COURSES OF STUDY
FOR
UNDERGRADUATE DEGREE
in
Civil Engineering

Effective for the students admitted in the years 2021-22 and onwards.

B.Tech. : Civil Engineering
4th Year - VII Semester

THEORY											
SN	**Category**	**Course Code**	**Course Title**	**Hours**			**Marks**			**Credit**
				L	**T**	**P**	**IA**	**ETE**	**Total**	
1	DC	7CE4-01	Numerical Methods for Engineers	3	0	0	30	70	**100**	**3**
2	DE*		**Departmental Elective IV**	2	0	0	30	70	**100**	**2**
		7CE5-11	Environmental and Sustainable Development							
		7CE5-12	Geosynthetics							
		7CE5-13	Matrix method of structural analysis							
		7CE5-14	Advanced Transportation Engineering							
		7CE5-15	Engineering hydrology							
3	UE	7CE6-60	**University Elective I**	3	0	0	30	70	**100**	**3**
			SUB TOTAL	**8**	**0**	**0**	**90**	**210**	**300**	**8**
PRACTICAL & SESSIONAL										
4	DC	7CE4-20	Civil Engineering Software Laboratory	0	0	2	60	40	**100**	**1**
6	UI	7CE7-30	Industrial Training	0	0	2*	60	40	**100**	**3**
7		7CE7-50	Project Stage-1	0	0	4*	60	40	**100**	**2**
8	CCA	7CE8-00	SODECA/NCC/NSS/ANANDAM/IPR	-	-	-	-	100	**100**	**1**
				0	**0**	**8**	**180**	**220**	**400**	**7**
			TOTAL OF VII SEMESTER	**8**	**0**	**8**	**270**	**430**	**700**	**15**

L = Lecture, **T** = Tutorial, **P** = Practical, **IA**=Internal Assessment, **ETE**=End Term Exam, **Cr**=Credits

***for calculation of contact hours**

* **It will be mandatory for the department to offer all the electives to the students. However, in case of scarcity of faculty members to offer the DEs, at least 3 electives from DE-IV must be offered.**

B.Tech. : Civil Engineering
4th Year - VIII Semester

THEORY										
SN	**Category**	**Course Code**	**Course Title**	**Hours**			**Marks**			**Credit**
				L	**T**	**P**	**IA**	**ETE**	**Total**	
1	UE	8CE6-60	University Elective II	3	0	0	30	70	**100**	**3**
			SUB TOTAL	**3**	**0**	**0**	**30**	**70**	**100**	**3**
PRACTICAL & SESSIONAL										
2	UI	8CE7-50	Project stage-II	0	0	4*	60	40	**100**	**4**
3		8CE7-40	Seminar	0	0	2*	60	40	**100**	**2**
4	CCA	8CE8-00	SODECA/NCC/NSS/ANAND AM/IPR	-	-	-	-	100	**100**	**2**
			SUB TOTAL	**0**	**0**	**6**	**120**	**180**	**300**	**8**
			TOTAL OF VIII SEMESTER	**3**	**0**	**6**	**150**	**250**	**400**	**11**

L = Lecture, **T** = Tutorial, **P** = Practical, **IA**=Internal Assessment, **ETE**=End Term Exam, **Cr**=Credits

***for calculation of contact hours**

7CE4-01: Numerical Methods for Engineers

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To obtain an understanding on the different methods of Solution of Equations and Eigen value Problems
2. To obtain concept of different Interpolation and Approximation methods.
3. To understand the different methods of numerical differentiation and integration.
4. To understand on Initial Value Problems for Ordinary Differential Equations.
5. To obtain basic understanding of Boundary Value Problems in Ordinary and Partial Differential Equations.

Course Outcomes: Upon completion of this course the students will be able to:

1. To apply different methods of Solution of Equations wherever necessary in Civil Engineering problems.
2. To use different Interpolation and approximation methods in Civil Engineering problems.
3. To use different methods of numerical differentiation and integration.
4. To use Initial Value Problems for Ordinary Differential Equations.
5. To use Boundary Value Problems in Ordinary and Partial Differential Equations.

S. No	Contents	Hours
1	Solution of Equations and Eigen value Problems: Solution of algebraic and transcendental equations, Fixed point iteration method, Newton Raphson method, Solution of linear system of equations, Gauss elimination method, Pivoting, Gauss Jordan method Iterative methods of Gauss Jacobi and Gauss Seidel - Matrix Inversion by Gauss Jordan method.	7
2	Interpolation and Approximation: Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae.	8
3	Numerical Differentiation and Integration: Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.	8
4	Initial Value Problems for Ordinary Differential Equations : Single Step methods - Taylor's series method - Euler's method - Modified Euler's method – Fourth order Runge-Kutta method for solving first order equations - Multi step methods - Milne's and Adams-Bash forth predictor corrector methods for solving first order equations.	9
5	Boundary Value Problems in Ordinary and Partial Differential Equations: Finite difference methods for solving two-point linear boundary value problems - Finite difference techniques for the solution of two-dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank	10

	Nicholson) methods – One dimensional wave equation by explicit method.	
	Total	42

REFERENCE BOOKS

1. Gerald. C. F., and Wheatley. P. O., "Applied Numerical Analysis " Pearson Education, Asia, 6th Edition, New Delhi.
2. Grewal. B.S., and Grewal. J.S, "Numerical methods in Engineering and Science " Khanna Publishers, 9th Edition, New Delhi
3. Chapra. S.C., and Canale.R.P , "Numerical Methods for Engineers" Tata McGraw Hill, New Delhi.
4. Brian Bradie, "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi.
5. Sankara Rao. K., "Numerical methods for Scientists and Engineers" Prentice Hall of India Private, New Delhi

7CE5-11: Environmental and Sustainable Development

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide basic introduction to sustainable development concepts, challenges of sustainable development and boundaries of sustainable development.
2. To give a basic understanding of sustainable development framework, its pillars and application.
3. To aware the students about various issues related to environmentally sustainable urban environment and different engineering tools assess and design them.
4. To aware them about the role of technology towards environmental sustainability.
5. To update students about the individual and social responsibilities and role of government towards sustainable development.

Course Outcomes: Upon completion of this course the students will be able to:

1. The student will be able to understand the basics about sustainable development & its concepts.
2. Understanding about different dimensions of sustainability as well as its different applications.
3. Able to identify the environmental sustainability of transport system and capable to suggest required steps for further enhancement.
4. The students will learn about role of technology in sustainable development.
5. Development of responsibilities towards the protection of environment and society.

S. No	Contents	Hours
1	Evolution of Ideas about sustainability, History of sustainability, Definitions of sustainability, Brundtland commission report, Principles of sustainable development, Objectives of sustainable development, Conc	6
2	Sustainable development framework, Pillars of sustainable development, Impediments to achieving sustainability, Concept of environmentally sustainable development, Environmental dimensions of sustainability, Frameworks to measure sustainable development, Application of sustainability strategies	5
3	Issues of environmentally sustainable urban environment, Sustainable urban transport, Sustainable transport indicators, Engineering tools for assessment and design for environment and sustainability	5
4	Strategies for promoting environmentally sustainable development technology role towards environmentally sustainable transport infrastructure, Importance of incorporating sustainability in design, Case studies of Sustainable design	6
5	Social and environmental, responsibilities towards environmentally sustainable development, Role of local Government, Sustainability in the Third World, Steps for adopting a sustainability approach	6
	Total	28

REFERENCE BOOKS

1. Jennifer A. Elliott. An introduction to sustainable development. ISBN-13: 978- 0415590730.
2. Abdul Malik, Elisabeth Grohmann. Environment protection strategies for sustainable development by. ISBN 978-94-007-1591-2.
3. Sylvie Faucheux, Martin O' Corner Jan van der strateen. Sustainable development: concepts, rationalities, and strategies, ISBN 978-94-017-3188-1.
4. LEAD India (Editor) Rio to Johannesburg: India's Experience in Sustainable Development, Orient Longman, Hyderabad, 2002.
5. Chopra, K., and Kadekodi, G.K. (1999), Operation listing Sustainable Development, Sage Publication, New Delhi.

7CE5-12: Geosynthetics

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+T+0P **End Term Exam: 3 Hours**

Course Objectives

1. In-depth understanding of the evolution, types, and broad applications of various geosynthetics, including geotextiles, geogrids, geonets, geomembranes, and geocomposites.
2. To assess the properties of geotextiles and apply them in designing for separation, reinforcement, stabilization, filtration, and drainage.
3. Understand the geogrids in designing for grid reinforcement and improving bearing capacity.
4. Properties of geonets and designing drainage systems that maximize their hydraulic performance and endurance.
5. Properties of geomembranes, including their chemical and biological resistance, and how to apply these in practical scenarios.
6. Skills in using geocomposites for a variety of functions such as separation, reinforcement, and filtration, emphasizing their use in innovative engineering

Course Outcomes: Upon completion of this course the students will be able to:

1. Understand the development and applications of various geosynthetics, effectively identifying appropriate materials for different engineering projects.
2. Designing with geotextiles for specific engineering purposes, utilizing their understanding of the material properties and test methods.
3. Design and evaluate engineering solutions using geogrids, considering their physical, mechanical, and environmental properties.
4. Design efficient drainage systems using geonets, applying their knowledge of the material's properties and test methods.
5. Proficient in applying geomembranes in various environmental and mechanical engineering contexts, based on their understanding of the material's properties.
6. Integrate geocomposites into complex engineering designs, employing their knowledge of the material's diverse functions and properties for innovative solutions.

S. No	Contents	Hours
1	Introduction: An overview on the development and applications various geosynthetics - the geotextiles, geogrids, geonets, geomembranes and geocomposites. Designing with geotextiles: Geotextile properties and test methods – functions - Designing for separation, reinforcement, stabilization, filtration, drainage	7
2	Designing with geogrids: Geogrid properties and test methods – physical properties, mechanical properties, endurance properties and environmental properties – Designing for grid reinforcement and bearing capacity.	6
3	Designing with geonets: Geonet properties and test methods – Physical properties, mechanical properties, hydraulic properties, endurance properties and environmental properties -Designing geonet for drainage.	5

4	Designing with geomembranes: Geomembrane properties and test methods – physical properties, mechanical properties, chemical properties and biological hazard - Applications for geomembranes.	5
5	Designing with geocomposites - Geocomposites in separation, reinforcement – reinforced geotextile composites – reinforced geomembrane composites – reinforced soil composites using discontinuous fibres and meshes, continuous fibres and three –dimensional cells, geocomposites in drainage and filtration.	5
	Total	28

REFERENCE BOOKS

1. Rao, G.V. – "Geosynthetics – an Introduction", Sai Master Geoenvironmental Services Pvt. Ltd. Hyderabad, 2011.
2. Sivakumar Babu G.L. "An Introduction to Soil Reinforcement and Geosynthetics" University Press, 2005.
3. Koerner, R.M. – "Designing with geosynthetics", Pearson Education Inc., 2005.
4. Shukla, "Fundamentals of Geosynthetic Engg. Imperial College Press, London, 2006.

7CE5-13: Matrix method of structural analysis

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To understand the basic idea of matrix and determinant and their operations
2. To obtain understanding of different type of structural systems, various principles of the structural systems and their characteristics based on which their analysis procedures are determined.
3. To understand the concept of flexibility and stiffness and formulation of matrices
4. To understand analysis procedures of flexibility method and its application on beams and trusses.
5. To understand analysis procedures of Stiffness method and its application on beams and trusses.

Course Outcomes: Upon completion of this course the students will be able to:

1. To perform various operations of matrix
2. To classify different type of structures and various principles
3. To understand the concept of flexibility and stiffness in relation to structure.
4. To analyze a beam and truss using a flexibility method
5. To analyze a beam and truss using the Stiffness method

S. No	Contents	Hours
1	Basic concept of Determinant and Matrix, Addition, subtraction and multiplication of matrix, Inversion of matrix by Adjoint method, Gauss-Jordan method and Choleski method.	6
2	Introduction: Structural systems, geometric and material non-linearity, principle of superposition, equilibrium and compatibility conditions, static and kinematic indeterminacy, principle of minimum potential energy and minimum complementary energy.	5
3	Concepts of stiffness and flexibility, Axial, Shear, Flexural and Torsional stiffness and flexibility; Formulation of flexibility and stiffness matrices of beam and truss elements.	5
4	Element Flexibility Method: Force transformation matrix, global flexibility matrix, analysis of continuous beams and trusses.	6
5	Direct Stiffness Method: Displacement transformation matrix, global stiffness matrix, analysis of continuous beams and trusses.	6
	Total	28

REFERENCE BOOKS

1. Matrix Method of Structural Analysis -Godbole P N et.al -PHI ltd, New Delhi.
2. Structural Analysis-A Matrix Approach -G.S. Pandit and S.P. Gupta- The McGraw Hill companies
3. Introduction to Matrix Methods in Structural Analysis-H C Martin-International textbook company,

McGraw Hill.

4. Matrix Analysis of Framed Structures -Weaver W and Gere J H -CBS publications, New Delhi.
5. Elements of Matrix Analysis and Stability of Structures -Manikaselvam -Khanna Publishers, New Delhi.

7CE5-14: Advanced Transportation Engineering

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+T+0P **End Term Exam: 3 Hours**

Course Objectives

1. An in-depth understanding of transportation system planning, including transportation policy, survey methodologies, and travel demand forecasting techniques.
2. To familiarize with various urban transport technologies, including mass and rapid transit systems, Intelligent Transportation Systems (ITS), and concepts of integrated intermodal transit systems.
3. To equip with knowledge of transport economics, including vehicle operation costs, economic evaluation methods, and financing mechanisms such as BOT and road pricing.
4. To introduce statistical methods used in traffic engineering, including probability distributions, regression analysis, and significance testing, for effective transportation planning.
5. To explore the role and importance of public transportation in urban environments, including transit demand estimation, route planning, and the integration of public transportation modes.

Course Outcomes: Upon completion of this course the students will be able to:

1. Develop a solid understanding of transportation system planning, including the ability to conduct surveys, create OD matrices, and perform travel demand forecasting.
2. To differentiate between various urban transport technologies and understand the application of systems like ITS, BRT, and metro projects in urban planning.
3. Capable of conducting economic evaluations of transportation projects using methods like benefit-cost analysis, NPV, and understanding different financing models for transportation infrastructure.
4. Proficient in applying statistical methods to solve traffic engineering problems, including regression analysis, significance testing, and probability distribution analysis.
5. Gain the skills to estimate transit demand, plan efficient routes, and integrate various public transportation modes into a cohesive urban transportation network.

S. No	Contents	Hours
1	**Transportation system planning:** transportation policy, and types of surveys. OD matrix.travel demand forecasting, trip generation, model split analysis, trip distribution, route assignment analysis, transport network, network	4
2	**Urban transport technology:** classification mass and rapid transit system, introduction to intelligent transportation system (ITS), public transport policy, Intermediate transport, Introduction to BRT, Mono rail, sky bus, metro projects, grade separated interchanges such as flyovers, under passes, overpasses, concept of integrated inter model transit system	4
3	**Transport economics and financing:** vehicle operations cost, running cost, pollution cost, value of travel time, road damage cost, congestion cost, accident cost economic evaluation, various economic studies, transportation plans- benefit cost method, net present value method, first year rate of return method, internal rate of return method and comparison of various methods. Pavement management systems. Highway financing, pay as you go method, credit financing, private financing, BOT, BOOT, dedicated road funds, road	7

	pricing, tolls, private provisions, advantages and limitations.	
4	**Statistical Methods for Traffic Engineering**: Elementary concepts and Probability, Mean, Standard Deviation and variance, Poisson and Binomial Distribution, Normal distribution, sampling Theory and Significance testing, Linear Regression and correlation.	8
5	**Public transportation**: role of urban public transportation modes, Transit System; Estimation of Transit Demand; Route planning techniques Integration of Public Transportation Modes. Public transport Infrastructure.	5
	Total	28

REFERENCE BOOKS

1. L. R. Kadiyali (2014). Traffic Engineering and Transport planning, , Khanna Publishers, ISBN No. :81-7409-220-X.
2. Nicholas J. Garber and Lester A. Hoel (2008). Principles of Traffic and Highway Engineering, Cengage Learning, ISBN-13:979-81-315-1246-3.
3. Kumar Molugaram, G. Shanker Rao (2017). “Statistical techniques for transportation Engineering”, Butterworth Heinemann.
4. Ortuzar, J.D.D. and Willumsen, L.G. (1990). “Modelling Transport”, John Wiley & Sons.
5. Papacostas, C.S. (2015). Transportation Engineering and Planning. 3rd Edition, Prentice - Hall of India Pvt Ltd.
6. Konstadinos G. Goulias (2003). Transportation Systems Planning Methods and Applications, CRC press.
7. Simon Washington, Fred L. Mannering, Matthew G. Karlaftis (2020). Statistical and Econometric Methods for Transportation Data Analysis, CRC Press.

7CE5-15: Engineering Hydrology

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To impart knowledge of various components of hydrological processes, measurements and analysis of variables involved.
2. To develop the fundamentals and practices engineering hydrology and successfully apply technical knowledge to solve engineering problems.
3. To study the basic principles and movement of ground water and properties of ground water flow.

Course Outcomes: Upon completion of this course the students will be able to:

1. Describe the basic concepts of hydrology and integrate the physical hydrological processes.
2. Describe the various process, measurement and estimation of hydrological components: evaporation, infiltration, etc.
3. To Develop runoff and hydrograph estimation and apply into engineering practices.
4. Understanding and analysis of groundwater hydrology.

S. No	Contents	Hours
1	**Introduction**: Porous media, distribution of subsurface water, porosity and related properties of soils, Darcy's law, hydraulic head and gradient Hydrologic cycle, processes and budget; factors affecting hydraulic conductivity, heterogeneity and anisotropy, limitations to the validity of Darcy's law, Storage in confined aquifers. **Precipitation Measurement and Analysis**: Precipitation variability, rainfall measurement techniques, design of precipitation gauging network, consistency of rain record, filling up of missing record, estimation of mean areal rainfall.	6
2	**Hydrologic Abstractions:** Interception and depression storage; Evaporation: factors affecting, measurement and estimation; Evapotranspiration: measurement and estimation; **Infiltration**: factors affecting infiltration, measurement of infiltration, empirical and analytical models of infiltration.	5
3	**Runoff and Hydrographs**: Factors affecting runoff, Rainfall - Runoff correlations, Flow duration curve, Mass curve, Unit Hydrograph and its analysis, S curve Hydrograph, Synthetic and Instantaneous Unit Hydro graphs.	6
4	**Watershed Management:** Watershed and its characteristics; Curve number method; Soil erosion and estimates; Watershed management techniques, Erosion control.	6
5	**Groundwater Hydrology:** Types of aquifers; Flow and storage parameters; Well hydraulics; Steady and unsteady flow, Well losses, Specific capacity.	5
	Total	28

REFERENCE BOOKS

1. Garg S.K., Hydrology and Water Resources Engineering, 2015.
2. H.M. Raghunath, Hydrology: Principles, Analysis and Design, 2nd edition, New Age International Publishers, 2006
3. Subramanya, K., Engineering Hydrology, 4th Edition, Tata Mc Graw Hill, 2013.
4. Fetter C.W., Applied Hydrogeology, Fourth Edition, CBS Publishers and Distributors, New Delhi, 2001

7CE4-20: Civil Engineering Software Laboratory

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To equip with the skills to perform and interpret settlement analysis of shallow foundations using numerical modeling techniques, focusing on soil behavior under applied loads and the use of FEM-based geotechnical software.
2. To provide a deep understanding of slope stability analysis using limit equilibrium methods, enabling them to assess and ensure the stability of slopes under various conditions using specialized geotechnical analysis software.
3. To provide the skills to create and simulate hydraulic models of river systems, watersheds, and pipe networks, enabling them to analyze water flow, flood zones, and water distribution effectively.
4. To familiarize with tools like QGIS and watershed modeling techniques, allowing them to perform flood risk mapping, watershed delineation, and simulate runoff and sediment yield.
5. To effectively use GPS technology and GIS software for field data collection, mapping, and boundary marking, with a focus on practical applications in surveying.
6. To teach the skills needed to create, export, and visualize maps using tools like Google Earth Pro and QGIS, including the addition of attributes and the analysis of area and volume from geospatial data.
7. To equip with the skills to create and analyze finite element (FE) models of structural elements such as beams, focusing on deflection and stress analysis under various loading and boundary conditions.
8. To provide the ability to compare FE analysis results with theoretical predictions, reinforcing their understanding of structural behavior and validating computational models against analytical methods.
9. To teach the fundamental techniques of traffic flow and density analysis, and traffic signal design, using tools like Excel for data processing and calculation.
10. To equip with the skills to perform geometric road design and pavement design using specialized software, enhancing their ability to plan and design transportation infrastructure.

Course Outcomes

Upon successful completion of the course the students will be able to:

1. Proficient in developing and executing numerical models for settlement analysis of shallow foundations, accurately predicting foundation behavior under specified loads using software like PLAXIS or ABAQUS.
2. To perform detailed slope stability analyses using limit equilibrium methods, calculate factors of safety, and conduct sensitivity analyses to evaluate the impact of different parameters on slope stability using tools like SLOPE/W or SLIDE.
3. To develop and simulate hydraulic models, analyze water surface profiles, identify potential flood zones, and perform hydraulic analysis of water distribution networks, including calculating pressures and head losses.

4. Capable of delineating watersheds, simulating runoff and sediment yield, and creating flood risk maps using DEM data and QGIS, effectively assessing and managing flood risks in various scenarios.
5. Be proficient in using cellphone GPS and Mapit GIS software to accurately mark landmarks, boundaries, and other surveying features, demonstrating practical field surveying skills.
6. Be able to create detailed maps by marking points, lines, and polygons in Google Earth Pro, and enhance these maps in QGIS by adding attributes and visualizing area and volume data from *.kml files.
7. To develop and analyze FE models of homogeneous and reinforced concrete beams, accurately predicting deflection and stress responses under specified loads and boundary conditions.
8. To demonstrate the ability to compare FE analysis outcomes with theoretical predictions, critically assessing the accuracy of their models and refining their understanding of structural mechanics.
9. To calculate vehicle flow rates, traffic density, and design efficient traffic signal cycles using Excel, applying these skills to real-world traffic management scenarios.
10. To gain the ability to use MX-Roads and other software for geometric road design and pavement design, demonstrating competence in creating and analyzing transportation infrastructure projects.

Note: Any two modules of 15 lab hours each to be taught on softwares used in Civil engineering related to Geotechnology, Hydraulics, Surveying, Structures and Transportation fields for basic analysis and learning.

S. No	Contents
1.	**Module (Geotechnology):** Basic Exercise(s): Exercise 1: Settlement Analysis of Shallow Foundations i. The objective of this exercise is to analyze and predict the settlement of a shallow foundation under a specified load using numerical modeling. Students will analyze a shallow foundation, such as a spread footing, placed on a soil layer. Their task is to develop a numerical model of the soil and foundation system to estimate the settlement under the given load. ii. Students will create a numerical model using FEM-based geotechnical analysis software such as PLAXIS, MIDAS, ABAQUS, among others. They need to define the soil properties, including Young's modulus, Poisson's ratio, cohesion, and friction angle, and specify the dimensions and load applied to the shallow foundation. Next, they must set appropriate boundary and loading conditions in the model. After setting up the model, students will perform a settlement analysis to determine the vertical displacement of the foundation. iii. In the interpretation phase, students will analyze the results of their model to evaluate the settlement and compare it with theoretical predictions or guidelines from relevant codes.

	Exercise 2: Slope Stability Analysis Using Limit Equilibrium Methods i. To start, students will develop a numerical model of the slope using Limit Equilibrium based geotechnical analysis software such as SLOPE/W, SLIDE, among others. They will need to define the soil properties, including cohesion, friction angle, and unit weight, as well as the geometry of the slope. ii. The model should also account for the water table and any external loads or conditions if they are provided (such as earthquake loads). Following the model setup, students will perform a limit equilibrium analysis using methods like Bishop's, Janbu's, and Morgenstern-Price to determine and compare the factor of safety of the slope. In addition, students will conduct a sensitivity analysis to explore how variations in soil properties, slope angle, or water table position impact the slope's stability.
2.	**Module (Hydraulics):** Basic Exercise(s): i. Flow Simulation: create a simple model of a river reach, define cross-sections, and simulate steady flow conditions to analyze water surface profiles and identify potential flood zones. ii. Watershed Delineation: Delineate a watershed, input rainfall and land use data, and simulate runoff and sediment yield for a small catchment area. iii. Pipe Network Analysis: Model a simple water distribution network, inputting pipe diameters, lengths, and demand nodes, and perform a hydraulic analysis to determine pressures, flows, and head losses within the network. iv. Flood Risk Mapping: Use QGIS to import DEM data, and model flood scenarios. Combine the results to create a flood risk map showing inundation areas under different flood events.
3.	**Module (Surveying):** Basic Exercise(s): i. Using cellphone's GPS and Mapit GIS software (free software) to mark points for landmarks in a region, marking boundary of a field, etc. ii. Using Google Earth Pro, marking points, lines for roads, polygons for buildings etc, and exporting a simple map with Google Satellite base layer. iii. Observations of area-volume from *.kml files generated from Mapit GIS, Google Earth pro. Visualization of the same in QGIS, adding further attributes such as 'Place Names', 'Landmark Type', etc. to prepare a map.
4.	**Module (Structures):** Basic Exercise(s):

	i.	Create a FE model of a beam of homogeneous material (eg. steel) with boundary condition (e.g. simply supported or cantilever) and load it with designated load (UDL, or Point load) and analyse its deflection response and stresses at various points (tip of cantilever, midspan point of simply supported beam) etc. Compute the theoretically predicted responses (learnt in structural analysis course) at the same points and compare them with your modelling results.
	ii.	Create a FE model geometry of a concrete beam with embedded rebars. Mesh the model. Apply suitable contact-restraints between rebar and surrounding concrete. Apply boundary conditions (simply supported/ cantilever or continuous over multiple spans). Apply UDL on the beam and submit the model for analysis. Also compare the results of analysis like deflection etc. Optionally, post-cracking stage may also be considered.
5.	**Module (Transportation):** Basic Exercise(s):	
	i.	Calculate the hourly flow of vehicles by traffic flow count using excel.
	ii.	Calculate the density of vehicles by traffic density measurement using excel.
	iii.	Design the traffic signal by calculating the signal cycle times and Peak hour factor using excel.
	iv.	Geometric design using the MX-Roads software
	v.	Flexible and rigid pavement design using available software.
	vi.	Aggregate blending and mix design using excel

REFERENCE BOOKS

1. Available software manuals and online tools.