

9. Subject Outcomes:

At the end of the course ,the student will be able to:-

1. Understand the various design elements
2. Understanding the road users, roads and vehicle interaction
3. Design of traffic regulations and controls
4. Road safety audit

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Elements of traffic engineering**

Road user, vehicle and road way. Vehicle characteristics - IRC standards - Design speed, volume. Highway capacity and levels of service - capacity of urban and rural roads - PCU concept and its limitations.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Roads users facilities**

Road user facilities - Parking facilities - Cycle tracks and cycle-ways, Pedestrian facilities. Traffic volume studies, origin destination studies, speed studies, travel time and delay studies, Parking studies, Accident studies.

Unit - 3	**Number of lectures = 08**	**Title of the unit: Elements of design**

Alignment - Cross sectional elements - Stopping and passing sight distance. Horizontal curves - Vertical curves. Design problems – Hill Roads.

Unit - 4	**Number of lectures = 14**	**Title of the unit: Traffic regulation and control**

Signs and markings - Traffic System Management - Design of at-grade intersections – Principles of design – Channelization - Design of rotaries - Traffic signals - pre-timed and traffic actuated. Design of signal setting - phase diagrams, timing diagram, signal coordination.

11. Books Recommended

Text Books

1. ITE Hand Book, Highway Engineering Hand Book, McGraw - Hill.
2. R. J. Salter and N. B. Hounsel, Highway Traffic Analysis and Design, Macmillan Press Ltd, 1996.

References

1. AASHTO A Policy on Geometric Design of Highway and Streets
2. John Wiley & Sons Inc., ITE Brian, Traffic Engineering handbook

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Airport Infrastructure, Planning and Design	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem()	Every Sem ()

6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 0**	**Practical =0**

7. Brief Syllabus:

ICAO standard for airport and air traffic operation, Various safety standard for aircraft, Airport components, Zoning laws, Capacity and traffic determination, Runway design, Taxiway design, Marking & signal, Lighting.

8. Learning objectives:

1. Students will be able to understand the various airport components
2. Students will be able to understand the different techniques used for air traffic calculation
3. Students will learn about the various factors affecting the runway orientation

9. Subject Outcomes:

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

1.Understanding the ICAO standards & regulations

2.Understanding the various design elements of an airport

3.Air traffic calculation

4.Runway design

5.Runway lighting design

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Classification of airports**

ICAO standards. Planning for airport, airport components, zoning laws.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Air traffic forecasting**

Various methods of air traffic forecasting, Capacity determination.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Runways Orientation and Geometric Design**

Runway patterns. Taxiways alignment geometry and turning radius exit taxiways

Unit - 4	Number of lectures = 10	Title of the unit: Aprons Planning and Design
Design principles of critical, semi-critical, non-critical airport pavements, and FAA and PCA methods. Airport hangars, their planning and design criteria.		

11. Books Recommended

Text Books

(v) Airport Engineering, N.J. Ashford, P.H. Wright, John Wiley

(vi) Planning and Design of Airports, R.M. Horonjeff, F.X. McKelvey, W.J Sproule, Seth Young,

References

(i) Airport Planning & Management, Wells, Alexander; Young, Seth, McGraw Hill.

(ii) TMH International Publishers

(iii) Airport Engineering (Planning and Design), S.C Saxena, CBS Publisher

1. Name of the Department: Civil Engineering Department						
2. Course Name	Pavement Design Lab	L	T	P		
3. Course Code		0	0	4		
4. Type of Course (use tick mark)		Core (✓)	**PE()**	**OE()**		
5. Pre-requisite (if any)		**Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	**Every Sem ()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =		**Tutorials =0**	**Practical = 28**			

7. Brief Syllabus:

Understanding the effect of various environmental factors effecting the pavement design, Traffic load calculation, Design, and analysis of flexible and rigid pavement.

8. Learning objectives:

1. Appreciate the importance of environmental factors for the pavement design.
2. Understand the effect of temperature and rainfall on the material behavior used for road construction
3. Understand the importance of gradation

9. Course Outcomes (COs):

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

1. Evaluate the effect of temperature and rainfall on the materials.
2. Design the required aggregate gradation.
3. Choose the suitable binder.

10. Unit wise detailed content

1. Soil-Cement / Soil-lime Mix Design
2. Blending of aggregates
3. Design and blending of sub-base material
4. Characterization of Aggregate and Bituminous materials
5. Visco-elastic Characteristics of bituminous and modified binders
6. Modified Marshall test for bituminous mixes
7. Repeated Load Testing of pavement materials

1. Name of the Department: Civil Engineering Department						
2. Course Name	Traffic lab	L	T		P	
3. Course Code		0	0		4	
4. Type of Course (use tick mark)		Core (✓)	**PE)**		**OE()**	
5. Pre-requisite (if any)		**Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem (√)	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =		**Tutorials =0**	**Practical = 28**			

7. Brief Syllabus:

Solid waste management, the collecting, treating and disposing of solid material that is discarded because it has served its purpose or is no longer useful. Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions in turn can lead to pollution of the environment and to outbreaks of vector borne disease, that is, disease spread by rodents and insects. The tasks of solid waste management present complex technical challenges. They also pose a wide variety of administrative, economic and social problems that must be managed and solved.

8. Learning objectives:

1. Students will understand the importance of traffic studies and traffic forecasting and how important it is for proper efficiency of any transport facility.
2. Students able to understand that how to determine the speed criteria.
3. Accidents analysis and mitigation

9. Course Outcomes (COs):

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

1. Understanding the ADT & AADT calculation from various techniques
2. Parking studies.
3. Accidents analysis using videography.

10. Unit wise detailed content

1. Traffic volume study using videography technique.
2. Traffic speed study using videography technique.
3. Speed study by radar gun & endoscope
4. Determination of reaction time of driver
5. Parking study
6. Accident investigation study
7. Study for improvement of an accident prone location

Third Semester

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Sustainable Built Environment	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical =0**			

7. Brief Syllabus:

The built environment is a complex system that shapes enormous resource flows (i.e., material, energy, labor and economic investments) and impacts the natural environment for decades, if not centuries. If one considers typical design, construction and maintenance practices used today, the relationship between the built environment and the natural environment is not sustainable.

8. Learning objectives:

1. Students will be able to understand the various Environmental impacts of building
2. Students will be able to understand the various traffic disruptions.
3. Students will learn about the on site natural resources.
4. Students will learn about the attributes of environmental sustainability.

9. Subject Outcomes:

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

1. 1. Students will be able to understand the various Environmental impacts of building
2. Students will be able to understand the various traffic disruptions.
3. Students will learn about the onsite natural resources.
4. Students will learn about the attributes of environmental sustainability.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit:** Introduction

Environmental impacts of building , Shortage of building materials, Noise, vibration, dust, and traffic disruptions, Water pollution, Disruption of natural scenery, Disappearing green spaces in urban areas.

Unit - 2	**Number of lectures = 12**	**Title of the unit:** Sustainable built environments

Economy of resources, Building materials, Energy, On-site natural resources, Three phases of building materials.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Attributes of environmental Sustainability**

Pollution prevention measures in manufacturing, waste reduction measures in manufacturing, Recycled cement, Embodied energy reduction , Use of natural materials

Unit - 4	**Number of lectures = 10**	**Title of the unit:** Technological innovation and built environments

Electronic technology in buildings , Functional shift of built environments, Human interaction

11. Books Recommended

Text Books

1) Cradle to Cradle: Remaking the Way We Make Things, William McDonough and Michael Braungart.
2) The Up cycle: Beyond Sustainability-Designing for Abundance, William McDonough and Michael Braungart

1. Name of the Department	**CIVIL ENGINEERING**					
2. Course Name	Research Methodology and IPR	L	T	P		
3. Course Code		3	0	0		
4. Type of Course (use tick mark)		Core (✓)	PE-()		OE()	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		Tutorials = 00	Practical = 0			

8.Brief Syllabus:

The aim of the course is to make students understand the importance of Research Paper Writing. Also, it covers all the concepts which involved in writing the Research Paper.

9 Learning objectives:

The objectives of the course are:

1. The students are able to recognize the steps involved in doing research work.
2. The students will be able to collect data using various media and using the best possible sample available.
3. The students would learn to propose their Hypothesis and build models for the problem.
4. The students would be able to correctly document their findings in the form of a report.

10.Course Outcomes:

After completion of this course, the student will be able to:

1. Recognize the various steps involved in research.
2. Collect data from samples, Examine and analyze the data.
3. Develop models for problems.
4. Explain the entire process in the form of a report.

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction**

Research - Types, Research process and steps, Hypothesis, Research Proposal and aspects. Research Design- Need, Problem Definition, Variables, Research Design concepts, Literature survey and review, Research design process, Errors in research. Research Modeling- Types of models, model building and stages, Data consideration.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Sampling**

Sampling and data collection- Techniques of sampling, Random, Stratified, Systematic, Multistage-sampling, Primary and secondary sources of data. Design of questionnaire.

Unit - 3	Number of lectures = 10	Title of the unit: Data Collection and Experiments
Design of Experiments- Objectives, strategies, Factorial experimental design, designing engineering experiments, basic principles-replication, randomization, blocking, guidelines for design of experiments.		
Unit - 4	**Number of lectures = 12**	**Title of the unit: Models and Hypothesis & Report writing**
Single factor experiment- Hypothesis testing, analysis of Variance component (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effect model, estimation of variance components, Model adequacy checking. Structure and components of Scientific Reports, Types of Report, Technical Reports and Thesis; Different steps in the preparation – Layout, structure and Language of typical reports; Illustrations and tables, Bibliography, Referencing and foot notes.		

12.Brief Description of self learning / E-learning component

https://research-methodology.net/research-methodology/

https://gradcoach.com/what-is-research-methodology/

13.Books Recommended

Text Book:

1. Research Methodology – Methods and Techniques – C.R. Kothari, New Age International, New Delhi, 2004.

Reference Book:

1. Design and Analysis of Experiments – Douglas C. Montgomery, Wiley India, 8th Edition, 2012.
2. Practical Research: Planning Design – Paul D. Leddy, London, 1980.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Research Methodology and IPR Lab**	**L**	**T**		**P**	
3. Subject Code		0	0		2	
4. Type of Subject		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	**Research Methodology and IPR**	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical (Assuming 14 weeks in semester)						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

1. Learning objectives:

The objectives of the course are:

2. The students are able to recognize the steps involved in Identifying research problem.
3. The students will be able to collect data using various media and using the best possible sample available.
4. The students would learn to propose their Hypothesis and build models for the problem.
5. The students would be able to correctly document their findings in the form of a report.

Outcomes:

On completion of this course, the students will be able to

1. Choose the topic for writing research paper.
2. Develop models for problems.
3. The students would learn to write the research paper.

7. Lab Content

Sr. No.	Title	CO covered
1	How to choose topic for research	1,2
2	How to collect data for the particular research problem	1,2
3	Writing Abstract	1,2
4	Writing Literature review	1,2
5	Explaining and writing methodology	1,2
6	How to analyze the data collected	1,2
7	Presentation of analysis and findings	1,2
8	How to write result and conclusion	2,3
9	References in research article	2,3

Departmental Elective

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Construction Project Management	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6 .Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials =**	**Practical**			

7. Brief Syllabus:

Understanding the various stages of project, Economic and financial analysis of project, Project selection, Network scheduling, Use of computer programs, Project bid, Project operation.

8. Learning objectives:

1. Students will understand the importance of project management for any infrastructure project.
2. Overall development of students in how to deal with different – different people involved in the project.
3. Learn about the use of various software in flow less execution of any infrastructure project.

9. Subject Outcomes:

At the end of the course ,the student will be able to:-

1.Understand solid waste and its composition

2. Understand various processes involved in solid waste collection, segregation and transportation.

3. Design Understand solid waste disposal facility.

10. Unit wise detailed content

Unit-1	**Number of lectures = 06**	**Title of the unit: Introduction**

Foundations of Project Management, Project Life Cycle, Project Environment, Project Selection, Project Proposal, Project Scope

Unit - 2	**Number of lectures = 12**	**Title of the unit: Project planning**

The Breakdown Structure. Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Assumptions in PERT

Unit - 3	**Number of lectures = 12**	**Title of the unit:** Modeling

Modeling, Time-cost Trade-offs, Linear Programming and Network Flow Formulations, PERT/COST Accounting.

Unit - 4	Number of lectures = 12	Title of the unit: Project schedule

Scheduling with limited resources, Resource Planning, Resource Allocation, Project Schedule Compression, Project Scheduling Software, Precedence Diagrams, Decision CPM, Generalized Activity Networks, GERT

11. Books Recommended

Text Books

(i) Projects: Planning, Analysis, Selection, Implementation & Review, Prasanna Chandra, 5th Ed., 2002.

(ii) Project Management: A systems approach to planning and controlling, Harold Kerzner, CBS Publisher, New Delhi, 2nd Ed., 2000.

References

(i) Lock, D., 2003, Project Management, 8th edition, Gower Publishing Limited

(ii) AMS REALTIME projects http://www.amsrealtime.com/products/project.htm

1. Name of the Department: Civil Engineering Department						
2. Course Name	Construction Project Management Laboratory	L	T		P	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		Core ()	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**Frequency (use tick marks)**	Even Sem ()	Odd (✓)	Either Sem ()	**Every Sem ()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =0		**Tutorials =0**	**Practical = 28**			

7. Brief Syllabus:

Understanding the various stages of project, Economic and financial analysis of project, Project selection, Network scheduling, Use of computer programs, Project bid, Project operation.

8. Learning objectives:

1. Students will understand the importance of project management for any infrastructure project.
2. Overall development of students in how to deal with different – different people involved in the project.
3. Learn about the use of various software in flow less execution of any infrastructure project.

9. Course Outcomes (COs):

At the end of the course ,the student will be able to:-

1.Understand solid waste and its composition

2. Understand various processes involved in solid waste collection, segregation and transportation.

3. Design Understand solid waste disposal facility.

10. Unit wise detailed content

1. Study of Foundations of Project Management.
2. Study of Project Selection, Project Proposal, Project Scope.
3. Study of Critical Path Method.
4. Evaluation by Program Evaluation & Review Technique.
5. Networking for Planning and Scheduling of Activity Networks.
6. Scheduling with limited resources, Resource Planning, Resource Allocation.
7. Project Scheduling Software, Precedence Diagrams.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Intelligent Transportation System	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6 .Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials =**	**Practical**			

7. Brief Syllabus:

Introduction to ITS and overview, Its applications and Highway Safety, Advance traffic management system, Interactive voice recognition and its applications, ITS standards .

8. Learning objectives:

1. Students will able to understand the various types of stresses developed in pavements.
2. Students will able to understand the causes of the road failure and how to mitigate them to the extent possible.
3. Students will learn about the overlay design.

9. Subject Outcomes:

At the end of the course ,the student will be able to:-

1. Understand the need for ITS and the subsets of ITS.
2. To equip the students with practical case studies leading to IT'S rather than conventional methods.

10. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction to ITS**

Overview and history of ITS Overview of ITS Applications Federal ITS Programs, Improving Highway Safety with ITS

Unit - 2	**Number of lectures = 10**	**Title of the unit: Advanced traffic management system**

Advanced Traveler Information Systems A Case Study – VA DOT Active Traffic Management Concept ITS Telecommunications Technologies Connected Vehicle Technology Connected Vehicle Technology and Applications

Unit - 3	**Number of lectures = 10**	**Title of the unit: Interactive Voice Recognition**

Interactive Voice Recognition (IVR) Technologies ITS Mobile Applications		
Unit - 4	**Number of lectures = 12**	**Title of the unit: ITS Standards ITS Architecture**
Economics of ITS Congestion Pricing Revenue Generation Models		

11. Books Recommended

Text Books

1. Joseph M. Sussman, Perspectives on Intelligent Transportation Systems, Springer2005.
2. Bob Williams, Intelligent Transportation Systems Standards, Artech House 2008.

References

1. Sumit Ghosh, and Tony.S.Lee, Intelligent Transportation Systems: Smart and Green Infrastructure Design, CRC press, 2010.
2. Mashrur A. Chowdhury and Adel Wadid Sadek Fundamentals of Intelligent Transportation Systems planning, Artech House 2009.

1. Name of the Department: Civil Engineering Department						
2. Course Name	Intelligent Transportation System Laboratory	L	T		P	
3. Course Code		0	0		4	
4. Type of Course (use tick mark)		Core ()	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**Frequency (use tick marks)**	Even Sem ()	Odd (✓)	Either Sem ()	**Every Sem ()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =0		**Tutorials =0**	**Practical = 28**			

7. Brief Syllabus:

Introduction to ITS and overview, Its applications and Highway Safety, Advance traffic management system, Interactive voice recognition and its applications, ITS standards.

8. Learning objectives:

1. To gain insight into traffic data collection.
2. Understand the various techniques of traffic data collection using ITS.
3. Understand the various techniques for traffic data analysis.

9. Course Outcomes (COs):

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

1. Understand the need for ITS and the subsets of ITS.
2. To equip the students with practical case studies leading to ITS rather than conventional methods.

10. Unit wise detailed content

1. Traffic data collection techniques.
2. Traffic data analysis.
3. Transportation modeling using network computing software like TRANSYT.
4. Dynamic Intersection Signal Control Optimization (DISCO),
5. Multi-class static and dynamic traffic assignment.
6. Traffic simulation via neural network modeling, and transportation network reliability.
7. Understanding the outcome of traffic data analysis.

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	Highway Construction Practices	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)	Foundation Engineering	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6 .Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical =0**			

7. Brief Syllabus:

Embankment construction, WBM & WMM, Dry lean concrete and cement treated base, Concrete road construction, Road construction in mountainous region.

8. Learning objectives:

1. Students will learn about the various layers of road and the material used in them for construction.
2. Construction of road embankment & base.
3. WBM & WMM construction techniques.
4. Construction of concrete road.

9. Subject Outcomes:

At the end of the course ,the student will be able to:-

1. Ability to prepare road sub-grade.
2. Ability to construct GSB, various types of unbounded base course.
3. Ability to construct various types of binder courses.

10. Unit wise detailed content

Unit-1	**Number of lectures = 06**	**Title of the unit: Embankment Construction**

Formation cutting in Soil and hard rock, Preparation of Sub grade, Ground improvement, Retaining and Breast walls on hill roads.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Granular and Stabilized**

Sub – bases / bases, Water Bound Macadam (WBM), Wet Mix Macadam (WMM), and Cement treated bases, Dry Lean Concrete (DLC).

Unit - 3	**Number of lectures = 12**	**Title of the unit: Bituminous Constructions**

Types of Bituminous Constructions, Interface Treatments, Bituminous Surfacing and wearing Courses for roads and bridge deck slabs, Selection of wearing Course under different Climatic and Traffic conditions, IRC specifications, Construction techniques and Quality Control.

Unit - 4	**Number of lectures = 12**	**Title of the unit: Concrete road construction**

Test on Concrete mixes, Construction equipment, Method of construction of joints in concrete pavements, Quality Control in Construction of Concrete pavements, Overlay Construction.

11. Books Recommended

Text Books

(i) Principles & practice of Highway Engg.-Dr. L. R. Kadiyali & Dr. N. B. Lal - Khanna Publishers
(ii) MOST, Specifications for Road and Bridge Work (4th Revision), Ministry of Road Transport and Highways, 2001.

References

(i) C. A. O' Flaherty, Highways – The Location, Design, Construction, & Maintenance of Pavements, Butterwsorth Heinemann, 2002.
(ii) R. N. Hunter, Bituminous Mixtures in Road Construction, Thomas Telford Services Ltd., 1995.

1. Name of the Department: Civil Engineering Department						
2. Course Name	Highway Construction Practices Laboratory	L	T		P	
3. Course Code		0	0		4	
4. Type of Course (use tick mark)		Core ()	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	**Every Sem ()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =00		**Tutorials =0**	**Practical = 28**			

7. Brief Syllabus:

Structural understanding of the road pavement, Characterization of the materials used in road construction, testing of the materials, Testing of the road pavement.

8. Learning objectives:

1. Students will learn about the pavement system as the multilayer system.
2. Students will learn about the materials used in each layer.
3. Learn about the various test to evaluate the performance of the materials used in various layers.

9. Course Outcomes (COs):

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

1. Perform the necessary test on the soil.
2. Perform the necessary test on the bitumen.
3. Able to evaluate the existing pavement structural conditions.

10. Unit wise detailed content

1. Sub-grade material testing
2. Sub-grade stabilization techniques – mechanical stabilization
3. Sub-grade stabilization techniques – chemical stabilization
4. Preparation of WBM
5. Preparation of WMM
6. Test on aggregate
7. Test on bitumen

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Highway Traffic Analysis and Design**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)	Geometric Design & Traffic Engineering	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6 .Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

7. Brief Syllabus:

Highway safety, Drivers behavior, Highway safety management system, Crash statistics and road safety audit.

8. Learning objectives:

1. The course addresses several sub-areas of transportation safety. Proactive and reactive safety planning and design.
2. Hotspot" identification and remediation.
3. Human factors considerations in highway safety.
4. State of the practice analysis methods for evaluating counter measures.

9. Subject Outcomes:

At the end of the course ,the student will be able to:-

1. Provide students with a working knowledge of traffic safety concepts, covering the range from traffic planning, operations, and design.
2. Gain an understanding of safety management systems, different safety countermeasures, statistical issues with countermeasures and their effectiveness, and crash investigation.

10. Unit wise detailed content

Unit-1	**Number of lectures=10**	**Title of the unit: Elements of Traffic Engineering**

.Road user, vehicle and road way. Vehicle characteristics - IRC standards - Design speed, volume. Highway capacity and levels of service - capacity of urban and rural roads - PCU concept and its limitations

Unit - 2	**Number of lectures = 10**	**Title of the unit: Road users facilities**

Road user facilities - Parking facilities - Cycle tracks and cycle-ways, Pedestrian facilities. Traffic

volume studies, origin destination studies, speed studies, travel time and delay studies, Parking studies, Accident studies.

Unit - 3	Number of lectures = 10	Title of the unit: Elements of design

Alignment - Cross sectional elements - Stopping and passing sight distance. Horizontal curves - Vertical curves. Design problems – Hill Roads.

Unit - 4	Number of lectures = 12	Title of the unit: Traffic regulation and control

Signs and markings - Traffic System Management - Design of at-grade intersections – Principles of design – Channelization - Design of rotaries - Traffic signals - pre-timed and traffic actuated. Design of signal setting - phase diagrams, timing diagram – Signal co-ordination

11. Books Recommended

Text Books

1. KW Ogden, Safer Roads: A Guide to Road Safety Engineering, Averbury Technical Press, Ash gate Publishers, 1996.
2. Rune Elvik and Truls Vaa, the Handbook of Road Safety Measures, Elsevier, 2004.

Reference Books

1. Leonard Evans, Traffic Safety, Science Serving Society, 2004.
2. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997 (reprinted 2002).
3. Highway Safety Manual (HSM).

Name of the Department: Civil Engineering Department

1. Course Name	**Highway Traffic Analysis and Design Laboratory**	L	T		P	
2. Course Code		0	0		2	
3. Type of Course (use tick mark)		Core ()	**PE(✓)**		**OE()**	
4. Pre-requisite (if any)		Odd ()	Either Sem ()	Odd (✓)	Either Sem ()	**Every Sem ()**
5. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials =0**	**Practical = 28**			

6. Brief Syllabus:

Traffic data collection of intersection and mid-block, Speed and delay study, traffic noise measurement and traffic analysis software introduction.

7. Learning objectives:

1. Knowledge on analyzing and solving traffic engineering problems
2. Ability to work with transportation planning software
3. Ability to conduct road safety audits

8. Course Outcomes (COs):

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

1. To introduce the practical problems on traffic engineering and road safety
2. To introduce the analysis software
3. To introduce the transportation planning software

9. Unit wise detailed content

1. Data Collection on traffic stream parameters and analysis

a) Mid-block section

b) Intersection

2. Journey Time and Delay Studies by Moving Car Observer method

3. Design of Roundabout

4. Noise Level Measurements

5. Parking Study

6. Introduction to Trans CAD

7. Introduction to EMME

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Environment Impact Assessment**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)	Waste water Engineering	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

6 .Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials =**	**Practical**

7. Brief Syllabus:

Understanding the importance of environmental effect of any infrastructure project and evaluating the socio-economic cost of that project, Understanding the various legal guideline to ensure proper evaluation and smooth execution of any project, Use of mathematical Models, Total Impact Assessment, Carbon trading.

8. Learning objectives:

1. Students will able to understand the Environment Damaging effects of any infrastructure project and how to minimize that.
2. Students will learn about the various legal guidelines for environment safety.
3. Students will learn about the use development of various mathematical models for Impact Assessment.
4. Concept of Carbon Trading.

9. Subject Outcomes:

At the end of the course ,the student will be able to:-

1. Recognizing the growing need of civil engineering professionals to be acquainted with the potential environmental risks of infrastructure projects
2. Their nature, methods of qualitative and quantitative assessments, environmental risk evaluation, risk management and remediation techniques and development of predictive model
3. The emerging aspects of environmental management including techniques of ecological foot printing and carbon trading will be illustrated.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Introduction to Environmental Impact Assessment (EIA)**

Technical and procedural aspects of Environmental Impact assessment, Guidelines and legal aspects of environmental protection.

Unit - 2	**Number of lectures = 10**	**Title of the unit:** Adverse effect of pollution

General Framework for characterizing environmental dislocation disruption due to pollution

Unit - 3	**Number of lectures = 14**	**Title of the unit: Applications of Mathematical Theories**

Theory and application of mathematical models:- Mathematical modeling for water quality systems, Stream and Estuarine models for pollution control

Unit - 4	Number of lectures = 10	Title of the unit: Socio Economic effect of pollution

Socio economic aspects, Measures of effectiveness of pollution control activities, Inter-sector pollutant transfers, total impact assessment.

11. Books Recommended

Text Books

(i) L. W. Canter, Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1997

(ii) P. Judith and G. Eduljee, Environmental Impact Assessment for Waste Treatment and Disposal Facilities, John Wiley & Sons, 1994.

References

(i) G. Burke, B. R. Singh and L. Theodore, Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2000.

(ii) K. Whitelaw and Butterworth, ISO 14001: Environmental System Handbook, 1997.

(iii)R. Welford, Corporate Environmental Management - Systems and Strategies, Universities Press, 1996.

1. Name of the Department: Civil Engineering Department						
2. Course Name	Environment Impact Assessment Laboratory	L	T		P	
3. Course Code		0	0		4	
4. Type of Course (use tick mark)		Core ()	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	**Every Sem ()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =		**Tutorials =0**	**Practical = 28**			

7. Brief Syllabus: Understanding the importance of environmental effect of any infrastructure project and evaluating the socio-economic cost of that project, Understanding the various legal guideline to ensure proper evaluation and smooth execution of any project, Use of mathematical Models, Total Impact Assessment, Carbon trading.

8. Learning objectives:

1. Students will able to understand the Environment Damaging effects of any infrastructure project and how to minimize that.
2. Students will learn about the various legal guidelines for environment safety.
3. Students will learn about the use development of various mathematical models for Impact Assessment.
4. Concept of Carbon Trading.

9. Course Outcomes (COs):

At the end of the course, the student will be able to:-

1. Recognizing the growing need of civil engineering professionals to be acquainted with the potential environmental risks of infrastructure projects
2. Their nature, methods of qualitative and quantitative assessments, environmental risk evaluation, risk management and remediation techniques and development of predictive model
3. The emerging aspects of environmental management including techniques of ecological foot printing and carbon trading will be illustrated.

10. Unit wise detailed content

1) Study of Guidelines and legal aspects of environmental protection.
2) Characterizing environmental dislocation disruption.
3) Theory and application of mathematical models
4) Mathematical modeling for water quality systems
5) Stream and Estuarine models for pollution control
6) Measures of effectiveness of pollution control activities

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Bridge Engineering**	**L**	**T**		**P**	
3. Subject Code		3	0		0	
4. Type of Subject (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
6 .Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials =0**	**Practical =0**			

7. Brief Syllabus:

Bridge Aesthetics, Analyzing techniques, Prestress concrete, Steel bridge, Bridge in service.

8. Learning objectives:

1. Various structural elements of bridge.
2. Students will be able to understand the various types of loading used for bridge analysis like Class A loading, 70R loading.
3. Steel structure analysis.
4. Maintenance of bridge.

9. Subject Outcomes:

At the end of the course ,the student will be able to:-

1. Understanding the importance of bridge aesthetics.
2. Understanding the various components and there importance in bridge.
3. Understanding the various kind of loading on bridge.
4. Use of concrete and steel bridge and their maintenance.

10. Unit wise detailed content

Unit-1	**Number of lectures=06**	**Title of the unit: Introduction & Bridge Aesthetics**

Introduction, Planning, Aesthetics and Bridge, Road bridges, Loading and IRC codes.

Unit - 2	**Number of lectures = 08**	**Title of the unit: Analyzing Techniques**

Slab Bridges and RCC T Beam Bridges, Different analysis techniques-finite element, finite strip, finite difference. Grillage analysis.

Unit - 3	**Number of lectures = 12**	**Title of the unit: Prestress Concrete**

Pre-stressed Concrete I Girder Bridges, Box Girder Bridges and Segmental Box Girder Bridges, Substructures including Abutments.

Unit - 4	Number of lectures = 16	Title of the unit: Steel Bridge
Railway Bridges and IRS codes , Steel bridges: Truss Bridges and Plate Girder Bridges		

11. Books Recommended

7. Relevant IRC & IRS codes.
8. N. Krishna Raju, “Design of Bridge”, Oxford & Ibh. (ISBN 8120417984).
9. Johnson Victor,” Essentials Of Bridge Engineering”, Oxford & Ibh, 2016.
10. Krishna Raju, “Prestressed Concrete”, McGraw Hill Education; Sixth edition.

1. Name of the Department: Civil Engineering Department						
2. Course Name	Bridge Engineering Lab	L	T		P	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		Core ()	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)	Structural Analysis	Odd ()	Either Sem ()	Odd (✓)	Either Sem ()	**Every Sem ()**
6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials =0**	**Practical =28**			

7. Brief Syllabus:

Bridge Aesthetics, Analyzing techniques, Prestress concrete, Steel bridge, Bridge in service.

8. Learning objectives:

1. Various structural elements of bridge.
2. Students will be able to understand the various types of loading used for bridge analysis like Class A loading, 70R loading.
3. Steel structure analysis.
4. Maintenance of bridge.

9. Course Outcomes (COs):

1. Students will understand the various elements of bridge.
2. Students will appreciate the complexity of bridge design and analysis
3. Students will appreciate the importance of wind load in bridge stability analysis

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

1. Study of relevant IS codes and other guidelines
2. Understanding class-A loading
3. Understanding 70R loading
4. Various types of bridge foundation design
5. Bridge piers design
6. Understanding the load transfer mechanism in various types of bridges
7. Wind load analysis for bridge