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

M. Tech. **Structural Engineering**

Scheme & Syllabus (2022-23)

Vision of SGT University

"Driven by Research & Innovation, we aspire to be amongst the top ten Universities in the Country by 2025"

Scheme of Examination for M.Tech. Structural Engineering 2022-23
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		Research Methodology & IPR	3	0	0	3	60	40	100
6		Matrix methods of Structural Analysis Lab (STAAD PRO)	0	0	2	1	40	60	100
7		Design of Concrete and Structural Systems Lab (STAAD PRO)	0	0	2	1	40	60	100
8		Seminar	0	0	2	1	00	100	100
		Total	**15**	**0**	**6**	**18**	**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	1	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		Minor Project	0	0	6	3	40	60	100
		Total	**12**	**1**	**10**	**18**	**360**	**340**	**700**

Scheme of Examination for M.Tech. Structural Engineering 2022-23

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	1	0	4	60	40	100
2		Department Electives-I	3	0	0	3	60	40	100
3		Department Electives-II	3	0	0	3	60	40	100
4		Dissertation Phase-I	0	0	12	6	40	60	100
		Total	**9**	**1**	**12**	**16**	220	180	400

Fourth Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Dissertation Phase-II	-	-	-	**16**	100	100	200
		Total	-	-	-	**16**	**100**	**100**	**200**

Departmental Electives

S. No.	Specialization	Departmental Elective I	Departmental Elective II
1	**Structural Engineering**	Pre-Fabricated Structures 3-0-0 (3)	Design of Bridges 3-0-0 (3)
2.		Design of Industrial Structures 3-0-0 (3)	Composite Structures 3-0-0 (3)
3.		Maintenance & Rehabilitation of Structures 3-0-0 (3)	Design of Tall Buildings 3-0-0 (3)

First Semester

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. To learn the concepts of pre-stress.
2. To Understand 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**	**Anchorage design**

	lectures = 08	

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 : 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	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. 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 :

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**	**Design of 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**	**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 Finite element analysis

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.

1. Name of the Department – Civil Engineering						
2. Course Name	**Minor Project**	**L**	**T**		**P**	
3. Course Code		00	00		6	
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 = 40**			

8. Brief Syllabus

Minor Project will include identification of the problem based on the literature review and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.

9. Learning objectives:

1. The course is intended to teach the basic concepts of identification and solution of a specific problem.
2. To compare and analyze the various topologies for the selected topic of interest.

10. Course Outcomes (COs):

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

1. Identify structural engineering problems reviewing available literature.
2. Study different techniques used to analyze complex structural systems.
3. Work on the solutions given and present solution by using his/her technique applying engineering principles.

11. Unit wise detailed content

Minor Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.

End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.

Continuous assessment of Mini Project at Mid Sem and End Sem will be monitored by the departmental committee

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	**Dissertation Phase-I**	**L**	**T**		**P**	
3. Course Code		00	00		12	
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 = 168**			

8. Brief Syllabus

In this course, student will finalize the research problem and will complete the literature review for Thesis.

9. Learning objectives:

1. Analyzing the literature will help students find structural engineering issues.
2. To determine the most effective methods for analyzing complex structural systems.

10. Course Outcomes (COs):

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

1. Identify structural engineering problems reviewing available literature.
2. Identify appropriate techniques to analyze complex structural systems.
3. Apply engineering and management principles through efficient handling of project

11. Unit wise detailed content

Dissertation-I will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.

End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research.

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. 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.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, Construction Scan

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, Fiber reinforced concrete - Fiber 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. 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.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:

Stress Strain relationship of composite materials, methods of analysis, finite element analysis of plates with Laminated plates.

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. 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.

Fourth Semester

<table>
<tr><td colspan="8">1. Name of the Department – Civil Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Dissertation Phase-II</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td colspan="2">00</td><td colspan="2">00</td><td>00</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td colspan="2">Core (✓)</td><td colspan="2">PE()</td><td colspan="2">OE()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td colspan="2"></td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="9">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 00</td><td colspan="3">Tutorials = 00</td><td colspan="3">Practical = 00</td></tr>
<tr><td colspan="9">8. Brief Syllabus
In this course, student will complete the thesis work.</td></tr>
<tr><td colspan="9">9. Learning objectives:
1. Utilize the right strategies and tools to resolve complicated structural issues.
2. Demonstrate effective communication to the engineering community and the general public.</td></tr>
<tr><td colspan="9">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="9">On completion of this course, the students will be able to
1. Solve complex structural problems by applying appropriate techniques and tools.
2. Exhibit good communication skill to the engineering community and society.
3. Demonstrate professional ethics and work culture.</td></tr>
<tr><td colspan="9">11. Unit wise detailed content</td></tr>
<tr><td colspan="9">Dissertation – II will be extension of the to work on the topic identified in Dissertation – I. Continuous assessment should be done of the work done by adopting the methodology decided involving numerical analysis/ conduct experiments, collection and analysis of data, etc.
There will be pre-submission seminar at the end of academic term. After the approval the student has to submit the detail report and external examiner is called for the viva-voce to assess along with guide.</td></tr>
</table>

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

M. Tech. **Transportation Engineering**

Scheme & Syllabus (2022-23)

Vision of SGT University

"Driven by Research & Innovation, we aspire to be amongst the top ten Universities in the Country by 2025

Scheme of Examination for M.Tech. Transportation Engineering 2022-23
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.		Research Methodology & IPR	3	0	0	3	60	40	100
6.		Pavement Materials Lab	0	0	2	1	40	60	100
7.		Geometric design Lab	0	0	2	1	40	60	100
8.		Seminar	0	0	2	1	00	100	100
		Total	**15**	**0**	**6**	**18**	**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	1	0	4	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		Minor Project	0	0	6	3	40	60	100
		Total	**12**	**1**	**10**	**18**	**360**	**340**	**700**

Scheme of Examination for M.Tech. Transportation Engineering 2022-23
Third Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Intelligent Transportation Systems	3	1	0	4	60	40	100
2		Department Electives-I	3	0	0	3	60	40	100
3		Department Electives-II	3	0	0	3	60	40	100
4		Dissertation Phase-I	0	0	12	6	40	60	100
		Total	**9**	**1**	**12**	**16**	220	180	400

Fourth Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Dissertation	-	-	-	**16**	100	100	200
		Total	-	-	-	**16**	**100**	**100**	**200**

Departmental Electives

S. No.	Specialization	Departmental Elective I	Departmental Elective II
1	**Transportation Engineering**	Construction Project Management & BOT 3-0-0 (3)	Pavement evaluation, Rehabilitation & Maintenance 3-0-0 (3)
2		Traffic Management and Road safety 3-0-0 (3)	Environment Impact Assessment 3-0-0 (3)
3		Highway Construction Practices 3-0-0 (3)	Bridge Engineering 3-0-0 (3)

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 understand

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, Analyse and 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-term and long-term 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 geometrical design.
3. Different types of Curves and the various types of intersections 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, safety barriers, setback distance etc.

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 and Interchanges**

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.
4. Different methods of Ground improvement

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**				
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 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	Geometric 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)	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. Civil 3D/Open Roads is an excellent string-based modeling tool that enables the rapid and accurate design of all types of roads.
2. Civil 3D/Open Roads 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, 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: Transportation economics & Its 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, Concept of Airport Planning & 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

<table>
<tr><td colspan="8">1. Name of the Department: Civil Engineering Department</td></tr>
<tr><td>2. Course Name</td><td colspan="2">Pavement Design Lab</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td>3. Course Code</td><td colspan="2"></td><td colspan="2">0</td><td colspan="2">0</td><td>4</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td colspan="2">Core (✓)</td><td colspan="2">PE()</td><td>OE()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td colspan="2"></td><td colspan="2">Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="9">6. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures =</td><td colspan="2">Tutorials =0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="9">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 using E-layer and IITPAVE</td></tr>
<tr><td colspan="9">8. Learning objectives:
1. Appreciate the importance of environmental factors for the pavement design.
2. Road traffic evaluation and forecasting.
3. Software application in road pavement design.</td></tr>
<tr><td colspan="9">9. Course Outcomes (COs):
At the end of the course, the student will be able to
1. Understand standard load used in the pavement thickness calculation.
2. Design and evaluation of single layer road system
3. Design and evaluation of multilayer pavement system</td></tr>
<tr><td colspan="9">10. Unit wise detailed content</td></tr>
<tr><td colspan="9">1. Analysis of traffic survey data
2. Introduction to E-layer software
3. Single layer analysis using E-layer software
4. Multilayer analysis using E-layer software.
5. Introduction to iitpave software interface
6. Design and analysis of single layer flexible pavement
7. Design and analysis of multi-layer flexible pavement</td></tr>
</table>

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:

Vehicle speed and volume survey, Traffic volume calculation and forecasting of (ADT, AADT, etc.), Axle load study, Drivers reaction time and road accidents investigation, Parking study.

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. Vehicle axle load survey.
3. Speed study by radar gun & endoscope
4. Determination of reaction time of driver
5. Parking study
6. Accident investigation study
7. Traffic signage standard equipment demonstration.

1. Name of the Department – Civil Engineering						
2. Course Name	**Minor Project**	**L**	**T**		**P**	
3. Course Code		00	00		6	
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 = 40**			

8. Brief Syllabus

Minor Project will include identification of the problem based on the literature review and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.

9. Learning objectives:

1. The course is intended to teach the basic concepts of identification and solution of a specific problem.
2. To compare and analyze the various topologies for the selected topic of interest.

10. Course Outcomes (COs):

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

1. Identify structural engineering problems reviewing available literature.
2. Study different techniques used to analyze complex structural systems.
3. Work on the solutions given and present solution by using his/her technique applying engineering principles.

11. Unit wise detailed content

Minor Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.

End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.

Continuous assessment of Mini Project at Mid Sem and End Sem will be monitored by the departmental committee

Third Semester

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 components and 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.

<table>
<tr><td colspan="8">1. Name of the Department – Civil Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Dissertation Phase-I</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td colspan="2">00</td><td colspan="2">00</td><td>12</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td colspan="2">Core (✓)</td><td colspan="2">PE()</td><td colspan="2">OE()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td colspan="2"></td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 00</td><td colspan="3">Tutorials = 00</td><td colspan="2">Practical = 168</td></tr>
<tr><td colspan="8">8. Brief Syllabus
In this course, student will finalize the research problem and will complete the literature review for Thesis.</td></tr>
<tr><td colspan="8">9. Learning objectives:
1. Analyzing the literature will help students find structural engineering issues.
2. To determine the most effective methods for analyzing complex structural systems.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="8">On completion of this course, the students will be able to
1. Identify structural engineering problems reviewing available literature.
2. Identify appropriate techniques to analyze complex structural systems.
3. Apply engineering and management principles through efficient handling of project</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td colspan="8">Dissertation-I will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.
End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research.</td></tr>
</table>

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 Project Planning Software, 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**				
2. Subject Name	**Traffic Management and Road Safety**	**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. Road inventory, 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).

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	Pavement evaluation, Rehabilitation & Maintenance	**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 = 40		**Tutorials = 0**	**Practical = 0**			

8. Brief Syllabus

Pavement distresses, Pavement rehabilitation techniques, Overlay design, Pavement maintenance.

9. 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.

10. Course Outcomes (COs):

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

1. Understand the importance of pavement health monitoring.
2. Understand the importance of overlay design.
3. Understand the maintenance of paved and unpaved road.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: Pavement distress**
Types of pavement distress, techniques for functional and structural evaluation of pavements (network survey vehicle, FWD, Retro reflectometer) and bridge(mobile bridge inspection unit).		
Unit - 2	**Number of lectures = 8**	**Title of the unit: Pavement Rehabilitation techniques**
Network and project survey and evaluation, pavement rehabilitation techniques.		
Unit – 3	**Number of lectures = 10**	**Title of the unit:Overlay Design**
Overlay design procedures, recycling of flexible and rigid pavements,		
Unit - 4	**Number of lectures = 16**	**Title of the unit: Road maintenance**
Maintenance of paved and unpaved roads, Pavement management systems.		

12. Books Recommended	
i)	Flexible Pavement Rehabilitation and Maintenance, Prithvi S. Kandhal, Mary Stoup Gardiner, American Society for Testing & Materials publication
ii)	Construction and Rehabilitation of Concrete Pavements Under Traffic, Shreenath Rao, Deepak Raghunathan, TRB
iii)	**STP1348; Flexible Pavement Rehabilitation and Maintenance**

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, Environmental 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**				
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.

Fourth Semester

<table>
<tr><td colspan="8">1. Name of the Department – Civil Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Dissertation Phase-II</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td colspan="2">00</td><td colspan="2">00</td><td>00</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td colspan="2">Core (✓)</td><td colspan="2">PE()</td><td colspan="2">OE()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td colspan="2"></td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 00</td><td colspan="3">Tutorials = 00</td><td colspan="2">Practical = 00</td></tr>
<tr><td colspan="8">8. Brief Syllabus
In this course, student will complete the thesis work.</td></tr>
<tr><td colspan="8">9. Learning objectives:
1. Utilize the right strategies and tools to resolve complicated structural issues.
2. Demonstrate effective communication to the engineering community and the general public.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="8">On completion of this course, the students will be able to
1. Solve complex structural problems by applying appropriate techniques and tools.
2. Exhibit good communication skill to the engineering community and society.
3. Demonstrate professional ethics and work culture.</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td colspan="8">Dissertation – II will be extension of the to work on the topic identified in Dissertation – I. Continuous assessment should be done of the work done by adopting the methodology decided involving numerical analysis/ conduct experiments, collection and analysis of data, etc.
There will be pre-submission seminar at the end of academic term. After the approval the student has to submit the detail report and external examiner is called for the viva-voce to assess along with guide.</td></tr>
</table>

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

M. Tech. **Remote Sensing & GIS**

Scheme & Syllabus (2022-23)

Vision of SGT University

"Driven by Research & Innovation, we aspire to be amongst the top ten Universities in the Country by 2025

Scheme of Examination for M.Tech. Remote sensing and GIS 2022-23
First Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Principles of Remote Sensing	3	0	0	3	60	40	100
2		Geographical Information Systems	3	0	0	3	60	40	100
3		Photogrammetry	3	0	0	3	60	40	100
4		Application Of Remote Sensing	3	0	0	3	60	40	100
5		Research Methodology & IPR	3	0	0	3	60	40	100
6		Geographical Information Systems Lab	0	0	2	1	40	60	100
7		Photogrammetry Lab	0	0	2	1	40	60	100
8		Seminar	0	0	2	1	00	100	100
		Total	**15**	**0**	**6**	**18**	**380**	**420**	**800**

Second Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1		Geospatial data Processing and Modelling	3	1	0	4	60	40	100
2		Satellite Image Processing	3	0	0	3	60	40	100
3		Advanced GIS	3	0	0	3	60	40	100
4		GPS & Surveying	3	0	0	3	60	40	100
5		Advanced GIS Lab	0	0	2	1	40	60	100
6		Satellite Image Processing Lab	0	0	2	1	40	60	100
7		Minor Project	0	0	6	3	40	60	100
		Total	**12**	**1**	**10**	**18**	**360**	**340**	**700**

Scheme of Examination for M.Tech. Remote sensing and GIS 2022-23
Third 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		Department Electives-I	3	0	0	3	60	40	100
3		Department Electives-II	3	0	0	3	60	40	100
4		Dissertation Phase-I	0	0	12	6	40	60	100
		Total	**9**	**1**	**12**	**16**	**220**	**180**	**400**

Fourth Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination Marks		Subject Total
							Ext.	Int.	
1		Dissertation Phase-II	-	-	-	16	100	100	200
		Total	-	-	-	**16**	**100**	**100**	**200**

S. No.	Specialization	Departmental Elective I	Departmental Elective II
1	Remote sensing and GIS	Web and Mobile GIS 3-0-0(3)	Global Navigation Satellite System 3-0-0(3)
2		Argo Remote Sensing 3-0-0(3)	Advanced Surveying and Cartography 3-0-0(3)
3		Remote Sensing Geology 3-0-0(3)	Pattern Recognition and Machine Learning 3-0-0(3)

First Semester

1. Name of the Department: CIVIL ENGINEERING						
2. Course Name	**Principles of 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)		**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

Physics of remote sensing, platforms, sensors, data acquisition systems, applications of remote sensing in science and engineering

9. Learning objectives:

- To understand the basic of remote sensing and its applications
- To understand the various platforms and sensors
- Knowledge of data acquisition and its processing

10. Course Outcomes (COs):

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

1. Select the type of remote sensing data for mapping earth surface features
2. Analyze the energy interactions with the atmosphere and earth surface features
3. Identify the earth surface features from satellite images
4. Apply remote sensing techniques for natural resources evaluation

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Physics of Remote Sensing**

Sources of Energy, Active and Passive Radiation, Electromagnetic Radiation - Reflectance, Transmission, Absorption, Thermal Emissions, Interaction with Atmosphere, Atmospheric windows, Spectral reflectance of Earth's surface features, and Multi concept of Remote Sensing..

Unit - 2	**Number of lectures = 10**	**Title of the unit: Platforms and Sensors**

Various types of platforms, different types of aircraft, manned and unmanned spacecrafts used for data acquisition - characteristics of different types of platforms - airborne and spaceborne, IRS Satellite Sensors, LANDSAT, SPOT, IKONOS, Quickbird, Geoeye, Kompsat, Worldview II & III, Microwave, ALOS, Planet Data, Sentinel, SMAP, MODIS

Unit - 3	**Number of lectures = 10**	**Title of the unit: Data Acquisition Systems**

Optical, Thermal and Microwave; Resolutions - spatial, spectral, radiometric and temporal, signal to noise ratio, LiDAR data acquisition and processing.

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

Applications of Remote sensing in various Engineering and Science domains such as Agriculture, Forest, Soil, Geology, LU/LC, Water Resources, Urban, Disaster Management, etc.

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

1. https://nptel.ac.in/courses/105/108/105108077/
2. https://nptel.ac.in/courses/105/101/105101206/

3.https://nptel.ac.in/courses/105/107/105107201/

13. Books Recommended (5 Text Books + 3 Reference Books)

TEXTBOOKS:

- Introduction to Remote Sensing, James B. Campbell & Randolph H. Wynne., The GuilfordPress, 2011.
- Introduction to the physics and techniques of Remote Sensing, Charles Elach & Jakobvan Zyl., John Wiley & Sons publications, 2006.
- Remote Sensing and Image Interpretation, Lillesand T.M & Kiefer R.W., John Wiely andSons, 2015

REFERENCE BOOKS:

- Thermal microwave radiation: Applications for remote sensing, Chritian Matzler., Theinstitution of Engineering and Technology, London, 2006
- Remote Sensing: Models and Methods for Image Processing, Schowengerdt, R.A., Academic Press, 2007.
- Introduction to Remote Sensing, Cracknell, A.P., Second Edition, Tylor & Francis, London,1991.

1. Name of the Department: CIVIL ENGINEERING						
2. Course Name	**Geographical Information Systems**	**L**	**T**		**P**	
3. Course Code		**3**	**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 = 42		**Tutorials = 0**	**Practical = 0**			

8. Brief Syllabus

Introduction of GIS, analysis and mapping system, Integration of location data, Layout the groundwork for mapping and analysis.

9. Learning objectives:

- Analyze the basic fundamental component of GIS
- Understand and analyze the maps and coordinate systems
- Identify the mapping inaccuracies
- Understand the spatial and attribute data

10. Course Outcomes (COs):

The basic concepts included in this course will help the student to gain:

1. Analysethebasic componentsof GIS
2. Classifythemaps,coordinatesystems andprojections
3. Processspatialandattribute dataandprepare thematicmaps
4. Identifyandrectifymappinginaccuracies
5. ConceptualizeaGISproject

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Map and Fundamentals of GIS**

Mapping concepts, analysis with paper based maps, limitations, Computer Automated Cartography – History and Developments, GIS- Definition, advantages of digital maps, projections and coordinate systems.

Information Systems, Modelling Real World Features Data, Data Models – Spatial and Non-spatial, Components, Data Collection and Input, DataConversion, Metadata.

Unit – 2	**Number of lectures = 8**	**Title of the unit: Database Management**

Database Structures, Files; Standard Data Formats, Compression Techniques, Hardware and Software.

Types of Errors, Editing and Error Rectification, Types of Topology, Modelling topological Relationships, Tolerances.

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

Proximity Analysis, Overlay Analysis, Buffer Analysis, Network Analysis — Route alignment, Canal alignment; Digital Elevation Models. Map composition, Preparation of qualitative and quantitative maps, levels of maps, map elements and map scales, 3D Analyst

Unit – 4	Number of lectures = 10	Title of the unit: GIS Project Planning and Implementation
Understanding the Requirements, Phases of Planning, Specifications, and Procedure for analysis projects and design projects		

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

1. https://nptel.ac.in/courses/105/102/105102015/
2. https://nptel.ac.in/courses/105/107/105107155/
3. https://nptel.ac.in/courses/107/105/107105088/

12. Books Recommended (5 Text Books + 3 Reference Books)

TEXTBOOKS:

- Geographic Information systems and Science, Paul Longley., John Wiley & Sons, 4th Edition,2015.
- Introduction to Geographic Information Systems, 9th Edition, Kang Tsung Chang., Tata McGraw Hill Publishing Company Ltd, New Delhi, 2018.
- Concepts and Techniques of Geographic Information Systems, C.P.Lo & Albert K.W.Yeung, second Edition, Prentice Hall India Pvt. Ltd, 2016.

REFERENCE BOOKS:

- Principles of GIS for Land Resource Assessment, Burrough, P.A., Oxford Publications,2005.
- The design and implementation of Geographic Information Systems, John E. Harmon &Steven J. Anderson., John Wiley & Sons, 2003.

1. Name of the Department: CIVIL ENGINEERING						
2. Course Name	**Photogrammetry**	**L**	**T**		**P**	
3. Course Code		**3**	**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 = 42		**Tutorials = 0**	**Practical = 0**			

8. Brief Syllabus

Fundamental of aerial photography system, scale, Stereoscopes, Analytical Photogrammetry**,** aerial triangulation, digital Photogrammetry, unmanned air vehicle (UAV) and its application

9. Learning objectives:

- Collection and analysis of aerial photographs
- Analyze the point cloud data for documentation and archiving of features
- Understand UAV

10. Course Outcomes (COs):

The basic concepts included in this course will help the student to gain:

1. Acquire, measure and analyze aerial photographs
2. Interpret aerial photographs
3. Perform orientation of photos to generate orthophotos and mosaics using aerial photographs and UAV data
4. Analyze the point cloud data for documentation and archiving of features

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Fundamentals of Aerial Photography Systems**

Historical development – classification, application – analogue and digital cameras – geometry of vertical photographs

scale – coordinate transformations, relief displacement – tilted and oblique photographs, Flight Planning, Interpretation keys.

Stereoscopes, stereoscopic view and its exaggeration – parallax equation – parallax measurement–parallax bar-measurement of heights and determination of slopes- stereoscopic plotting instruments.

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

Concepts of orientation-interior, relative and absolute orientation of aerial photographs, Aerial triangulation, Block adjustment, Orthophotos, Kinds of mosaics- controlled, semi-controlled, uncontrolled.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Digital Photogrammetry**

Automatic DTM acquisition from stereo pairs or image blocks, Colour balancing, Digital image enhancement, Feature extraction. DEM Applicationsin Civil Engineering

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

History of unmanned air vehicle (UAV) development. Classifications and components of UAVs – Design standards and Regulatory aspects – Environment, Budget & Time, Airframe Design &

Payload, Flight planning, Mosaicing, Ground control, Feature detection and mapping, Point cloud, 3D Models, DEM generation, Orthophoto generation, UAV Applications.

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

https://nptel.ac.in/courses/105/104/105104100/

13. Books Recommended (5 Text Books + 3 Reference Books)

TEXTBOOKS:

- Elements of Photogrammetry with Application in GIS, Wolf P. R., McGraw HillInternational Book Company, Fourth Edition, 2014.
- Photogrammetry, Moffitt, Francis H. & Mikhail, Edward M., Harper and Row Publishers,1980.
- Fundamentals of Computational Photogrammetry, Sanjib K Ghosh., Concept PublishingCompany, 2005
- Introduction to UAV Systems, Paul Gerin F & Thomas James Gleason., WileyPublications, 2012

REFERENCE BOOKS:

- Digital Photogrammetry Theory and Applications, Wilfried Linder., Springer 2013
- Unmanned Aircraft Systems, Reg Austin, Wiley Publications, 2010
- Aerial Photography and Image Interpretation, Paine D. P., Kiser J. D., John Wiley & Sons,Inc., 2012.
- Introductory Course in Photogrammetry, Zorn H.C., Sixth Edition, ITC, Netherlands, 1980.

1. Name of the Department: CIVIL ENGINEERING						
2. Course Name	**Application Of 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)		**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

Introduction to Remote sensing, Geological Mapping, Geo Science, Remote Sensing Softwares

9. Learning objectives:

- Application of remote sensing data with GIS techniques
- Understand the various geological structures and Geomorphic Landforms
- Understand the concepts involved in mapping of crop acreage and yield estimation, crop damage assessment.
- Understand mapping lithological and structural features, concepts involved in Geomorphic Mapping.

10. Course Outcomes (COs):

On completion of this course, the student shall be able to understand

1. application potentialities of remote sensing data separately and in combination with GIS techniques for Agriculture, Forestry
2. Impart knowledge about the various geological structures and Geomorphic Landforms.
3. Exposure to various Remote Sensing Applications to earth Sciences, urban andregional planning
4. Understand the concepts involved in the mapping of crop acreage and yield estimation, crop damage assessment.
5. Understand mapping lithological and structural features, concepts involved in Geomorphic Mapping.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Remote Sensing In ~~Environmental~~ Geological Mapping**
Rocks types, forms, Minerals and their field characteristics, Image interpretation for delineation oflithology (Rocks) and minerals, Geological structures - Folds, Faults and Joints and their field characteristics, Various important land forms, Image characteristics of geological structures and major land forms		
Unit - 2	**Number of lectures = 10**	**Title of the unit: Cultural Geo Science**
Field Application: Urban Planning and management, Application of Archeology, Agriculture. Application in Disaster management, wet land management, Wildlife management, Forest management		
Unit - 3	**Number of lectures = 8**	**Title of the unit: Remote Sensing Application**
Hyperspectral RS and its application; Microwave RS and its application; Thermal RS and its application; Optical RS and its application		
Unit - 4	**Number of lectures = 12**	**Title of the unit: Remote Sensing Software**
P.C . I Geometica, Tacit ViewTNTmips, ERDAS, ENVI, Opticks,Dragon ,IDRISI, USGS Global		

Visualization Viewer (GloVis), NASA Earth Observation (NEO), USGS Earth,Explorer, ESA's Sentinel data, NOAA, IPPMUS Terra, LANCE, VITO Vision, Bhuva n,MOSDAC, India- WRIS

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

1. https://nptel.ac.in/courses/105/108/105108077/
2. https://nptel.ac.in/courses/105/101/105101206/
3. https://nptel.ac.in/courses/105/107/105107201/

13. Books Recommended (5 Text Books + 3 Reference Books)

TEXTBOOKS:

- Remote Sensing and Image interpretation: Thomas Lille sand & R.W. Keifer, John Wileyand Sons (3rd Ed.).
- Manual of Remote Sensing, Vol. 1, American Society of Photogrammetry.

REFERENCE BOOKS:

- Remote Sensing: Principles and Interpretation: F. Sabins, Freeman Publication.
- Remote Sensing of the Environment by J.R. Jensen, Pearson Publication

1. Name of the Department		**CIVIL ENGINEERING**				
2. Course Name	**Research Methodology and IPR**	L	T		P	
3. Course Code		3	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 = 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. 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:

Triangulation, Concept of Lines of sight

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	Geographical Information Systems Lab	**L (3)**	**T (0)**		**P (2)**	
3. Course Code						
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. Brief Syllabus

Mapping, Layering, Georeferencing, Data Analysis

9. Learning objectives:

- Computation of geometric measurement
- Preparation and integration of different geospatial layers
- Creation of high quality maps and associated graphics

10. Course Outcomes (COs):

The basic concepts included in this course will help the student to enhance his/her skills in:

1. Prepare the different geospatial layers
2. Compute geometric measurements and perform spatial analysis
3. Create high-quality maps and associated graphics
4. Integrate different geospatial layers

11. List of Experiment

Sr. No.	Title
1	Importing maps and layers from various sources
2	Georeferencing and projection
3	Digitization of Points and Lines
4	Editing Map Elements
5	Attribute Data Entry and Manipulation
6	Cleaning, Building and Transformation
7	Buffer Analysis
8	Network Analysis
9	Data Analysis – Overlay, Buffer

Second Semester

1. Name of the Department: CIVIL ENGINEERING						
2. Course Name	**Geospatial data Processing and Modeling**	**L**	**T**		**P**	
3. Course Code		**3**	**1**		**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 = 14**	**Practical = 0**			

8. Brief Syllabus

Interpolation, Geo-statistical Method, DTM application, GIS models, programming tools

9. Learning objectives:

- Understand various advanced GIS tools
- Analyze GIS data using complex geospatial models
- Solve geospatial problems using programming tools

10. Course Outcomes (COs):

The basic concepts included in this course will help the student to gain:

1. Apply advanced GIS tools
2. Prepare GIS data for various elevation models
3. Solve geospatial problems using programming tools
4. Analyze GIS data using complex geospatial models

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Interpolation Methods**
Local and Global methods of Interpolation, Kriging methods, Geo-statistical Methods.		
Unit – 2	**Number of lectures = 8**	**Title of the unit: DTM Applications**
Slope and aspect; site selection studies, viewshed and watershedanalysis; Working with Open Source DEM's		
Unit – 3	**Number of lectures = 12**	**Title of the unit: GIS Models and Programming tools**
Modelling Process; Classification; Model builder tools. Python, R programming and MATLAB concepts for geo-processingtools		
Unit – 4	**Number of lectures = 14**	**Title of the unit: Free and Open Source GIS**
Components, Data Sources, Free and open source GISsoftware and applications		

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

1.https://nptel.ac.in/courses/105/102/105102015/

2.https://nptel.ac.in/courses/105/107/105107155/

3.https://nptel.ac.in/courses/107/105/107105088/

13. Books Recommended (5 Text Books + 3 Reference Books)

TEXTBOOKS:

1. Principles of GIS for Land Resource Assessment, Burrough, P.A., Oxford Pub., 2005.
2. Concepts and Techniques of Geographic Information Systems, C.P. Lo & Albert K.W. Yeung, second Edition, Prentice Hall India Pvt. Ltd, 2016.
3. Remote Sensing and Image Interpretation, Lilles T.M and Kiefer R.W., John Wiley, 2015

REFERENCE BOOKS:

- Remote Sensing Imagery, Florence Tupin, Jordi Inglada and Jean-Marie Nicolas, ISTEand Wiley, 2014
- Principles of GIS for Land Resource Assessment, Burrough, P.A., Oxford Publications,2005.

1. Name of the Department: CIVIL ENGINEERING						
2. Course Name	**Satellite Image Processing**	**L**	**T**		**P**	
3. Course Code		3	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 = 42		**Tutorials = 0**	**Practical = 0**			

8. Brief Syllabus

Data products, digital image formation, enhancement, and processing, segmentation, image classification techniques

9. Learning objectives:

- Classification of remote sensing data
- Analysis of remote sensing data using image processing
- Evaluation of accuracy of image classification

10. Course Outcomes (COs):

The basic concepts included in this course will help the student to gain:

1. Analyze remote sensing data using image processing techniques.
2. Classify the remote sensing data
3. Evaluate the accuracy of image classification
4. Apply advanced processing methods to map geographical features

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Data Products and Image Preprocessing**

Data Products and Their Characteristics, Digital image formation, digital image display mechanism, image histograms, look up table data, Pre-processing — Atmospheric, Radiometric, Geometric Corrections - Basic Principles of Visual Interpretation, Ground Truth, Orthorectification, Applications

Unit - 2	**Number of lectures = 12**	**Title of the unit: Image enhancements and processing**

Linear and non-linear Contrast enhancement techniques, density slicing, pseudo colour images, spatial enhancement techniques (convolution filtering), spectral enhancement techniques, Image algebra, PCA, data fusion techniques

Segmentation - Methods, MDL, Watershed, Mean-shift, Edge detection; Spectral indices - Vegetation indices, water related indices, indices related to cloud properties, Google Earth Engine platform for satellite data processing

Unit - 3	**Number of lectures = 12**	**Title of the unit: Image Classification Techniques**

Supervised Classification, Training set - Statistical computation, understanding feature space & scatter plots, signature purity & separability, Signature Baye's decision rule, non-parametric & parametric classification techniques, minimum distance rule, Parallelepiped algorithm, maximum like-hood method, unsupervised and hybrid classification techniques, classification analysis - confusion matrix, error analysis & kappa coefficient, Analysis of Multi-Temporal series and change detection.

Number of lectures = 8	**Number of lectures = 8**	**Title of the unit: Advanced classification techniques**

Learning methods, Object, Texture, Object based Fuzzy, ANN and SVM classification techniques, sub-pixel mixture analysis; Object Oriented Image Classification

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

1. https://www.nrcan.gc.ca/maps-tools-publications/satellite-imagery-air-photos/tutorial-fundamentals-remote-sensing/9309
2. https://nptel.ac.in/courses/105/107/105107160/

13. Books Recommended (5 Text Books + 3 Reference Books)

TEXTBOOKS:

- Digital Image Processing, John R J, Introductory Prentice Hall, New Jersey,2016.
- Remote Sensing Imagery, Florence Tupin, Jordi Inglada and Jean-Marie Nicolas, ISTEand Wiley, 2014.
- Remote Sensing and Digital Image Processing, Jarocińska, Anna, van der Meer, Freek D.,Springer, 2016

REFERENCE BOOKS:

- An Introduction to Support Vector Machines, Nello Cristiani and John Shawe Taylor.,Cambridge University Press, 2013
- Remote Sensing and Image Interpretation, Lillesand, T.M., Kiefer, R.W. and Chapman, J.W., Fifth Edition, John Wiley & Sons, 2007.
- Digital Image Processing, Gonzalez, Rafael C. and Richard E. Woods, Third Edition, Pearson Education, London.

1. Name of the Department: CIVIL ENGINEERING						
2. Course Name	Advanced GIS Technology	**L**	**T**		**P**	
3. Course Code		**3**	**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 = 42		**Tutorials = 0**	**Practical = 0**			

8. Brief Syllabus

Data quality, error in GIS database, project evaluation, web mapping, application of internet service to GIS, Spatial and network analysis

9. Learning objectives:

- Study of advanced spatial analysis using GIS tools
- Analysis of GIS data with geospatial models
- Solution of geospatial error using GIS tools
- Development and analysis of GIS model

10. Course Outcomes (COs):

The basic concepts included in this course will help the student to gain:

1. Conduct advanced spatial analyses using GIS tools
2. Study GIS data with complex geospatial models.
3. Solve the geospatial error using GIS tools.
4. Develop models in GIS using Open source and Web GIS.
5. Analyse GIS model like TIN, DEM, Watershed and View shed.

11. Unit wise detailed content

Unit-1	**Number of lectures = 16**	**Title of the unit: Data quality and errors in GIS**

Nature of geographic data, Sources of errors in GIS database, Data quality parameters, Handling error in GIS, Error propagation in GIS. Human and Organizational issues: The issue of GIS applications and users, Justifying the investment in GIS. Choosing and implementation of GIS, Organizational changes due to GIS. GIS project design and management: Problem identification, designing a data model, Project management, Implementation problem, Project evaluation.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Internet GIS**

Principles of computer network, Network type, Client server computing concept, Application of internet services to GIS software. Issues in GIS and trends: Development of computer method for handling spatial data, Web Page Basics, Web Mapping, Geospatial Web Services, Application of Internet services to GIS, Internet GIS software

Unit – 3	**Number of lectures = 10**	**Title of the unit: Spatial analysis**

Digital Terrain Modeling and other raster analysis, Vector overlay analysis, TIN. View shed analysis and its application. Watershed analysis and its application

Unit – 4	**Number of lectures = 8**	**Title of the unit: Network Analysis**

Link and link impedance, Node and turn impedance, Overpass and underpass. Network applications: Shortest path analysis, closest facility allocation, Location allocation.

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

1. https://nptel.ac.in/courses/105/108/105108077/
2. https://nptel.ac.in/courses/105/101/105101206/
3. https://nptel.ac.in/courses/105/107/105107201/

13. Books Recommended (5 Text Books + 3 Reference Books)

TEXTBOOKS:

- Principles of GIS: P.A. Burrough and Rachel A.M. McDonnel, Oxford.
- Concepts and Techniques of GIS by C.P. Lo and A.K.W. Yeung, Prentice Hall.

REFERENCE BOOKS:

- An Introduction to GIS by Heywood, Cornelius and Carver, Pearson Education
- Pinde Fu and Jiulin Sun, Web GIS: "Principles and Applications", ISBN:9781589482456, ESRI, 2010.

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**			

7. Brief Syllabus:

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. 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

10. 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 = 12**	**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 = 10**	**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.,

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

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

12. 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. Course Name	**Satellite Image Processing Lab**	
2. Course Code		
3. Type of Course (use tick mark)		
4. Pre-requisite (if any)		
Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)		
Lectures = 00	**Tutorials = 00**	Practical = 28

Sr. No.	**Title**
1	Loading, Creating Image and Display Manipulation
2	Image Enhancement – Linear and Nonlinear
3	Geometric Correction and Mosaicing
4	Band Ratioing
5	Image Indices – NDVI, LAI, RVI etc.
6	Spectral Enhancement
7	Generation of Training Sets
8	Supervised Classification and Accuracy Assessment
9	Change Detection
10	Model Builder
11	Programs for Image Analysis

1. Name of the Department: CIVIL ENGINEERING						
2. Course Name	Advanced GIS Lab	**L (3)**	**T (0)**		**P (2)**	
3. Course Code						
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 = 36		**Tutorials = 0**	**Practical = 0**			

8. Brief Syllabus

Programming tools for geospatial application,

9. Learning objectives:

- Performance of advanced geospatial analysis
- Development of programming tools for geospatial application

10. Course Outcomes (COs):

The basic concepts included in this course will help the student to gain:

1. Model Geospatial data
2. Perform advanced geospatial analysis
3. Develop programming tools for geospatial applications
4. Publish geospatial data in public domain

11. Unit wise detailed content

Sr. No.	Title
1	Interpolation methods
2	Viewshed and watershed analysis
3	Modelling tools
4	Python and R programming geospatial tools
5	Web GIS Applications

<table>
<tr><td colspan="8">1. Name of the Department – Civil Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Minor Project</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td colspan="2">00</td><td colspan="2">00</td><td>6</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td colspan="2">Core (✓)</td><td colspan="2">PE()</td><td colspan="2">OE()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td colspan="2"></td><td colspan="2">6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 00</td><td colspan="3">Tutorials = 00</td><td colspan="2">Practical = 40</td></tr>
<tr><td colspan="8">8. Brief Syllabus
Minor Project will include identification of the problem based on the literature review and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.</td></tr>
<tr><td colspan="8">9. Learning objectives:
1. The course is intended to teach the basic concepts of identification and solution of a specific problem.
2. To compare and analyze the various topologies for the selected topic of interest.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="8">On completion of this course, the students will be able to
1. Identify structural engineering problems reviewing available literature.
2. Study different techniques used to analyze complex structural systems.
3. Work on the solutions given and present solution by using his/her technique applying engineering principles.</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td colspan="8">Minor Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.
End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.
Continuous assessment of Mini Project at Mid Sem and End Sem will be monitored by the departmental committee</td></tr>
</table>

Third 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 =12**	**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 =12**	**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 lectures =8**	**Title of the unit: Data Merging and GIS Integration**

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 = 10**	**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 link to the E-Learning portal.

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

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

<table>
<tr><td colspan="8">1. Name of the Department – Civil Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Dissertation Phase-I</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td colspan="2">00</td><td colspan="2">00</td><td>12</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td colspan="2">Core (✓)</td><td colspan="2">PE()</td><td colspan="2">OE()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td colspan="2"></td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 00</td><td colspan="3">Tutorials = 00</td><td colspan="2">Practical = 168</td></tr>
<tr><td colspan="8">8. Brief Syllabus
In this course, student will finalize the research problem and will complete the literature review for Thesis.</td></tr>
<tr><td colspan="8">9. Learning objectives:
1. Analyzing the literature will help students find structural engineering issues.
2. To determine the most effective methods for analyzing complex structural systems.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="8">On completion of this course, the students will be able to
1. Identify structural engineering problems reviewing available literature.
2. Identify appropriate techniques to analyze complex structural systems.
3. Apply engineering and management principles through efficient handling of project</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td colspan="8">Dissertation-I will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.
End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research.</td></tr>
</table>

Departmental Elective

1. Name of the Department: CIVIL ENGINEERING						
2. Course Name	**Web and Mobile GIS**	**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

Web GIS, its function, wen mapping, mobile GIS

9. Learning objectives:

- Analysis of geospatial layers in web environment.
- Development of application in web and mobile platforms
- Publication of geospatial data in mobile applications

10. Course Outcomes (COs):

The basic concepts included in this course will help the student to gain:

1. Publish geospatial data in web environment
2. Analyze the geospatial layers in web environment
3. Prepare and publish geospatial data in mobile applications
4. Develop applications in web and mobile platforms

11. Unit wise detailed content

Unit-1	**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, Distributed GIS, users and stake holders of web GIS, advantages and limitations of web GIS, overview of Web GIS.

Unit – 2	**Number of lectures = 8**	**Title of the unit: Web Mapping**

Static and interactive web mapping, Web-map services, open GIS web map server, Geographic Mark-up Language - principles and characteristics, commercial web mapping programs.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Functions of Web GIS**

Hosting and Display of general information for the public, display of planning information, interactive display of spatial information, sharing and distribution of spatial data as well as management of spatial data, Style Layer Description (SLD), Open layers, Geo-server applications

Unit – 4	**Number of lectures = 12**	**Title of the unit: Mobile GIS**

Location based services, Case studies on Mobile Solutions; Mobile App Development Approaches, HTML5 Geolocation; Creating a Mobile App, jQuery Mobile - Components, Event Handling, Mobile Configuration Third-party APIs; Google Maps API; ArcGIS API; Leaflet API, Mobile App development in Android, IOS platforms

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

This will involve the NPTEL and SWAYAM portal systems for holistic knowledge. PowerPoint Presentation will be used and assist in the pictorial-based learning and enhance the knowledge in a planned

way. The lecture series on the online platform will be beneficial for the students. The online assignments will be designated to students at large.

OnlineResources:

1.https://felix-rz.github.io/pdf/2013_Tutorial_GIS.pdf

13. Books Recommended (5 Text Books + 3 Reference Books)

TEXTBOOKS:

- A. Web Cartography: Development and Prospects, Kraak, M. and Brown, Taylor andFrancis, London, 2001.
- Web GIS Application in Local Government, Tereshenkov, A., VDM Verlag, 2009.
- GIS for Web Developers. Adding where to your web applications, Davis, S, First Edition,The Pragmatic Programmers LLC, 2007.

REFERENCE BOOKS:

- Web GIS: Principles and Applications, Pinde Fu and Jiulin Sun, ESRI Press, 2011
- Mobile: Up and Running, Maximiliano Firtman., jQuery, O'Reilly, 2012
- Dynamic and Mobile GIS, Drummond, J., & Group, F., First Edition, CRC Press Taylor andFrancis Group, 2007.

1. Name of the Department: CIVIL ENGINEERING						
2. Course Name	Argo Remote Sensing	**L (3)**	**T (0)**		**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

Statellite sensors, Agro-Meteorological Applications of Optical, Microwave, Thermal and Hyperspectral Remote Sensing, crop informatics, Crop condition and cropping system analysis using different sensors

9. Learning objectives:

- Analysis of basic vegetation parameters and their interaction
- Assessment of sensor role in crop conditions during various stages of agricultural practices.
- Application of different sensors to predict and forecast the variable affecting the agricultural production.

10. Course Outcomes (COs):

The basic concepts included in this course will help the student to gain:

1. Acquire state of art sensor data to retrieve crop parameters
2. Analyze the basic vegetation parameter and their interaction with different parts of the Electromagnetic Spectrum
3. Assess the role of sensor data to study the crop conditions during various stagesof agricultural practices.
4. Apply different sensors to predict and forecast the variables affecting the agricultural production

11. Unit wise detailed content

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

Satellite sensors and their characteristics, Principles, instrumentation and approaches of estimating crop water requirement/ crop ET, Remote sensing of water stress (thermal/optical approaches), various crop parameters: albedo, leaf area index, fAPAR and evapotranspiration

Unit - 2	**Number of lectures = 14**	**Title of the unit: Agro-Meteorological Applications of Optical, Microwave, Thermal and Hyperspectral Remote Sensing**

Surface and vadose zone soil moisture estimation using microwave optical and hyperspectral remote sensing techniques; Soil mapping large-scale high spatial resolution mapping of soil texture information; Assessment, Prediction and Monitoring of Droughts through satellite retrieved causal variable information; Flood mapping and monitoring; Water resources mapping; Real-time weather monitoring.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Crop condition and cropping system analysis using different sensors**

Crop classification and crop area estimation using digital analysis; Crop stress assessment using satellite

data; Crop parameter retrieval, cropping pattern & cropping indices analysis, Crop yield modelling and estimation. Crop water requirements, Irrigation water requirements

Unit - 4	**Number of lectures = 8**	**Title of the unit: Crop Informatics**

ICT application in agriculture at village/ block scale, Demonstration on DSS in agriculture; Precision farming

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

- https://appliedsciences.nasa.gov/join-mission/training/english/arset-satellite-remote- sensing-agricultural-applications
- https://www.nrsc.gov.in/sites/default/files/pdf/ebooks/Chap_1_Agriculture.pdf
- https://www.nrsc.gov.in/sites/default/files/pdf/ebooks/Chap_13_AgricultureDroughtMonitoring.pdf

13. Books Recommended (5 Text Books + 3 Reference Books)

TEXTBOOKS:

- Applications of remote sensing in agriculture., M.D. Steven, J.A. Clark, Butterworthpublisher, London, 1990
- Manual of Remote Sensing, Ustin, S, Remote Sensing for Natural Resource Management and Environmental Monitoring, 3rd Edition, Volume 4, Willey Publishing. 2001
- Agrometeorology and sustainable agriculture. M.V.K. Sivakumar, R. Gommes, W. Baier Agricultural and Forest Meteorology 103 (2000) 11–26
- Application radar in Agriculture, Holmes M.G., Remote sensing applications to agriculture, Butterworth publisher, London, 1990.

REFERENCE BOOKS:

- Introduction to Agrometeorology (1994), Second edition by H.S. Mavi, Oxford & IBH Publishing Co. Pvt. Ltd.
- Remote Sensing for Agriculture, Ecosystems, and Hydrology, Manfred Owe; Guido D'Urso(2005). Proceedings of SPIE Volume: 5976.

1. Name of the Department: CIVIL ENGINEERING							
2.	**Course Name**	Remote Sensing Geology	**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

Radiation, concept of remote sensing, platforms, spacecraft, sensors, data acquisition and processing, Hydrogeology, Subsurface exploration techniques

9. Learning objectives:

- Interpretation of the satellite imageries for geological features
- Identification and analysis of geological structures from satellite images
- Application of geophysical principles for subsurface exploration
- Identification of ground water potential zones, landslide hazard zones and mineral resources

10. Course Outcomes (COs):

The basic concepts included in this course will help the student to gain:

1. Interpret the satellite imageries for geological features
2. Identify and analyse geological structures from satellite images
3. Apply geophysical principles for subsurface exploration
4. Identify ground water potential zones, landslide hazard zones and mineral resources

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Physics of Remote Sensing**

Sources of Energy, Active and Passive Radiation, Electromagnetic Radiation - Reflectance, Transmission, Absorption, Thermal Emissions, Interaction with Atmosphere, Atmospheric windows, Spectral reflectance of Earth's surface features, and Multi concept of Remote Sensing.

Unit – 2	**Number of lectures = 12**	**Title of the unit: Platforms and Sensors**

Various types of platforms, different types of aircraft, manned and unmanned spacecrafts used for data acquisition - characteristics of different types of platforms - airborne and spaceborne, IRS Satellite Sensors, LANDSAT, SPOT, IKONOS, Quickbird, Geoeye, Kompsat, Worldview II & III, Microwave, ALOS, Planet Data, Sentinel, SMAP, MODIS etc

Unit – 3	**Number of lectures = 10**	**Title of the unit: Data Acquisition Systems**

Optical, Thermal and Microwave; Resolutions - spatial, spectral, radiometric and temporal, signal to noise ratio, LiDAR data acquisition and processing.

Unit – 4	**Number of lectures = 8**	**Title of the unit: Exploration Techniques**:

Subsurface exploration techniques, geophysical investigations — electrical resistivity and seismic methods.

Hydrogeology - principles of groundwater and ground water geology Ground water flow, surface and ground water interaction; controls of ground water occurrence and movement Ground water geology: Hydrogeological properties of different rocks, structures and landforms and their detection from remotelysensed data, Ground water targeting and resource assessment Ground water targeting in different geologic terrains, rain water harvesting, artificial ground water recharge.

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

1. https://www.nrcan.gc.ca/maps-tools-publications/satellite-imagery-air-photos/tutorial-fundamentals-remote-sensing/9309

13. Books Recommended (5 Text Books + 3 Reference Books)

TEXTBOOKS:

- Remote Sensing Geology, Ravi P. Gupta, Springer Verlag Publications, 2017.
- Remote sensing: Principles and Interpretation, Floyd F. Sabins., W.H. Freeman andCompany, 2020.
- Text Book of Engineering Geology, N. Chenna Kesavulu., Mac Millan Ltd., New Delhi.2018

REFERENCE BOOKS:

- Principles of Geomorphology, Thornbury, W.D., New Age International Publishers, 2018.
- Image Interpretation in Geology, Druary, S.A., Allen and Unwin Ltd, 2004.
- Remote Sensing and Image Interpretation, Thomas Lillesand, Ralph W. Kiefer, JonathanChipman, Wiley Publishers, 2015
- Fundamentals of Remote Sensing, George Joseph, C Jeganathan, University Press, 2015

1. Name of the Department: CIVIL ENGINEERING						
2. Course Name	**Global Navigation Satellite 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)		**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

Introduction, GPS system, reference system, coordinate system, GNSS Survey**,** Satellite Orbits and signal

9. Learning objectives:

- Identification of GNSS components and functions
- Interpretation of navigation message and GNSS satellite signals
- Identification of error sources and application corrections in GNSS observations
- Processing of GNSS data for accurate positioning

10. Course Outcomes (COs):

The basic concepts included in this course will help the student to gain:

1. Identify GNSS components and their functions
2. Select GNSS survey method
3. Interpret navigation message and GNSS satellite signals
4. Identify error sources and apply corrections in GNSS observations
5. Process GNSS data for accurate positioning

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Introduction**

History of GNSS; GPS system - Services and Segments, GLONASS system- Services and Segments, Galileo System- Services and Segments, Regional Navigation Satellite Systems (RNSS), Augmentation Systems, GAGAN, IRNSS systems.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Reference Systems and Coordinate systems**

Definition and scope of Geodesy, Earth, Geoid and Ellipsoid of rotation, Reference surfaces and coordinate systems in Geodesy, Indian Geodetic System and Everest Spheroid, WGS84, Geodetic coordinate systems, Datum transformations, Height systems, Time systems.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Satellite Orbits and signal**

Orbit - Description, Determination and Dissemination

Structure of Signal, Navigation messages. Pseudo range measurements, Atmospheric effects, Antenna phase center offset and variation, Multipath, system accuracy characteristics, Data formats, Error budget.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Surveying with GNSS and data**

		processing

Planning a GNSS Survey, Positioning methods — point positioning, relative positioning, Static, Differential, RTK, and Field data collection.

Ambiguity resolution, Post processing, real time processing, Accuracy measures, software modules, GIS and GNSS data integration, Applications of GNSS

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

This will involve the NPTEL and SWAYAM portal systems for holistic knowledge. PowerPoint Presentation will be used and assist in the pictorial-based learning and enhance the knowledge in a planned way. The lecture series on the online platform will be beneficial for the students. The online assignments will be designated to students at large.

Online Resources:

1.https://nptel.ac.in/courses/105/107/105107194/

13. Books Recommended (5 Text Books + 3 Reference Books)

TEXTBOOKS:

- GNSS: Global Navigation Satellite Systems, Hofmann-Wellenhof, Lichtennegger andWasle., Springer-Verlag Wein, New York, 2008.
- Satellite Geodesy Foundations-Methods and Applications, Gunter Seeber., 2003.
- GNSS Remote Sensing: Theory, Methods and Applications, Shuanggen Jin, EstelCardellachadn Feiqin Xie., Springer, London, 2017.

REFERENCE BOOKS:

- Springer Handbook of Global Navigation Satellite Systems, Peter J.G. Teunissen, OliverMontenbsruck., Springer International Publishing, 2017
- GNSS Insights into GPS, GLONASS, Galileo, Compass and Others, B. Bhatta., CRCPress, 2011
- GNSS Systems and Engineering: The Chinese Beidou Navigation and Position LocationSatellite, Tan, S.,John Wiley& Sons, Singapore, 2018.
- Environmental Monitoring using GNSS: Global Navigation Satellite Systems, Awange, J.L, Springer, London, 2012

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. 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**

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

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**

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.

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**	**Title of the unit: Field Astronomy:**

	lectures = 10	
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-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. 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.

Fourth Semester

<table>
<tr><td colspan="8">1. Name of the Department – Civil Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Dissertation Phase-II</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td colspan="2">00</td><td colspan="2">00</td><td>00</td></tr>
<tr><td colspan="4">4. Type of Course (use tick mark)</td><td colspan="2">Core (✓)</td><td colspan="2">PE()</td><td>OE()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td colspan="2"></td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="9">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 00</td><td colspan="3">Tutorials = 00</td><td colspan="3">Practical = 00</td></tr>
<tr><td colspan="9">8. Brief Syllabus
In this course, student will complete the thesis work.</td></tr>
<tr><td colspan="9">9. Learning objectives:
1. Utilize the right strategies and tools to resolve complicated structural issues.
2. Demonstrate effective communication to the engineering community and the general public.</td></tr>
<tr><td colspan="9">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="9">On completion of this course, the students will be able to
1. Solve complex structural problems by applying appropriate techniques and tools.
2. Exhibit good communication skill to the engineering community and society.
3. Demonstrate professional ethics and work culture.</td></tr>
<tr><td colspan="9">11. Unit wise detailed content</td></tr>
<tr><td colspan="9">Dissertation – II will be extension of the to work on the topic identified in Dissertation – I. Continuous assessment should be done of the work done by adopting the methodology decided involving numerical analysis/ conduct experiments, collection and analysis of data, etc.
There will be pre-submission seminar at the end of academic term. After the approval the student has to submit the detail report and external examiner is called for the viva-voce to assess along with guide.</td></tr>
</table>