

B. Tech. in Civil Engineering and Minor in Infrastructure Engineering

Program Learning Objectives:	Program Learning Outcomes:
Program Goal 1: Equip the students with strong foundation in civil and environmental engineering for both research and industrial scenarios.	Program Learning Outcome 1a: Student develops ability to design and conduct experiments. Program Learning Outcome 1b: Student is able to organize and analyze the experiment data to draw conclusions.
Program Goal 2: Provide scientific and technical knowledge in planning, design, construction, operation and maintenance of civil engineering infrastructure.	Program Learning Outcome 2: Students are able to (i) develop material and process specifications, (ii) analyze and design projects, (iii) perform estimate and costing and (iv) manage technical activities.
Program Goal 3: Prepares the students to apply knowledge in policy and decision making related to civil engineering infrastructure.	Program Learning Outcome 3a: Student develops understanding of professional and ethical responsibility. Program Learning Outcome 3b: Student is able to consider economic, environmental, and societal contexts while developing engineering solutions.
Program Goal 4: Prepare students to attain leadership careers to meet the challenges and demands in civil engineering practice.	Program Learning Outcome 4a: Students is prepared for leading roles/profiles in government sector, construction industry, consultancy services, NGOs, corporate houses and international organizations. Program Learning Outcome 4b: Student develops ability to identify, formulate, and solve engineering problems
Program Goal 5: Nurture interdisciplinary education for finding innovative solutions.	Program Learning Outcome 5: Student is able to solve complex engineering problems by applying principles of engineering and science.

Sl. No.	Subject Code	SEMESTER I	L	T	P	C
1.	MA1101	Calculus and Linear Algebra	3	1	0	4.0
2.	CS1101	Foundations of Programming	3	0	3	4.5
3.	PH1101/PH1201	Physics	3	1	3	5.5
4.	CE1101/CE1201	Engineering Graphics	1	0	3	2.5
5.	EE1101/EE1201	Electrical Sciences	3	0	3	4.5
6.	HS1101	English for Professionals	2	0	1	2.5
TOTAL			15	2	13	23.5

Sl. No.	Subject Code	SEMESTER II	L	T	P	C
1.	MA1201	Probability Theory and Ordinary Differential Equations	3	1	0	4
2.	CS1201	Data Structure	3	0	3	4.5
3.	CH1201/CH1101	Chemistry	3	1	3	5.5
4.	ME1201/ME1101	Mechanical Fabrication	0	0	3	1.5
5.	ME1202/ME1102	Engineering Mechanics	3	1	0	4
6.	IK1201	Indian Knowledge System (IKS)	3	0	0	3
TOTAL			15	3	9	22.5

Sl. No.	Subject Code	SEMESTER III	L	T	P	C
1.	CE2101	Geomatics Engineering	3	1	2	5.0
2.	CE2102	Structural Mechanics	3	1	0	4.0
3.	CE2103	Fluid Mechanics	3	1	2	5.0
4.	CE2104	Geology for Engineers	3	0	2	4.0
5.	HS21XX	HSS Elective - I	3	0	0	3.0
TOTAL			15	3	6	21.0

Sl. No.	Subject Code	SEMESTER IV	L	T	P	C
1.	CE2201	Structural Analysis	3	0	2	4.0
2.	CE2202	Soil Mechanics	3	0	2	4.0
3.	CE2203	Civil Engineering Materials	3	0	2	4.0
4.	CE2204	Water Resources Engineering-I	3	0	0	3.0
5.	CE2205	Numerical Methods in Civil Engineering	3	0	0	3.0
6.	XX22PQ	IDE - I	3	0	0	3.0
TOTAL			18	0	6	21.0

Sl. No.	Subject Code	SEMESTER V	L	T	P	C
1.	CE3101	Design of Reinforced Concrete Structures	3	0	2	4.0

2.	CE3102	Foundation Engineering	3	0	2	4.0
3.	CE3103	Transportation Engineering - I	3	1	2	5.0
4.	CE3104	Environmental Engineering - I	3	0	2	4.0
5.	XX31PQ	IDE - II	3	0	0	3.0
TOTAL			15	1	8	20.0

Sl. No.	Subject Code	SEMESTER VI	L	T	P	C
1.	CE3201	Design of Steel Structures	3	1	0	4.0
2.	CE3202	Infrastructure Drawing and Estimation	1	2	0	3.0
3.	CE3203	Construction Planning & Management	3	0	0	3.0
4.	CE3204	Environmental Engg-II	3	1	0	4.0
5.	CE3205	Water Resources Engineering - II	3	0	2	4.0
6.	CE3206	Transportation Engineering - II	3	0	0	3.0
TOTAL			16	4	2	21.0

Sl. No.	Subject Code	SEMESTER VII	L	T	P	C
1.	CE41XX	Departmental Elective – I	3	0	0	3.0
2.	CE41XX	Departmental Elective – II	3	0	0	3.0
3.	XX41PQ	IDE-III	3	0	0	3.0
4.	HS41XX	HSS Elective II	3	0	0	3.0
5.	CE4198	Summer Internship*	0	0	12	3.0
6.	CE4199	Project – I	0	0	12	6.0
TOTAL			12	0	24	21.0

*** For specific cases of internship after 6th Semester, the performance evaluation would be made on joining the VIIth Semester and graded accordingly in the VIIth Semester:**

Note :

a) (i) Summer internship (*) period of at least 60 days' (8 weeks) duration begins in the intervening vacation between semester VI and VII that may be done in industry / R&D / Academic Institutions including IIT Patna. The evaluation would comprise **combined grading based on host supervisor evaluation, project internship report after plagiarism check and seminar presentation at the Department (DAPC to coordinate)** with equal weightage of each of the three components stated herein.

a) (ii) Further, on return from internship, students will be evaluated for internship work through combined grading based on host supervisor evaluation, project internship report after plagiarism check, and presentation evaluation by the parent department with equal weightage of each component.

b) (i) In the VIIth semester, students can opt for a semester long internship on recommendation of the DAPC and approval of the Competent Authority.

b) (ii) On approval of semester long internship, at the maximum two courses (properly mapped/aligned syllabus) at par with institute electives may be opted from NPTEL and / or SWAYAM and the other two more should be done at the institute through course overloading in any other semester (either before or after the internship) and/or during following summer semester.

b) (iii) The candidates opting two courses from NPTEL and / or SWAYAM would be required to appear in the examination at the Institute as scheduled in the Academic Calendar.

Sl. No.	Subject Code	SEMESTER VIII	L	T	P	C
1.	CE42XX	Departmental Elective – III	3	0	0	3.0
2.	CE42XX	Departmental Elective – IV	3	0	0	3.0
3.	CE42XX	Departmental Elective – V	3	0	0	3.0
4.	CE4299	Project – II	0	0	16	8.0
TOTAL			9	0	16	17.0
GRAND TOTAL (including Semester I & II)			167.0			

ELECTIVE GROUPS

Department Elective-I						
Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE4101	Introduction to Bridge Engineering	3	0	0	3
2.	CE4102	Prestressed and Precast Concrete Structures	3	0	0	3
3.	CE4103	Fundamentals of Solid Mechanics	3	0	0	3
4.	CE4104	Matrix Method for Structural Analysis	3	0	0	3

Department Elective-II						
Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE4105	Stochastic Hydrology	3	0	0	3
2.	CE4106	Irrigation Engineering and Hydraulic Structures	3	0	0	3

Department Elective-II						
Sl. No.	Subject Code	Subject	L	T	P	C
3.	CE4107	Elementary Soil Behaviour	3	0	0	3
4.	CE4108	Fundamentals of Geoenvironmental Engg.	3	0	0	3
5.	CE4109	Biogeotechnical Engineering	3	0	0	3
6.	CE4110	Pavement Geotechnology	3	0	0	3

Department Elective-III						
Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE4201	Elements of Remote Sensing and GIS	3	0	0	3
2.	CE4202	Introduction to Soil Structure Interaction	3	0	0	3
3.	CE4203	Introduction to Underground Excavation	3	0	0	3
4.	CE4204	Multiphysical Processes in fractured rocks	3	0	0	3
5	CE4205	Rock Engineering for Hydropower Projects	3	0	0	3
6	CE4206	Fundamentals of Forensic Geotech Engineering	3	0	0	3
7	CE4207	Ground Improvement for Civil Engineering Structures	3	0	0	3

Department Elective-IV						
Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE4208	Solid Waste Engineering	3	0	0	3
2.	CE4209	Air Pollution Engineering	3	0	0	3
3.	CE4210	Pavement Evaluation and Management	3	0	0	3
4.	CE4211	Pavement Materials	3	0	0	3
5.	CE4212	Introduction to Traffic Flow Modelling and Intelligent Transportation systems	3	0	0	3
6.	CE4213	Design of Transportation Facilities and Safety	3	0	0	3

Department Elective-V						
Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE4214	Introduction to Geotechnical Earthquake Engineering	3	0	0	3
2.	CE4215	Structural Dynamics and Earthquake Engineering	3	0	0	3
3.	CE4216	Rehabilitation of Structures	3	0	0	3
4.	CE4217	Introduction to Structural Health Monitoring	3	0	0	3

IDE (Available to students of B. Tech. other than Dept. of Civil and Environmental Engineering)

Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE2206	IDE I: Construction Technology and Management	3	0	0	3
2.	CE3105	IDE II: Green Building	3	0	0	3

Sl. No.	Subject Code	Subject	L	T	P	C
3.	CE4111	IDE III: Smart Transportation	3	0	0	3
4.	CE4112	IDE III: Industrial Pollution and Control	3	0	0	3

Minor in Infrastructure Engineering

Minor						
Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE2102	Minor I: Structural Mechanics	3	1	0	4
2.	CE2203	Minor II: Civil Engineering Materials	3	0	2	4
3.	CE3103	Minor III: Transportation Engineering – I	3	1	2	5
4.	CE3202	Minor IV: Infrastructure Drawing and Estimation	1	2	0	3
TOTAL			10	4	4	16

Sl. No.	Subject Code	SEMESTER I	L	T	P	C
1.	MA1101	Calculus and Linear Algebra	3	1	0	4.0
2.	CS1101	Foundations of Programming	3	0	3	4.5
3.	PH1101/PH1201	Physics	3	1	3	5.5
4.	CE1101/CE1201	Engineering Graphics	1	0	3	2.5
5.	EE1101/EE1201	Electrical Sciences	3	0	3	4.5
6.	HS1101	English for Professionals	2	0	1	2.5
TOTAL			15	2	13	23.5

Course Number	MA1101
Course Credit (L-T-P-C)	3-1-0-4
Course Title	Calculus and Linear Algebra
Learning Mode	Lectures and Tutorials
Learning Objectives	To provide the essential knowledge of basic tools of Differential Calculus, Integral Calculus, Vector spaces and Matrix Algebra.
Course Description	This course provides a foundation for Calculus and Linear Algebra. Topics related to properties of single and two variable functions along with their applications will be discussed. In addition fundamentals of linear algebra and matrix theory with applications will also be discussed.
Course Content	Differential Calculus (12 Lectures): Limit and continuity of one variable function (including ε-δ definition). Limit, continuity and differentiability of functions of two variables, Tangent plane and normal, Change of variables, chain rule, Jacobians, Taylor's Theorem for two variables, Extrema of functions of two or more variables, Lagrange's method of undetermined multipliers. Integral Calculus (10 Lectures): Riemann integral for one variable functions, Double and Triple integrals, Change of order of integration. Change of variables, Applications of Multiple integrals such as surface area and volume. Vector Spaces (12 Lectures): Vector spaces (over the field of real numbers), subspaces, spanning set, linear independence, basis and dimension. Linear transformations, range and null space, rank-nullity theorem, matrix of a linear transformation. Matrix Algebra (8 Lectures): Elementary operations and their use in getting the rank, inverse of a matrix and solution of linear simultaneous equations, Orthogonal, symmetric, skew-symmetric, Hermitian, skew-Hermitian, normal and unitary matrices and their elementary properties, Eigenvalues and Eigenvectors of a matrix, Cayley-Hamilton theorem, Diagonalization of a matrix.
Learning Outcome	Students completing this course will be able to: 1. Understand various properties of functions such as limit, continuity and differentiability. 2. Learn about integrations in various dimension and their applications. 3. learn about the concept of basis and dimension of a vector space. 4. define Linear Transformations and compute the domain, range, kernel, rank, and nullity of a linear transformation. 5. compute the inverse of an invertible matrix. 6. solve the system of linear equations. 7. Apply linear algebra concepts to model, solve, and analyze real-world problems.
Assessment Method	Quiz /Assignment/ MSE / ESE

Textbooks:

1. Thomas, G. B., Hass, J., Heil, C. and Weir M. D., "Thomas' Calculus", 14th Ed., Pearson Education, 2018
2. Kreyszig, E., "Advanced Engineering Mathematics", 10th Ed., Wiley India Pvt. Ltd, 2015

Reference Books:

1. Jain, R. K. and Iyenger, S. R. K., "Advanced Engineering Mathematics", 5th Ed., Narosa Publishing House, 2017
2. Axler, S., "Linear Algebra Done Right", 3rd Ed., Springer Nature, 2015
3. Strang, G., "Linear Algebra and Its Applications" 4th Ed., Cengage India Private Limited, 2005

Course Number	CS1101
Course Credit	3-0-3-4.5
Course Title	Foundations of Programming
Learning Mode	Offline
Learning Objectives	- To understand the fundamental concepts of programming - To develop the basic problem-solving skills by designing algorithms and implementing them. - To learn about various data types, control statements, functions, arrays, pointers, and file handling. - To achieve proficiency in debugging and testing a C program
Course Description	This introductory course provides a solid foundation in programming principles and techniques. Designed for students with little to no prior programming experience, it covers fundamental concepts such as variables, data types, control structures, functions, and basic data structures. Students will learn to write, debug, and execute programs using a high-level programming language. Emphasis is placed on developing problem-solving skills, logical thinking, and the ability to write clear and efficient code. By the end of the course, students will be equipped with the essential skills needed to pursue more advanced studies in computer science and software development.
Course Outline	Introduction and Programming basics, Expressions Control and Iterative statements, Functions, Arrays, Recursion vs. Iteration Pointers, 2D-Array with pointers, Structures, String, Dynamic memory allocation, File handling, Contemporary programming languages, and applications Practical component: Lab to be conducted on a 3-hour slot weekly. It will be conducted with the theory course so the topics for problems given in the lab are already initiated in the theory class.
Learning Outcome	- Understanding of Basic Syntax and Structure in C language - Proficiency in Data Types, Operators, and Control Structures - Function Implementation and learn to use them appropriately - Efficient Use of Arrays and Strings - Pointer Utilization - Ability to perform dynamic memory allocation and deallocation using malloc (), calloc (), realloc (), and free () functions. - Structured data management with structures and unions - Exposure of file Handling - Learning debugging and error Handling
Assessment Method	Internal (Quiz/Assignment/Project), Mid-Term, End-Term

Suggested Reading

- Knuth, Donald E. The art of computer programming, volume 4A: combinatorial algorithms, part 1. Pearson Education India, 2011.
- P.J. Deitel and H.M. Deitel, C How To Program, Pearson Education (7th Edition)
- Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice–Hall
- A. Kelley and I. Pohl, A Book on C, Pearson Education (4th Edition)
- K. N. King, C PROGRAMMING A Modern Approach, W. W. Norton & Company

Course Number	PH1101/PH1201
Course Credit	3-1-0-4
Course Title	Physics

Learning Mode	Lectures and Tutorials
Learning Objectives	Complies with Program Goals 1 and 2
Course Description	This course deals with fundamentals in Classical mechanics, Waves and Oscillations and Quantum Mechanics. As a prerequisite, the mathematical preliminaries such as coordinate systems, vector calculus etc will be discussed in the beginning.
Course Outline	Orthogonal coordinate systems (Plane polar, Spherical, Cylindrical), concept of generalised coordinates, generalised velocity and phase space for a mechanical system, Introduction to vector operators, Gradient, divergence, curl and Laplacian in different co-ordinate systems. Central force problem and its applications. Rigid body rotation, vector nature of angular velocity, Finding the principal axes, Euler's equations; Gyroscopic motion and its application; Accelerated frame of reference, Fictitious forces. Potential energy and concept of equilibrium, Lennard-Jones and double-well potentials, Small oscillations, Harmonic oscillator, damped and forced oscillations, resonance and its different examples, oscillator states in phase space, coupled oscillations, normal modes, longitudinal and transverse waves, wave equation, plane waves, examples two- and three-dimensional waves. Michelson-Morley experiment, Lorentz transformation, Postulates of special theory of relativity, Time dilation and length contraction, Applications of special theory of relativity.
Learning Outcome	Complies with PLO 1a, 2a, 3a
Assessment Method	Quiz, Assignments and Exams

Suggested Readings:

Textbooks:

1. Engineering Mechanics, M. K. Harbola, 2nd ed., Cengage, 2012
2. D. Kleppner and R. J. Kolenkow, An introduction to Mechanics, Tata McGraw-Hill, New Delhi, 2000.
3. I. G. Main, Oscillations and Waves
4. H. G. Pain, The Physics of Vibrations and Waves, 1968
5. Frank S. Crawford, Berkeley Physics Course Vol 3: Waves and Oscillations, McGraw Hill, 1966.

References:

1. R. P. Feynman, R. B. Leighton and M. Sands, The Feynman Lecture in Physics, Vol I, Narosa Publishing House, New Delhi, 2009.
2. David Morin, Introduction to Classical Mechanics, Cambridge University Press, NY, 2007.
3. P. C. Deshmukh, Foundations of Classical Mechanics, Cambridge University Press, 2019

Course code	CE1101/CE1201
Course Credit (L-T-P-C)	1-0-3-2.5
Course Title	Engineering Graphics
Learning Mode	Lectures and Practical
Learning Objectives	Complies with PLO-1a 1. The course on engineering drawing is designed to introduce the fundamentals of technical drawing as an important form of conveying information. 2. Apply principles of engineering visualization and projection theory to prepare engineering drawings, using conventional and modern drawing tools. 3. Practice drawing orthographic projections, isometric views, and sectional views, of simple and combined solids in different orientations.
Course Description	This course will introduce drawing as a tool to represent a complex three-dimensional object on two-dimensional paper through methods of projections. The course explains the use of different drafting tools and the importance of conventions for uniformity and standardization of the interpretation of the drawings.
Course Outline	Fundamental of engineering drawing, line types, dimensioning, and scales. Conic sections: ellipse, parabola, hyperbola; cycloidal curves. Principle of projection, method of projection, orthographic projection, plane of projection, first angle of projection, Projection of points, lines, planes and solids. Section of solids: Sectional views of simple solids- prism, pyramid, cylinder, cone, sphere; the true shape of the section. Methods of development, development of surfaces. Isometric projections: construction of isometric view of solids and combination of solids from orthographic projections. Introduction to AutoCad and solving isometric problems.
Learning Outcome	After attending this course, the following outcomes are expected: 1. The student will understand the basic concepts of engineering drawing. 2. The student will be able to use basic drafting tools, drawing instruments, and sheets. 3. The student will be able to represent three-dimensional simple and combined solid objects on two-dimensional paper. 4. The student will be able to visualize and interpret the orientation of simple and combine solid objects.
Assessment Method	Laboratory Assignments (30%), Mid-semester examination (25%) and End-semester examination (45%).

Suggested Readings:

Textbooks:

1. N.D. Bhatt, Engineering Drawing, Charotar Publishing House.
2. Agrawal & Agrawal, Engineering Drawing, McGraw Hill.
3. Jolhe, Engineering Drawing.

References:

1. Engineering Drawing and Design by David Madsen

Course Number	EE1101/EE1201
Course Credit	3-0-3-4.5
Course Title	Electrical Sciences
Learning Mode	Lectures and Experiments
Learning Objectives	Complies with Program goals 1, 2 and 3
Course Description	The course is designed to meet the requirements of all B. Tech programmes. The course aims at giving an overview of the entire electrical engineering domain from the concepts of circuits, devices, digital systems and magnetic circuits.
Course Outline	Circuit Analysis Techniques, Circuit elements, Simple RL and RC Circuits, Kirchoff's law, Nodal Analysis, Mesh Analysis, Linearity and Superposition, Source Transformations, Thevenin's and Norton's Theorems, Time Domain Response of RC, RL and RLC circuits, Sinusoidal Forcing Function, Phasor Relationship for R, L and C, Impedance and Admittance, Instantaneous power, Real, reactive power and power factor. Semiconductor Diode, Zener Diode, Rectifier Circuits, Clipper, Clamper, UJT, Bipolar Junction Transistors, MOSFET, Transistor Biasing, Transistor Small Signal Analysis, Transistor Amplifier and their types, Operational Amplifiers, Op-amp Equivalent Circuit, Practical Op-amp Circuits, Power Opamp, DC Offset, Constant Gain Multiplier, Voltage Summing, Voltage Buffer, Controlled Sources, Instrumentation Amplifier, Active Filters and Oscillators. Number Systems, Logic Gates, Boolean Theorem, Algebraic Simplification, K-map, Combinatorial Circuits, Encoder, Decoder, Combinatorial Circuit Design, Introduction to Sequential Circuits. Magnetic Circuits, Mutually Coupled Circuits, Transformers, Equivalent Circuit and Performance, Analysis of Three-Phase Circuits, Power measurement in three phase system, Electromechanical Energy Conversion, Introduction to Rotating Machines (DC and AC Machines). <u>Laboratory:</u> Experiments to verify Circuit Theorems; Experiments using diodes and bipolar junction transistor (BJT): design and analysis of half -wave and full-wave rectifiers, clipping and clamping circuits and Zener diode characteristics and its regulators, BJT characteristics (CE, CB and CC) and BJT amplifiers; Experiment on MOSFET characteristics (CS, CG, and CD), parameter extraction and amplifier; Experiments using operational amplifiers (op-amps): summing amplifier, comparator, precision rectifier, Astable and Monostable Multivibrators and oscillators; Experiments using logic gates: combinational circuits such as staircase switch, majority detector, equality detector, multiplexer and demultiplexer; Experiments using flip-flops: sequential circuits such as non-overlapping pulse generator, ripple counter, synchronous counter, pulse counter and numerical display; Power Measurement by two Wattmeter method; Open and Short Circuit Tests of Transformer.
Learning Outcomes	Complies with PLO 1a, 2a and 3a
Assessment Method	Quiz, Assignments and Exams

Texts/References

1. C. K. Alexander, M. N. O. Sadiku, Fundamentals of Electric Circuits, 3rd Edition, McGraw-Hill, 2008.
2. W. H. Hayt and J. E. Kemmerly, Engineering Circuit Analysis, McGraw-Hill, 1993.
3. R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 6th Edition, PHI, 2001.
4. M. M. Mano, M. D. Ciletti, Digital Design, 4th Edition, Pearson Education, 2008.
5. Floyd, Jain, Digital Fundamentals, 8th Edition, Pearson.
6. David V. Kerns, Jr. J. David Irwin, Essentials of Electrical and Computer Engineering, Pearson, 2004.
7. Donald A Neamen, Electronic Circuits; analysis and Design, 3rd Edition, Tata McGraw-Hill Publishing Company Limited.
8. Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits, 5th Edition, Oxford University Press, 2004.
9. A. E. Fitzgerald, C. Kingsley Jr., S. D. Umans, Electric Machinery, 6th Edition, Tata McGraw-Hill, 2003.
10. D. P. Kothari, I. J. Nagrath, Electric Machines, 3rd Edition, McGraw-Hill, 2004.
11. Del Toro, Vincent. "Principles of electrical engineering." (No Title) (1972).

Course Number	HS1101
Course Credit	L-T-P-W: 2-0-1-2.5
Course Title	English for Professionals

Learning Mode	Offline
Learning Objectives	This course aims to help the students (a) attain proficiency in written English through the construction of grammatically correct sentences, utilization of subject-verb agreement principles, mastery of various tenses, and effective deployment of active and passive voice to ensure coherent and impactful written expression; (b) enhance oral communication skills by honing public speaking abilities, acquiring strategies to deliver persuasive presentations, and cultivating a polished telephone etiquette, enabling confident and articulate verbal communication; (c) foster active listening capabilities by recognizing different types of listening, and applying proven methods and strategies to improve active listening skills; (d) strengthen reading skills, including comprehension, interpretation, and critical analysis, to grasp diverse written materials and derive meaning from various types of texts encountered in academic and professional contexts; (e) develop adeptness in written communication for business purposes, encompassing the understanding of essential writing elements, mastery of appropriate writing styles thereby enhancing prospects for successful job interviews and subsequent professional endeavors.
Course Description	This academic course on communication skills aims to equip students with fluency in spoken and written English for effective expression in both academic and professional settings. By focusing on essential communication principles and providing practical experiences, students develop clarity, precision, and confidence in their communication. Through interactive discussions and exercises, students enhance critical thinking and adaptability in diverse contexts. Upon completion, students will excel in formal presentations, group discussions, and persuasive writing, enhancing their overall communication proficiency.
Course Outline	Unit I: Introduction to professional communication – LSRW - Phonetics and phonology Sounds in English Language – production and articulation – rhythm and intonation – connected speech - Basic Grammar and Advanced Vocabulary Sounds in English Language – production and articulation – rhythm and intonation – connected speech – persuading and negotiating – brevity and clarity in language. Unit II: Characteristics of Technical Communication: Types of communication and forms of communication - Formal and informal communication Verbal and non-Verbal Communication – Communication barriers and remedies Intercultural communication – neutral language Unit III: Comprehension and Composition – summarization, precis writing Business Letter Writing CV/ Resume – E-Communication Unit IV: Statement of Purpose, Writing Project Reports, Writing research proposal, writing abstracts, developing presentations, interviews – combating nervousness Tutorial: Listening Exercises, Speaking Practice (GDs, and Presentations), and Writing Practice Learning Outcome • Attain proficiency in written English, enabling the construction of grammatically correct sentences and coherent written expression through the use of appropriate grammar, tenses, and voice. • Enhance oral communication skills, including public speaking, persuasive presentation, and polished telephone etiquette, fostering confident and articulate verbal expression. • Cultivate active listening abilities, recognizing different listening types, overcoming obstacles, and employing strategies for attentive and effective communication. • Develop proficient written communication skills for business purposes, demonstrating understanding of essential writing elements, appropriate styles, and the creation of reports, notices, agendas, and minutes that effectively convey information.
Assessment Method	Class test + Quiz = 20%; Mid-semester = 25%; Assignment = 15%; End semester = 40%

Suggested Reading

1. Balzotti, Jon. Technical Communication: A Design-Centric Approach. Routledge, 2022.
2. Kaul, Asha, Business Communication. PHI Learning Pvt. Ltd. 2009
3. Laplante, Phillip A. Technical Writing: A Practical Guide for Engineers, Scientists, and Nontechnical Professionals. CRC Press, 2018.
4. Lawson, Celeste, et al. Communication Skills for Business Professionals, Second Edition. CUP, 2019.
5. Sharon Gerson and Steven Gerson. Technical Writing: Process and Product (8th Edition), London: Longman, 2013
6. Rentz, Kathryn, Marie E. Flatley & Paula Lentz. Lesikar's Business Communication Connecting in a Digital world, McGraw-Hill, Irwin.2012
7. Allan & Barbara Pease. The Definitive Book of Body Language, New York, Bantam,2004

8. Jones, Daniel. The Pronunciation of English, New Delhi, Universal Book Stall.2010
9. Savage, Alice. Effective Academic Writing. OUP. 2014
10. Swan and Alter. Oxford English grammar course. OUP. 201

Sl. No.	Subject Code	SEMESTER II	L	T	P	C
1.	MA1201	Probability Theory and Ordinary Differential Equations	3	1	0	4
2.	CS1201	Data Structure	3	0	3	4.5
3.	CH1201/CH1101	Chemistry	3	1	3	5.5
4.	ME1201/ME1101	Mechanical Fabrication	0	0	3	1.5
5.	ME1202/ME1102	Engineering Mechanics	3	1	0	4
6.	IK1201	Indian Knowledge System (IKS)	3	0	0	3
TOTAL			15	3	9	22.5

Course Number	MA1201
Course Credit (L-T-P-C)	3-1-0-4
Course Title	Probability Theory and Ordinary Differential Equations
Learning Mode	Lectures and Tutorials
Learning Objectives	To introduce the basic concepts of probability, statistics, and Differential equations.
Course Description	This course aims to cover basic concepts of probability, statistics and ordinary differential equations. In particular, popular distributions, random sampling, various estimators and hypothesis testing will be discussed. Students will also get exposure to the linear ordinary differential equations and their solution techniques.
Course Content	Probability (12 Lectures): Random variables and their probability distributions, Cumulative distribution functions, Expectation and Variance, probability inequalities, Binomial, Poisson, Geometric, negative binomial distributions, Uniform, Exponential, beta, Gamma, Normal and lognormal distributions. Statistics (10 Lectures): Random sampling, sampling distributions, Parameter estimation, Point estimation, unbiased estimators, maximum likelihood estimation, Confidence intervals for normal mean, Simple and composite hypothesis, Type I and Type II errors, Hypothesis testing for normal mean. Ordinary Differential Equations (20 Lectures): First order ordinary differential equations, exactness and integrating factors, Picard's iteration, Ordinary linear differential equations of n-th order, solutions of homogeneous and non-homogeneous equations (Method of variation of parameters). Systems of ordinary differential equations, Power series methods for solutions of ordinary differential equations. Legendre equation and Legendre polynomials, Bessel equation and Bessel functions.
Learning Outcome	Students will get exposure and understanding of: 1. Random variables and their probability distributions 2. Understand popular distributions and their properties 3. Sampling, estimation and hypothesis testing 4. Solution of ordinary differential equations 5. Solution of system of ordinary differential equations 6. Special functions arising as power series solutions of ordinary differential equations
Assessment Method	Quiz /Assignment/ MSE / ESE

Text Books:

1. Hogg, R. V., McKean, J. and Craig, A. T., "Introduction to Mathematical Statistics", 8th Ed., Pearson Education India, 2021
2. S.M. Ross "An introduction to Probability Models, Academic Press INC, 11th edition.
3. Miller, I. and Miller, M., "John E. Freund's Mathematical Statistics with Applications", 8th Ed., Pearson Education India, 2013
4. S. L. Ross, Differential equations, 3rd Edition, Wiley, 1984
5. W. E. Boyce and R. C. Di Prima, Elementary Differential equations and Boundary Value Problems, 7th Edition, Wiley, 2001.

Course Number	CS1201
Course Credit	3-0-3-4.5
Course Title	Data Structure
Learning Mode	Offline
Learning Objectives	• Understand the principles and concepts of data structures and their importance in computer science. • Learn to implement various data structures and understand how different algorithms works. • Develop problem-solving skills by applying appropriate data structures to different computational problems. • Achieving proficiency in designing efficient algorithms.
Course Description	This course provides a comprehensive study of data structures and their applications in computer science. It focuses on the implementation, analysis, and use of various data structures such as arrays, linked lists, stacks, queues, trees, and graphs. Through theoretical concepts and practical programming exercises, this course aims to develop problem-solving and algorithmic thinking skills essential for advanced topics in computer science and software development.
Course Outline	• Introduction to Data Structure, • Time and space requirements, Asymptotic notations • Abstraction and Abstract data types • Linear Data Structure: stack, queue, list, and linked structure • Unfolding the recursion • Tree, Binary Tree, traversal • Search and Sorting, • Graph, traversal, MST, Shortest distance • Balanced Tree Practical component: Lab to be conducted on a 3-hour slot weekly. It will be conducted with the theory course so the topics for problems given in the lab are already initiated in the theory class.
Learning Outcome	• Understand Data Structure Fundamentals • Implement Basic Data Structures using a programming language • Analyse and Apply Algorithms • Design and Analyse Tree Structures • Understand the usage of graph and its related algorithms • Design and Implement Sorting and Searching Algorithms • Debug and Optimize Code
Assessment Method	Internal (Quiz/Assignment/Project), Mid-Term, End-Term

Suggested Reading

- Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, Data Structures and Algorithms, Published by Addison-Wesley
- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein., Introduction to Algorithms,
- Mark Allen Weiss, Data Structures and Algorithm Analysis in Java
- Robert Sedgewick and Kevin Wayne, Algorithms
- Narasimha Karumanchi, Data Structures and Algorithms Made Easy

Course Number	CH1101/CH1201
Course Credit	L-T-P-C: 3-1-3-5.5
Course Title	Chemistry
Learning Mode	Offline
Learning Objectives	The course aims to lay a foundation for all three branches of chemistry, viz. Organic, Inorganic, and Physical Chemistry. The course aims to nurture knowledge to appreciate the interface of chemistry with other science and Engineering branches by combining theoretical concepts and experimental studies.
Course Description	This course introduces basic organic chemistry, inorganic chemistry and Physical chemistry to understand fundamental laws that governs various reactions, reaction rates, equilibrium, and their applications in daily life through relevant experimentation.
Course Outline	Module 1: Thermodynamics: The fundamental definition and concept, the zeroth and first law. Work, heat, energy and enthalpies. Second law: entropy, free energy and chemical potential. Change of Phase. Third law. Chemical equilibrium. Conductance of solutions, Kohlrausch's law-ionic mobilities, Basic Electrochemistry. Module 2: Coordination chemistry: Crystal field theory and consequences color, magnetism, J.T distortion. Bioinorganic chemistry: Trace elements in biology, heme and non-heme oxygen carriers, haemoglobin and myoglobin; Organometallic chemistry. Module 3: Stereo and regio-chemistry of organic compounds, conformational analysis and conformers, Molecules devoid of point chirality (allenes and biphenyls); Significance of chirality in living systems, organic photochemistry, Modern techniques in structural elucidation of compounds (UV-Vis, IR, NMR). Module 4 (Lab Component): Experiments based on redox and complexometric titrations; synthesis and characterization of inorganic complexes and nanomaterials; synthesis and characterization of organic compounds; experiments based on chromatography; experiments based on pH and conductivity measurement; experiment related to chemical kinetics and spectroscopy.
Learning Outcome	Students will be able to 1. identify organic and inorganic molecules and relate them to daily life applications through experiments. 2. understand important hypothesis, laws and their derivations to interpret physical phenomenon of chemical reactions and apply them in hands-on experiments. 3. understand the importance of organic and inorganic molecules in our body and environment. 4. know important analytical techniques to interpret chemical entity. 5. approach organic and inorganic synthesis as a skillset for drug manufacturing, calculate limiting reagents and yields, use various analytical tools to characterize organic compounds, interpret and ascertain data related to Physical chemistry aspects and know laboratory safety measures, risk factors and scientific report writing skills.
Assessment Method	Theory: 20% Quiz and assignment, 30% Mid sem and 50% End semester exams for theory part (4 credits). Lab: 60% lab report, lab performance and assignment, 20% End semester exam for practical part, 20% viva/quiz (1.5 credits). Overall Weightage: Theory (70%), Lab (30%).

Suggested Reading:

Text books:

1. Vogel's Qualitative Inorganic Analysis, G. Svehla, 7th Edition, Revised, Prentice Hall, 1996.
2. A. J. Elias, S. S. Manoharan and H. Raj, "Experiments in General Chemistry", Universities Press (India) Pvt. Ltd., 1997.
3. A. J. Elias, A Collection of Interesting General Chemistry Experiments, revised edition, Universities Press (India) Pvt. Ltd., 2007.
4. F. Albert Cotton, G. Wilkinson, C. A. Murillo, M. Bochmann, Advanced Inorganic Chemistry - 6th Edition New Delhi: Wiley India, 2008.
5. K. Mukkanti, Practical Engineering Chemistry, B.S. Publications, Hyderabad, 2009.
6. Shriver and Atkins inorganic chemistry / Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong-5th Edition – Oxford: UOP. 2012.
7. Atkins' Physical Chemistry, Peter Atkins, Julio de Paula, James Keeler, Oxford University Press, 11th Edition

2017.

8. K. L. Kapoor, A Textbook of Physical Chemistry, Vol: 1, 2 (6th Edition, 2019), Vol: 3 (5th Edition, 2020) MaGraw Hill.
9. G. R. Chatwal, S. K. Anand, Instrumental Methods of Chemical Analysis, 5th Edition, Himalaya Publications, 2023.

	PLO-1	PLO-2	PLO-3	PLO-4	PLO-5	PLO-6	PLO-7	PLO-8
CLO-1	X	X	X	X	X	X	X	X
CLO-2	X	X		X	X			
CLO-3	X	X	X	X		X	X	
CLO-4	X	X		X	X	X	X	X
CLO-5			X	X	X			X

Course Number	ME1101/ME1201
Course Credit	L-T-P-C: 0-0-3-1.5
Course Title	Mechanical Fabrication
Learning Mode	Fabrication work – hands on fabrication work in Workshop
Learning Objectives	Complies with PLOs 3-4. - This course aims to develop the concepts and skills of various mechanical fabrication methods. - Fabrication of metallic and non-metallic components, fabrication using bulk and sheet metals, subtractive and additive manufacturing methods, and assemble the parts
Course Description	This course is designed to fulfil the need of hand on experience about various approaches (conventional and CNC, subtractive and additive) of mechanical fabrication approaches. Prerequisite: NIL
Course Outline	The jobs for various shops should be planned such that they are the parts of an assembled item. The student groups will fabricate different parts in various shops which will involve some amount of their creativeness/input particularly in design and/or planning. Various components as required for the assembled part can be made using the following shops: Sheet Metal Working: Development, sheet cutting and fabrication of designated job using sheet metal (ferrous/nonferrous); Joining of required portions by soldering, in case part is desired to be made leak proof. Pattern Making and Foundry: Making of suitable pattern (wood); making of sand mould, melting of non-ferrous metal/alloy (Al or Al alloys), pouring, solidification. Observation/identification of various defects appeared on the component. Joining: Butt/lap/corner joint job fabrication as required of low carbon steel plates; weld quality inspection by dye-penetration test (non-destructive testing approach) of the component made. Demonstration of semi-automatic Gas Metal Arc welding (GMAW). Conventional machining: Operations on lathe and vertical milling to fabricate the required component. The fabrication of the component should cover various lathe operations like straight turning, facing, thread cutting, parting off etc., and operations using indexing mechanism on vertical milling. CNC centre: Fundamentals of CNC programming using G and M code; setting and operations of job using CNC lathe or milling, tool reference, work reference, tool offset, tool radius compensation to fabricate the component with a designed profile on Al/Al-alloy plate. 3D printing (Fused Filament Fabrication): (2 weeks) Create the model, select appropriate slicing and path for fabrication of a 3D job by layer deposition (additive manufacturing approach) using polymeric material. Demonstration on pattern fabrication using 3D printing.
Learning Outcome	- This course would enable the students to develop the concept of design, fabrication (subtractive and additive) for various engineering applications. Fabrication of components and assemble them. - The practical skill and hands on experience for various fabrication methods from bulk, sheet metal using conventional as well as CNC machines.
Assessment Method	Fabrication of components in each of the shops required for assembly of the given part; submission of reports for each shop, and quiz assessment.

Text and Reference books:

- Hajra Choudhury, HazraChoudhary and Nirjhar Roy, 2007, Elements of Workshop Technology, vol. I, Mediapromoters and Publishers Pvt. Ltd.
- W A J Chapman, Workshop Technology, 1998, Part -1, 1st South Asian Edition, Viva Book Pvt Ltd.
- P.N. Rao, 2009, Manufacturing Technology, Vol.1, 3rd Ed., Tata McGraw Hill Publishing Company.
- M.Adithan, B.S. Pabla, 2012, CNC machines, New Age International Publishers

Course Number	ME1102/ME1202
Course Title	Engineering Mechanics
L-T-P-C	3-1-0-4

Pre-requisites	Nil
Semester	Spring
Learning Mode	Lectures
Learning Objectives	Complies with PLOs 1, 4 The objective of this first course in mechanics is to enable engineering students to analyze basic mechanics problems and apply vector-based approach to solve them.
Course Outline	Rigid body statics: Equivalent force system. Equations of equilibrium, Free body diagram, Reaction, Static indeterminacy. Structures: 2D truss, Method of joints, Method of section. Beam, Frame, types of loading and supports, axial force, Bending moment, Shear force and Torque Diagrams for a member. Friction: Dry friction (static and kinetic), wedge friction, disk friction (thrust bearing), belt friction, square threaded screw, journal bearings, Wheel friction, Rolling resistance. Centroid and Moment of Inertia Introduction to stress and strain: Definition of Stress, Normal and shear Stress. Relation between stress and strain, Cauchy formula. Stress in an axially loaded member and stress due to torsion in axisymmetric section
Learning Outcomes:	Following learning outcomes are expected after going through this course. - Learn and apply general mathematical and computer skills to solve basic mechanics problems. - Apply the vector-based approach to solve mechanics problems.
Assessment Method	Mid semester examination, End semester examination, Class test/Quiz, Tutorials

Reference Books

- H. Shames, Engineering Mechanics: Statics and dynamics, 4th Ed, PHI, 2002.
- F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, 3rd Ed, Tata McGraw Hill, 2000.
- J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I - Statics, 5th Ed, John Wiley, 2002.
- E.P. Popov, Engineering Mechanics of Solids, 2nd Ed, PHI, 1998.
- F. P. Beer and E. R. Johnston, J.T. Dewolf, and D.F. Mazurek, Mechanics of Materials, 6th Ed, McGraw Hill Education (India) Pvt. Ltd., 2012.

Sl. No.	Subject Code	SEMESTER III	L	T	P	C
1.	CE2101	Geomatics Engineering	3	1	2	5.0
2.	CE2102	Structural Mechanics	3	1	0	4.0
3.	CE2103	Fluid Mechanics	3	1	2	5.0
4.	CE2104	Geology for Engineers	3	0	2	4.0
5.	HS21XX	HSS Elective - I	3	0	0	3.0
TOTAL			15	3	6	21.0

Course	CE2101: Geomatics Engineering
Course Credit (L-T-P-C)	3-1-2-5
Course Title	Geomatics Engineering
Learning Mode	Lectures
Learning Objectives	Complies with PLO- 1 and 4 1. Understand the need of survey for the start of any project 2. Understand the utilities of basic survey equipment 3. Understand the importance of precise measurement, errors and accuracy, Importance of levels, R.L. and advance methods for plotting the points on ground with the help of map.
Course Description	This course deals with the theoretical learning of basic and advance survey methods and finding the errors and accuracy of any measurement. It also deals with the learning of basic and advanced survey methods.
Course Outline	Lecture: Introduction to surveying; linear measurements; chain surveying; compass surveying; accuracy, precision and errors, leveling; plane table; contouring, theodolite surveying, tacheometric survey; trigonometrical surveying; triangulation; curves; advanced survey instruments; Electronic Distance Measurement, Total station and Global Positioning System, Introduction to photogrammetry and remote sensing. Practical: Chain (tapes) surveying; Offsets, Compass surveying; Plane table survey; Theodolite surveying; Vertical and horizontal angle measurements, Theodolite Traversing; Triangulation and correction of errors; Leveling, computation of earth work; Contours; Tacheometric surveying; Trigonometric surveying; Total station; Setting out of buildings; Layout of simple circular curves.
Learning Outcome	At the end of the course, the student will be able to gather the information on accurate measurement of lines, angles, areas. Finding the errors and accuracy. Purpose and utility of basic and advanced survey for any construction project.
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.

Textbooks/ Reference books:

1. B. C. Punmia, A.K. Jain & A.K. Jain, Surveying, Vol-I and Vol-II, Laxmi Publication Pvt., 1996.
2. S.K. Duggal, Surveying, Vol-I and Vol-II, Mc.Graw Hill Publication, 2013.
3. T. P. Kanetkar and S. V. Kulkarni, Surveying and Levelling, Vol-I and Vol-II, Pune Vidyarthi Griha Prakshan, 1972.
4. G. W. Schofield, Engineering Surveying, Butterworth, Heinemann, New Delhi, 2001.
5. IS Code Provisions.

Course	CE2102: Structural Mechanics
Course Credit (L-T-P-C)	3-1-0-4
Course Title	Structural Mechanics
Learning Mode	Lectures
Learning Objectives	Objective for learning this course are Lectures: Complies with PLO-1, 2, and 4 1. Understand the need of mechanics of material and structure for the design of any civil engineering project. 2. Equip the students with strong foundation in civil and environmental engineering for both research and industrial scenarios. 3. Provide scientific and technical knowledge in planning, design, construction, operation and maintenance of civil engineering infrastructure.
Course Description	The course discusses the basic mechanics and behavior of materials under loads, strains, and deformations with various examples.
Course Outline	Introduction to mechanics of materials and structures, Simple bending theory, flexural and shear stresses, Stress / Strain Transformation unsymmetrical bending, shear centre. Thin walled pressure vessels, uniform torsion, buckling of column, combined and direct bending stresses. Different types of structures, loads on the structural system, static and kinematic indeterminacy, Methods of Analysis: Equilibrium equations, compatibility requirements, Introduction to force and displacement methods, Analysis of trusses: plane truss, compound truss, complex truss and space truss, three hinged arches and suspension cables, Bending moment and shear force diagram, Deflection of Beams, various methods for calculation of deflection.
Learning Outcome	At the end of the course, student would be able to Lectures: 1. Understand the basics of the strength of materials. 2. Get an overview of structural engineering. 3. Study this course as a prerequisite for any civil engineering design-based courses.
Assessment Method	Assignments, Quizzes, Project work, Mid-semester examination and End-semester examination.

Textbooks/ Reference books:

1. Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, Mechanics of Materials, McGraw-Hill Education, 8th edition (2020).
2. R.C. Hibbeler, Mechanics of Materials, Prentice Hall, 11th edition (2022).
3. G. N. Frantziskonis, Essentials of the Mechanics of Materials, Destech Pubns Inc., 3rd edition (2017).
4. C.S. Reddy, Basic Structural Analysis, Tata McGraw Hill, 3rd edition (2017).
5. R.C. Hibbeler, Structural Analysis, Pearson Education, 10th edition (2022).
6. E. P. Popov, Engineering Mechanics of Solids, Pearson, 2nd edition (1998).
7. L. S. Negi and R. S. Jangid, Structural Analysis, Tata McGraw Hill, New Delhi, 6th edition (2003).
8. R. S. Khurmi and N. Khurmi, Theory of structures, Schand, 10th edition, 2000.
9. K. M. Leet, C. M. Uang, J. T. Lanning, and A. M. Gilbert, Fundamentals of Structural Analysis, McGraw Hill, 5th edition, 2017.
10. S. K. Roy and S. Chakrabarty, Fundamentals of Structural Analysis, S Chand & Company, 2nd edition, 2003.

Course	CE2103 Fluid Mechanics
Course Credit (L-T-P-C)	3-1-2-5
Course Title	Fluid Mechanics
Learning Mode	Lectures and Practical
Learning Objectives	Complies with PLO-1, 2, 3 and 5 4. The course on fluid mechanics is devised to introduce fundamental aspects of fluid behaviour. 5. The students will be able to understand and apply the principles of mechanics i.e. conservation of mass, momentum and energy to fluid flow and deformation for civil engineering applications.
Course Description	This course will discuss the definition of fluid and its properties, basic concepts of fluid statics, kinematics and dynamics of fluid flow. The course uses differential fluid mechanics for the theoretical solution of various fluid flow systems.
Course Outline	Fluid properties; Pressure measurement; Hydrostatic forces on plane and curved surfaces; Buoyancy and equilibrium; Stability, metacentric height; Types of flow; Continuity; Energy and momentum equations; Velocity distribution and velocity coefficients, practical applications; Navier-Stoke equation; Shear stress and pressure gradient; Flow through pipes, Hagen-Poiseuille equation; Turbulence, Prandtl's mixing length, eddy viscosity; Darcy-Weisbach equation for flow through pipes, friction factor, Moody diagram, minor losses, pipes in series and parallel, equivalent length, pipe network analysis; Water hammer; Boundary layer concept, drag coefficients, control of boundary layer; Dimensional analysis and similitude, Introduction to pumps and turbines.
Learning Objectives	Practical: Complies with PLOs 1, 2, 3 and 5 1. Hands-on experience in the measurement of hydro-meteorological data and environmental parameters influencing water resources. Students will learn to analyze and interpret the environmental data and understand the controls in hydraulic structures.
Course Description	This course exposes the students to experimental setups for measuring fluid properties, and visualize behaviour of the fluid under static, kinematic and dynamic conditions. It also gives exposure to measure flow parameters required in civil engineering applications.
Course Outline	Measurement of fluid pressure using various manometers and gauges, Experimental study on capillarity, Determination of coefficient of viscosity of a fluid using viscometer, Experimental study on the stability of floating bodies, Study on fluid pressure distribution on immersed bodies, Study of different types of flow using Reynold's apparatus, Determination of friction factor in pipes using pipe friction apparatus, Experimental studies on centrifugal and reciprocating pumps, Experimental studies on impulse and reaction turbines.
Learning Outcome	After attending this course, the students are expected to know the following: 5. Fluid properties stress-strain relationship in fluids 6. Understand and apply the principles of conservation to fluid under static, kinematic and dynamic conditions 7. Should be able to understand the principles of flow measurement i.e. discharge, pressure, losses in flow and its application to civil engineering.
Assessment Method	Assignments, Quizzes, Mid-semester examination, and End-semester examination

Text Books/ Reference Book:

1. F. M. White, Fluid Mechanics, McGraw Hill, 1994.
2. Som, Biswas and Chakrabarty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw-Hill Education
3. Modi P.N. & Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi 2013
4. Fundamentals of Fluid Mechanics by Munson, Young & Okiishi
5. V.L. Streeter and E.B. Wylie, Fluid Mechanics, McGraw Hill, 1997
6. K. S. Massey, Mechanics of Fluids, Van Nostrand Reinhold Co., 1979.

7. J. Frabzini, Fluid Mechanics with Engineering Applications, McGraw Hill, 1997.
8. J.H. Spurk, Fluid Mechanics – Problems and Solutions, Springer, 2003.
9. Mohd. K. Khan, Fluid Mechanics and Machinery, Oxford Higher Education, 2015.
10. P. N. Modi and S.M. Seth, Hydraulics and Fluid Mechanics, Standard Book House, 1998.
11. K. L. Kumar, Engineering Fluid Mechanics, Eurasia Publishing Company (P) Ltd., New Delhi, 1999.
12. Annapureddy Domodara Reddy, “Fluid Mechanics and Hydraulic Machines Lab manual”, LAMBERT Academic Publications.
13. Madan Mohan Das, Mimi Das Saikia , Bhargab Mohan Das, “Hydraulics and Hydraulic Machines Textbook”, PHI Learning, 1st edition, 2013.

Course	CE2104 Geology for Engineers
Course Credit (L-T-P-C)	3-0-2-4
Course Title	Geology for Engineers
Learning Mode	Lectures & Practical
Learning Objectives	Complies with PLO- 1, 2, 3, 4 and 5. Students will be able to 1. Understand about the fundamentals of earth system and their dynamics. 2. Provide scientific and technical knowledge about earth minerals, groundwater system and geological structures. 3. Identify the various geological structures and stress distribution due to various loading. 4. Analyze the engineering properties of rocks and site investigation of various geological rock mass 5. Perform laboratory and field observations to apply knowledge for better understanding of geology in engineering practices.
Course Description	The course is designed to provide both theoretical and practical knowledge to geology, its significance and application in Civil Engineering.
Course Outline	Theory: Introduction to Engineering Geology, Silicate Structures and Symmetry Elements, Origin and Formation of Rocks, Groundwater related Engineering Issues, Geological Structures, Stress Distribution, Geologic Hazards, Engineering Properties of Rocks, Geological Site Criteria, Site Investigation. Laboratory Experiments and Practices: Geological Maps; Geological Mapping; Apparent and true dips; Three point problems; Depth and thickness problems; Joints; Faults; Megascopic and Microscopic identification of minerals and rocks; Rock classification and engineering properties of rocks: refraction and resistivity methods; Field trip.
Learning Outcome	At the end of the course, student would be able to: 1. Develop ability to understand the importance of geology and complexity associated. 2. Understand the origin of rocks and their characteristics. 3. Comprehend with various issues such as ground water, geological structures and geological hazards 4. Analyze the stress and strain behaviour, engineering properties of rocks and site investigation of various geological rock mass 5. Perform laboratory tests, field observations and apply knowledge for better understanding of geology and construction of structures in complex geological terrain
Assessment Method	Assignment, Quizzes, Mid-semester examination and End-semester examination.

Textbooks:

1. Gokhale, K. V. G. K., Principles of Engineering Geology, Revised Edⁿ., B S Publications, Hyderabad, 2019.
2. Singh, P., Engineering and General Geology, S. K. Kataria and Sons, Reprint, 2013.
3. Waltham, A. C., Foundations of Engineering Geology, Taylor & Francis, 3rd Ed., 2009.

Reference books:

1. Kehew, Alan E., General Geology for Engineers, Prentice Hall, 1988.
2. Kesavulu, N. Chenna, Textbook of Engineering Geology, Laxmi Publications Pvt Ltd., 3rd Edⁿ. 2018.
3. Ramamurthy, T., Engineering in rocks for slopes, foundations and tunnels, Prentice Hall India, 2010.
4. All relevant Indian Standard (IS) and international codes.

Sl. No.	Subject Code	SEMESTER IV	L	T	P	C
1.	CE2201	Structural Analysis	3	0	2	4.0
2.	CE2202	Soil Mechanics	3	0	2	4.0
3.	CE2203	Civil Engineering Materials	3	0	2	4.0
4.	CE2204	Water Resources Engineering–I	3	0	0	3.0
5.	CE2205	Numerical Methods in Civil Engineering	3	0	0	3.0
6.	XX22PQ	IDE - I	3	0	0	3.0
TOTAL			18	0	6	21.0

Course	CE2201: Structural Analysis
Course Credit (L-T-P-C)	3-0-2-4
Course Title	Structural Analysis
Learning Mode	Lectures and Practical
Learning Objectives	Objective for learning this course are Lectures: - Complies with PLO-1, 2, and 4 1. Understand the determinate and indeterminate structures and develop abilities to idealize and analyses such structures. 2. Familiarity with the concept of influence line for solving problems with moving loads. 3. Understand the matrix method and its application for computer-based analysis of structure. Practical: - Complies with PLO- 1 and 4 1. Calculation of influence line diagram for different type of structures. 2. Application of software in advance structural analysis.
Course Description	Structural analysis is the determination of the effects of loads on physical structures and their components. It incorporates the fields of applied mechanics, materials science and applied mathematics to compute a structure's deformations, internal forces, stresses, and support reactions. This is an important part of the engineering design of structures. Practical of the course will focuses on the understanding of behaviour and response of different civil engineering structures (beam, column, truss, frame, bridge) under static and moving loads.
Course Outline	Lecture: Introduction to structural analysis: determinate and indeterminate structures, Analysis of the indeterminate structures by force methods, flexibility coefficients, Energy methods: Principle of minimum potential energy, principle of virtual work, Reciprocal theorem, unit load method, Influence line and Rolling loads, beam, frames and arches, Muller-Breslau Principles and its applications to determinate and indeterminate structures. Analysis of Beams and Frames: Moment Area method, Slope deflection method, Three Moment Equation, Moments distribution methods, effect of symmetry and antisymmetry, sway correction, Matrix method of structural analysis, Displacement/ Stiffness methods. Practical: Bending moments and deflection analysis of determinate and indeterminate beams, Unsymmetrical bending and shear centre, Analysis of pin jointed frameworks, Bending moments in a portal frame, Column buckling, Flexural test on steel beam, Analysis of 2-D and 3-D truss, Analysis on suspension cable bridge, Influence line diagram of bridge under moving loads, Exposure to advanced structural analysis softwares.
Learning Outcome	At the end of the course, student would be able to Lectures: 1. Analyze determinate and indeterminate structures. 2. Use influence line diagram in design. Practical: 1. Estimate response of different civil engineering structures such as beam, column, truss, frame and bridge under static loads. 2. Determination of influence line diagram for bridge structure. 3. Able to use advanced structural analysis softwares.
Assessment Method	Assignments, Lab Reports, Quizzes, Project work, Mid-semester examination and End-semester examination.

Textbooks/ Reference books:

1. R .C. Hibbeler, Structural Analysis, Pearson Education, 10th edition (2022).
2. C. S. Reddy, Basic Structural Analysis, Tata McGraw Hill, 3rd edition (2017).

3. C. K. Wang, Intermediate Structural Analysis, McGraw Hill Education, 1st edition (2017).
4. D. S. Prakash Rao, Structural analysis: Unified approach, Universities Press, 1996.
5. C. H. Norris, J. B. Wilbur, S. Utku, Elementary Structural Analysis, Tata McGraw Hill, 4th edition (2003).
6. L. S. Negi and R. S. Jangid, Structural Analysis, Tata McGraw Hill, New Delhi, 6th edition (2003).
7. W. Weaver and J. M. Gere, Matrix analysis of framed structures, CBS Publishers, 2nd edition (2018).
8. G. S. Pandit and S.P. Gupta, Structural Analysis - A matrix approach, Tata McGraw Hill, 2nd edition (2008).
9. M. B. Kanchi, Matrix Methods of Structural analysis, Enlarged edition, Wiley Eastern Limited (2016).
10. R. S. Khurmi and N. Khurmi, Theory of structures, Schand, 10th edition, 2000.
11. K. M. Leet, C. M. Uang, J. T. Lanning, and A. M. Gilbert, Fundamentals of Structural Analysis, McGraw Hill, 5th edition, 2017.
12. S. K. Roy and S. Chakrabarty, Fundamentals of Structural Analysis, S Chand & Company, 2nd edition, 2003.

	CE2202: Soil Mechanics
Course Credit (L-T-P-C)	3-0-2-4
Course Title	Soil Mechanics
Learning Mode	Lectures and Practical
Learning Objectives	Complies with PLO- 1, 2, 3, and 5. Soil is most important material for Civil Engineers, therefore, learning the procedure to determine soil properties and gaining knowledge about variation of properties is of utmost important for any Civil Engineering students Following are the learning objectives 1. Students should be appraised of importance of Soil Mechanics for various Civil Engineering applications. 2. Take appropriate decision to determine important properties as per site condition and structure to be built. 3. Should be able to find out whether soil investigation report provides right or wrong data.
Course Description	This course provides an overview of soil mechanics that is applicable in Civil Engineering for foundation design of any superstructure. Detailed soil characterizations, strength, permeability, and compaction properties are covered. Further, the course covers a detailed laboratory testing by using various method as per Indian Standard (IS code) test procedures to determine and understand the physical and engineering properties of soils for design of different civil engineering construction projects.
Course Outline	Lectures: Origin and Mineralogy, Classification, Index Properties, Consistency Limits, Effective Stress, Stress within Soil, Permeability, Compaction, Consolidation, Shear strength. Practical: Determination of water content, specific gravity, in-situ density, Relative density. Particle size distribution by sieve analysis and hydrometer, Atterberg's limits, Standard and modified Proctor test, Determination of Coefficient of permeability; Shear strength parameters of soil using direct shear, vane shear test.
Learning Outcome	At the end of theory lectures, student would be able to: 1. Identify type of soil based on soil property 2. Determine settlement of soil from consolidation property 3. Determine required OMC, MDD for compaction test results 4. Determine shear strength properties of soil. 5. Take appropriate decision on tests to be conducted for finding design parameters of particular foundation. At the end of practical classes, student would be able to: 1. Determine physical and engineering properties of soils 2. Classify the soil based on laboratory test results 3. Verify any soil investigation report 4. Decide type of test to be conducted for particular type of soil.
Assessment Method	Theory: Assignments, Quizzes, Mid-semester examination and End-semester examination. Practical: Lab Reports, Viva, Mid-semester examination and End-semester examination.

Textbooks:

1. V. N. S. Murthy, Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, CRC Press, Taylor & Francis Group, Third Indian Reprint, 2013.
2. R. F. Craig, Craig's Soil Mechanics, Taylor & Francis Group, 7th Edition, 2004.
3. Indian Standard (IS) codes practices for soil testing.
4. J. Bardet, Experimental Soil Mechanics, Upper Saddle River, Prentice Hall, USA, 1992.
5. D. Fratta, J. Aguettant, and L. R. Smith, Soil Mechanics Laboratory Testing, Boca Raton, CRC Press, USA, 2007.

Reference books:

1. Gopal Ranjan, and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International Publishers, 2nd Edition 2000.

2. K. Terzaghi, R. B. Peck and G. Mesri, Soil Mechanics in Engineering Practice, John Wiley & Sons, 1996.
3. B.M. Das, Principle of Geotechnical Engineering, Cengage Learning, eighth Edition, 2013.
4. All other relevant IS and international codes such as BS code, ASTM etc.

Course	CE2203 Civil Engineering Materials
Course Credit (L-T-P-C)	3-0-2-4
Course Title	Civil Engineering Materials
Learning Mode	Lectures and Practical
Learning Objectives	Complies with PLO- 2 1. To provide fundamental knowledge in civil engineering materials. 2. Provide scientific and technical knowledge to prepare students to address civil engineering materials-related challenges in the field. 3. To train students to meet the current and future demand for civil engineering materials for construction industries.
Course Description	This course will discuss fundamental concepts in civil engineering materials. The course will cover theory and real-world practices in materials used in construction industries, their operations, and execution. The principal properties of building materials and up-to-date knowledge of the manufacturing of civil engineering materials will be discussed.
Course Outline	Introduction to building materials, Cement: Chemical composition, manufacturing, physical characteristics, hydration, properties of cement compounds, different types of cements, Aggregate: Coarse and fine aggregates, Influence of aggregate on the properties of concrete, aggregate selection. Fresh Concrete: Batching, Mixing, workability, effect of admixture, Hardened Concrete: mechanical properties of hardened concrete, Water-cement ratio, Porosity, Curing of concrete, High performance concrete, Design of concrete mix: IS code recommendation. Flyash. Brick: Raw materials, drying and burning, Strength and durability, mortar for masonry and strength of masonry, Timber, Seasoning and conversions, properties, tests, defects in timbers, FRPs: Chemical compositions, mechanical and physical properties, Various types of FRPs, Metals: steel for reinforced concrete and prestressed concrete construction, structural steel sections, Deterioration of building materials: Corrosion, chloride and sulphate attack on concrete, alkali-aggregate reaction, acid aggregate reactions Practical: Cement tests: normal consistency, initial and final set time; Coarse and fine aggregate tests: specific gravity, Sieve analysis, Los Angeles/Deval's abrasion, Flakiness and elongation, Impact test; fineness modulus, moisture content, SSD condition, unit weight and bulking of sand; Concrete tests: workability, strength, admixtures, mix design; Brick tests: moisture absorption, compressive strength, flyash.
Learning Outcome	At the end of the course, student would be able to: 1. Understand the physical and engineering properties, principles, testing, and standards of civil engineering materials used in construction. 2. Design mix of concrete for various construction industries. 3. The use of different civil engineering materials subjected to different construction scenarios and needs. 4. Understand the in-depth knowledge of mechanisms and factors influencing the manufacturing of civil engineering materials.
Assessment Method	Assignment, Quizzes, Mid-semester examination and End-semester examination .

Textbooks:

1. S. Somayaji, Civil Engineering Materials, Prentice Hall, New Jersey, 2001.
2. M. Neville and J. J. Brooks, Concrete Technology, Pearson Education, Fourth Indian reprint, 2004.
3. M. S. Shetty, Concrete Technology, S. Chand and Company Ltd. 2005.
4. M. S. Mamlouk and J. P. Zaniewski, Materials for Civil and Construction Engineers, Pearson, Prentice Hall, Second edition, 2006.
5. P.C Varghese, Building Materials, Publisher: Prentice Hall India Learning Private Limited; 2nd edition (1 January 2015)

Reference books:

1. All relevant IS Codes.
2. N. Jackson and R. K. Dhir, Civil Engineering materials, Macmillan Fourth edition 1997.
3. P. C. Aitcin, High Performance Concrete, E & F Spon, 1998.
4. J. F. Shackelford and M. K. Muralidhara, Introduction to Material science for Engineers, Pearson Education, Sixth edition, 2007.

5. Haimei Zhang, Building materials in civil engineering, Publisher: Woodhead Publishing (9 May 2011).
6. Parbin Singh, Civil engineering materials, Publisher : S K Kataria and Sons; Reprint 2013 edition.
7. S.K Duggal, Building Materials, New Age International Publisher, 4th edition.

Course	CE2204 Water Resources Engineering-I
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Water Resources Engineering-I
Learning Mode	Lectures
Learning Objectives	Lectures: Complies with PLOs 1, 2, 3 and 5 6. Students will be enabled to understand the fundamental principles governing open channel hydraulics for the design of engineering systems. 7. The students will be exposed to the application of water conveyance and water retention/detention structures in the context of agriculture.
Course Description	This course offers an introduction and analysis of flows in open channels with emphasis on applying efficient solution techniques.
Course Outline	Flow through open channels: Uniform flow, Critical flow, Gradually Varied flow, Rapidly Varied flow, Spatially Varied flow, Unsteady flow. Pumps and turbines, surges, water hammer. Flow Measurement: Pressure, Velocity and Discharge measurement techniques. Introduction to Hydraulic Structures, importance and uses.
Learning Outcome	At the end of the course, students would be able to understand: 8. The governing principles of gravity flow system 9. The application of open channels in irrigation. 10. The methods of flow measurement and various components of the hydrologic cycle that affect the movement detention/retention of water resources.
Assessment Method	Assignments, Quizzes, Mid-semester examination, and End-semester examination

Text Books/ Reference Book:

1. K Subramaniya, Flow in Open Channels, McGraw Hill, 1997.
2. H. Chaudhury, Open channel flow, Second Edition. Springer (2008).
3. Rajesh Srivastava, Flow through open channels, Oxford University Press (2008).
4. Sturm, 2001, Open-Channel Hydraulics, McGraw Hill
5. V.T. Chow, Open-channel hydraulics, McGraw Hill Publications (1959, 1973).
6. Modi P.N. & Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi 2013
7. Todd D.K., Ground Water Hydrology, John Wiley and Sons, 2000
8. V.T. Chow, D.R. Maidment, and L.W. Mays, Applied Hydrology, McGraw Hill, 1998

Course	CE2205: Numerical Methods in Civil Engineering
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Numerical Methods in Civil Engineering
Learning Mode	Lectures
Learning Objectives	Complies with PLO- 1 1. Understanding applicability of numerical methods to solve engineering problems 2. Knowledge about various types of errors 3. Solving simultaneous equations 4. Basic of Matlab
Course Description	The course comprises a comprehensive method of numerical analysis. Minimization of error in numerical calculations, solving simultaneous equations, numerical differentiation, numerical integration are covered.
Course Outline	Introduction to Numerical Methods: Objectives of numerical methods, sources of error in numerical solutions: truncation error, round off error, order of accuracy - Taylor series expansion. Roots of Equations: Graphical Methods, Bisection Method, Simple Fixed-Point Iteration, Newton-Raphson Method, Secant Method, modified Secant Method. Direct Solution of Linear systems: Naive Gauss elimination, LU Decomposition, matrix Inverse, error analysis and system condition, Gauss-Seidel, Gauss-Jordon, Jacobi iteration, Factorization, Cholesky decomposition. diagonal dominance, condition number, ill-conditioned matrices. Numerical Optimization: Newton's method in one and multiple dimension, Gradient Method. Curve Fitting: Linear Regression, Polynomial Regression, interpolation, spline fitting and their Civil Engineering application. Numerical Calculus: Trapezoidal and Simpson's rule for integration and their application. Solving Differential Equation: Euler's method, Runge-Kutta method, Boundary-Value and Eigenvalue Problem and their application, solving partial differential equation. Applicability of Numerical Methods in Civil Engineering: Exposure to software packages like MATLAB.
Learning Outcome	At the end of the course, student would be able to: 1. Solve simultaneous equations. 2. Write programs using Matlab to numerical solve engineering problems 3. Apply various methods for numerical differentiation 4. Apply various methods for numerical integration 5. Apply various methods of interpolation
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination .

Textbooks/ Reference books:

1. S. Chapra and R. Canale, Numerical Methods for Engineers, 6th Ed., McGraw Hill, 2010.
2. S. Guha and R. Srivastava, Numerical Methods: For Engineering and Science, 1st Ed., Oxford University Press, 2010.
3. D. Dahlquist, and A. Bork, Numerical Methods, Prentice-Hall, Englewood Cliffs, NJ, 1974.
4. K. E. Atkinson, Numerical Analysis, John Wiley, Low Price Edition, 2004.
5. J. D. Hoffman, Numerical Methods for Engineers and Scientists, McGraw-Hill, 2001.
6. S. C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill 2008.

Sl. No.	Subject Code	SEMESTER V	L	T	P	C
1.	CE3101	Design of Reinforced Concrete Structures	3	0	2	4.0
2.	CE3102	Foundation Engineering	3	0	2	4.0
3.	CE3103	Transportation Engineering - I	3	1	2	5.0
4.	CE3104	Environmental Engineering - I	3	0	2	4.0
5.	XX31PQ	IDE - II	3	0	0	3.0
TOTAL			15	1	8	20.0

Course	CE3101: Design of Reinforced Concrete Structures
Course Credit (L-T-P-C)	3-0-2-4
Course Title	Design of Reinforced Concrete Structures
Learning Mode	Lectures and Practical
Learning Objectives	Objective for learning this course are Lectures: Complies with PLO-1, 2, 3 and 4 1. Understand the structural load calculation and design process of concrete structure as per Indian standards/ codes (IS 875 and IS 456: 2000). 2. Understand the design process of different concrete structural components such as beam, column, slab etc. 3. Develop abilities to design and reinforce detailing of concrete structures. 4. Learn analysis and design procedure of RC building. Practical: Complies with PLO- 1, 3 and 4 1. Use of different sensors and devices for destructive and non-destructive testing. 2. Learn behaviour of different RC structural elements under different loading scenario.
Course Description	In this course, fundamental components of entire structures that are controlled by bending, shear, axial forces, or a combination of them, are identified. The limits of collapse and serviceability will be introduced after a brief description of various design approaches. The design will be carried out in accordance with IS 456:2000. Practical of the course will cover destructive and non-destructive testing, testing of RC structural elements and reinforcement bars.
Course Outline	Lecture: Introduction to reinforced concrete structures, Basic material properties: stress-strain relation of concrete and reinforcing steel, Design philosophy: assumptions and code of practice, limit state method. Theory of singly reinforced members in bending, Design of simply supported and continuous beams with rectangular and flanged section, Limit state of collapse in shear, torsion, Design for bond, Design of one-way and two-way slab systems, Design of columns under uniaxial and biaxial bending, Design of footings and staircase. Introduction to bridges. Practical: Destructive and non-destructive test (UPV & rebound hammer); semi-destructive (core cutting), Testing of reinforcement bar (mild, HYSD & TMT) in tension; Bend and rebend of TMT bar, RCC beam with three and four point-loading (under-reinforced, balanced and over-reinforced).

Learning Outcome	At the end of the course, student would be able to Lectures: 1. Identify the method of analysis for indeterminate structures. 2. Determine the reactions and forces in indeterminate structures using approximate and exact analysis methods. 3. Use of influence line diagram. 4. Analyses the multi-storey frames. Practical: 1. Be familiar with the materials used for building structures. 2. Learn different testing methods of materials used in the concrete structures. 3. Understand the working principle of various sensors and devices to measure physical response of structures. 4. Develop the various concepts of structural analysis through experiments and hands-on.
Assessment Method	Assignments, Lab Reports, Quizzes, Project work, Mid-semester examination and End-semester examination.

Textbooks/ Reference books:

1. S. U. Pillai and D. Menon, Reinforced Concrete Design, Tata McGraw-Hill, 4th edition, 2021.
2. N Subramanian, Design of Reinforced Concrete Structures, Oxford, 2013.
3. P. C. Varghese, Limit State Design of Reinforced Concrete, Prentice Hall India, 2nd edition, 2008.
4. M. L. Gambhir, Fundamentals of Reinforced Concrete Design, Prentice Hall India, 2006.
5. A. K. Jain, Reinforced Concrete: Limit State Design, Nem Chand and Bros., 6th edition, 2002.
6. J. G. MacGregor and J. K. Wight, Reinforced Concrete: Mechanics and Design, Prentice Education India, 6th edition, 2016.
7. R. Park and T. Paulay, Reinforced Concrete Structures, John Wiley and Sons, 1975.
8. P. M. Ferguson, J. E. Breen and J. O. Jirsa, Reinforced Concrete Fundamentals, John Wiley and Sons, 5th edition, 1988.
9. J. C. McCormac and R. H. Brown, Design of Reinforced Concrete, John Wiley and Sons, 9th edition, 2014.
10. N. Krishnaraju, Advanced Reinforced Concrete Design, CBS Publisher, 2013.
11. IS 456 : Plain and Reinforced Concrete - Code of Practice, BIS.
12. IS 875 : Part 1 : Code of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures Part 1 Dead Loads - Unit Weights of Building Material And Stored Materials.
13. IS 875 : Part 2 : Code of Practice for Design Loads (Other Than Earthquake) For Buildings And Structures: Part 2 Imposed Loads.
14. IS 875 : Part 5 : Code of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures Part 5 Special Loads And Combinations.

	CE3102 Foundation Engineering
Course Credit (L-T-P-C)	3-0-2-4
Course Title	Foundation Engineering
Learning Mode	Lectures and Practical
Learning Objectives	<u>Theory complies with PLO- number 1, 2, 3, and 4. The objectives are to</u> 1. Understand the soil exploration and sub-surface ground investigation. 2. Determine earth pressure, stability of retaining walls and slopes for structural design. 3. Evaluate and analyze bearing capacity of soils for application in the different foundations design. 4. Understand various important soil stabilization and ground improvement techniques for engineering applications. <u>Practical complies with PLO- number 1, 2, 3, and 4. The objectives are to</u> 4. Investigate the shear strength behaviour of various types of soil at different conditions. 5. Determine volume change behaviour of soils. 6. Examine the strength of subgrade soils to be used for design and analysis of highway projects 7. Investigate the bearing capacity and settlement behaviour of soils and identify the sub-surface soil behaviour using field tests. 8. Apply the knowledge to identify the suitability of soils for infrastructure construction and further improvement if required to achieve the goal.
Course Description	The main objectives of this course are to understand, determine and analyze the engineering properties of soils and their application on the foundation design of structures. Further, the course covers a detailed advance laboratory testing by using laboratory and large scale investigation as per standard test procedures to determine and understand the engineering properties of soils and grounds for design of different civil engineering construction projects.
Course Outline	Lectures: Fundamentals of soil exploration and sub-surface ground investigation, Earth Pressure & Retaining Walls, Foundations classification, Shallow Foundation Analysis & Design: Shallow and deep Foundation; Pier and well foundations, Introduction to Mat/Raft foundation, Introduction to ground improvement techniques. Practical: Unconfined Compressive Strength (UCS) of soil; Shear strength parameters of soils using Triaxial tests; Swelling pressure of soils; Volume change behaviour of soils by using one dimensional oedometer test; California Bearing Ratio (CBR) of soils; Plate load test; Standard penetration test for soils; Static cone penetration test.
Learning Outcome	<u>At the end of theory lectures, student would be able to:</u> 6. Analyze the problem related to ground investigation and foundation engineering. 7. Determine earth pressure, stability of retaining walls and slopes for structural design. 8. Evaluate bearing capacity of soils for application in the foundations design. 9. Analyze the capacity and design of deep foundations 10. Understand various important soil stabilization and ground improvement techniques for engineering applications. <u>At the end of practical classes, student would be able to:</u> 5. Investigate the shear strength behaviour of various types of soil at different conditions. 6. Determine volume change behaviour of soils. 7. Examine the strength of subgrade soils to be used for design and analysis of highway projects 8. Investigate the bearing capacity and settlement behaviour of soils and identify the sub-surface soil behaviour using field tests. 9. Apply the knowledge to identify the suitability of soils for infrastructure construction and further improvement if required to achieve the goal.
Assessment Method	Theory: Assignments, Quizzes, Mid-semester examination and End-semester examination. Practical: Lab Reports, Viva, Mid-semester examination and End-semester examination.

Textbooks:

1. V. N. S. Murthy, Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, CRC Press, Taylor & Francis Group, Third Indian Reprint, 2013.
2. J.E. Bowles, Foundation Analysis and Design, McGraw-Hill, 2001.
3. V. N. S. Murthy, Advanced foundation Engineering, CBS Publishers & Distributers, 2011.
4. D. Fratta, J. Aguettant, and L. R. Smith, Soil Mechanics Laboratory Testing, Boca Raton, CRC Press, USA, 2007.

Reference books:

5. Gopal Ranjan, and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International Publishers, 2nd Edition 2000.
6. K. Terzaghi, R. B. Peck and G. Mesri, Soil Mechanics in Engineering Practice, John Wiley & Sons, 1996.
7. B.M. Das, Principle of Geotechnical Engineering, Cengage Learning, eighth Edition, 2013.
8. J. Bardet, Experimental Soil Mechanics, Upper Saddle River, Prentice Hall, USA, 1992.
9. All relevant Indian Standard (IS) and international codes.

Course	CE3103: Transportation Engineering - I
Course Credit (L-T-P-C)	3-1-2-5
Course Title	Transportation Engineering-I
Learning Mode	Lectures and Practical
Learning Objectives	Lectures: Complies with PLO- 1, 2, 3, 4 1. To provide fundamental knowledge in transportation engineering. 2. Train students to plan, design and operate transportation facilities in industry. 3. Provide scientific and technical knowledge, to prepare students to address transportation problems in field. Practical: Complies with PLO- 1, 3, 4 3. Learn laboratory tests required to evaluate bitumen used in road construction. 4. Learn laboratory tests required to evaluate aggregate used in road construction. 5. Learn bituminous mix design. 6. To conduct filed studies for obtained traffic data (speed, flow) 7. To estimate traffic flow density using indirect methods
Course Description	This course will discuss fundamental concepts in transportation engineering. Course will cover theory and real world practice in planning, design, construction and operation in road transportation. Practical will focuses on the tests to measure engineering properties of aggregate and bitumen to evaluate them for road construction. Course will also cover tests to measure traffic stream characteristics.
Course Outline	Lectures: Introduction to transportation engineering; Road plans; Factors controlling highway alignment; Vehicle and driver characteristics, PIEV theory; Pavement materials and characterization: subgrade soil, aggregates, bituminous and modified binders, straight-run bitumen, cutback bitumen, tar; Pavement analysis and design: Flexible pavements, Rigid pavements; Geometric design of Highways: Cross sectional elements, Horizontal alignment, Vertical alignment; Analysis of Traffic Flow, Mixed traffic (PCU), Design of Traffic facilities. Practical: Evaluation of road aggregates for various properties: Blending of aggregate, specific gravity, crushing value, Evaluation of bitumen for various properties: Softening point test, Penetration test, Viscosity test, Ductility test, Flash and fire point test, Stripping test; Bituminous mix design- Marshal mix design method; Headway studies: Free flow, Intermediate flow, High flow; Speed-Volume studies; O-D survey.
Learning Outcome	At the end of the course, from lectures students would be able to: 1. Understand engineering properties of road construction materials. 2. Design flexible and rigid pavements using Indian Codes. 3. Design highway geometrics 4. Identify factors influencing drivers behaviour. 5. Understand basic traffic stream parameters and traffic flow models. From practical students would be able to: 1. Test aggregates to determine its engineering properties to check its acceptability in road construction. 2. Test bitumen to determine its engineering properties to check its acceptability in road construction. 3. Conduct Marshall mix design. 4. Build fundamental diagrams of traffic flow 5. Differentiate time mean speed and space mean speed 6. Understand difference between microscopic and macroscopic variables and how to collect such data in real-field
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.

Textbooks (Lectures):

1. P. Chakroborty and A. Das, Principles of Transportation Engineering, Prentice Hall India, 2003.
2. A.T. Papagiannakis and E.A. Masad, Pavement Design and Materials, John Wiley & Sons Inc, 2012.
3. C. J. Khisty and B. K. Lall, Transportation Engineering: An Introduction, Prentice Hall India, 2003.
4. L. R. Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, 1987.

Reference books (Lectures):

1. Relavent IRC codes.
2. F. L. Mannering, W. P. Kilareski, and S.S. Washburn, Principles of Highway engineering and traffic analysis, John Wiley and Sons, 2005. C. S.
3. Papacostas and P. D. Prevedouros, Transportation Engineering and Planning, Prentice Hall India, 2001.
4. J. H. Banks, Introduction to Transportation Engineering, McGraw-Hill, 2002.
5. S. K. Khanna and C. E. G. Justo, Highway Engineering, Nem Chand Bros., 2002.
6. Y. H. Huang, Pavement Analysis and Design, Pearson Education, India 2008.

Textbooks (Practical):

1. N. A. Harold, Highway materials, Soil and Concrete, Prentice Hall, 2004.
2. C. S. Papacostas and P.D. Prevedouros, Transportation Engineering and Planning, Hall India, 2001

Reference books (Practical):

1. IS Codes and IRC Codes.
2. R.P. Roess, W.R. McShane, and E.S. Prassas, Traffic Engineering, Prentice Hall, 1990.

Course	CE3104: Environmental Engineering - I
Course Credit (L-T-P-C)	3-0-2-4
Course Title	Environmental Engineering - I
Learning Mode	Lectures and Practical
Learning Objectives	Complies with PLOs 1, 4 and 5 1. Understand and apply principles of population forecasting, water demand estimation, and the design of water supply and sewerage systems. 2. Analyze the physical, chemical, and biological characteristics of water and wastewater, incorporating fundamental concepts of microbiology and environmental chemistry. 3. Gain insight into the foundational aspects of water and wastewater treatment processes, factoring in stoichiometry, chemical kinetics, and equilibrium principles. 4. Identify the environmental ramifications arising from solid waste, air pollution, and noise pollution through the formulation of targeted mitigation strategies. 5. To understand the knowledge and principles of determination of different water and wastewater quality parameters and to understand the basis of the water and wastewater treatment process.
Course Description	This course provides a foundational understanding of Environmental Engineering principles and practices. It covers key topics such as water supply, wastewater management, environmental chemistry, microbiology, and pollution control. Students will gain insights into the environmental impacts of solid waste, air pollution, and noise pollution. The practical course explores the knowledge and principles of determining different water and wastewater quality parameters. It also enables an understanding of the relationships between different parameters and their effect on water and wastewater treatment.
Course Outline	Theory Introduction, population forecasting and estimation of future water demand, water supply and distribution, physical, chemical and biological characteristics of water and wastewater, generation and collection of wastewater, design principles for sewerage systems. Basic microbiology, metabolic processes and their role in the environment., microorganisms in natural water systems, biological oxidation of organic matter. Fundamental concepts in environmental chemistry, stoichiometry and kinetics of chemical reactions, equilibrium constant and solubility products, pH and alkalinity and their significance in water chemistry. Process layout for water and wastewater treatment. Introduction to solid waste management, air pollution and noise pollution. Practical Introduction to Laboratory: Identification of Common/ General/ Facilities/ Equipment/ Chemicals/ Glassware; Weighing Chemicals and Making up Solutions. Examination of Water/ Wastewater: Analytical methods of commonly encountered water/wastewater quality parameters; Determination of pH, Eh, turbidity and conductivity; Determination of alkalinity, sulfate, solids, chloride and hardness of water/wastewater; Determination of COD, DO and BOD of water, Optimum coagulant dose and Determination of Pathogenic content (TC & FC) of water/wastewater. Advance Instrumentations for Environmental Analysis: Demonstration of atomic absorption spectrometer, microwave digester, centrifuge, ion chromatography, TOC analyzer, ICPMS, etc.
Learning Outcome	Students will gain knowledge in: Theory: 1. Demand for water supply to households, industry and public services. 2. Environmental microbiology: microbial metabolism, roles in natural water, and organic matter oxidation 3. Applying the environmental chemistry concepts: stoichiometry, kinetics, equilibrium, pH, and alkalinity in water and waste water analysis.

	4. Develop skills for environmental impact assessment and mitigation: treatment processes, waste management, pollution control. Practical: 1. Interpret the quality of water and wastewater before and after treatment. 2. Demonstrate the process involved in the treatment of water and wastewater. 3. Analyse the water and wastewater quality parameters using advanced instruments
Assessment Method	Lecture: Assignments, Quizzes, Mid-semester examination, and End-semester examination. Practical: Lab Reports, Lab written Examination and Practical Examination with Viva-voce

Text Books:

- H. S. Peavy, D. R. Rowe and George Tchobanoglous, Environmental Engineering, McGraw-Hill International Ed., 1985.
- M. L. Davis and D. A. Cornwell, Introduction to Environmental Engineering, McGraw-Hill, Inc., 2014.
- T. J. McGhee, Water Supply and Sewerage, McGraw-Hill Inc., 1991.
- C. N. Sawyer, P. L. McCarty and G. F. Parkin, Chemistry for Environmental Engineers, McGraw-Hill, 1994.
- Garg, S.K., Environmental Engineering (Vol. I) Water Supply Engineering, Khanna Publishers, 37th edition, 2024
- Garg, S.K., Environmental Engineering (Vol. II) Sewage Waste Disposal and Air Pollution Engineering, Khanna Publishers, 40th edition, 2024
- Laboratory Manual.

Reference Books:

- Metcalf & Eddy, Wastewater Engineering- Treatment and Reuse (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill, 4th Edn., 2004.
- S. J. Arceivala and S. R. Asolekar, Wastewater Treatment for Pollution Control and Reuse, Tata McGraw Hill, 2006.
- Manual on Sewerage and Sewage Treatment Systems, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 2013.
- Manual on Water Supply and Treatment Systems (Drink from Tap): Revised and Updated, Ministry of Housing and Urban Affairs, Govt. of India, 2024.
- APHA, Standard Methods Examination of Water and Wastewater, American Public Health Association, Washington DC, 2012.
- M. Radojevic and V. N. Bashkin, Practical Environmental Analysis. Royal Environmental Analysis, 1999.

Sl. No.	Subject Code	SEMESTER VI	L	T	P	C
1.	CE3201	Design of Steel Structures	3	1	0	4.0
2.	CE3202	Infrastructure Drawing and Estimation	1	2	0	3.0
3.	CE3203	Construction Planning & Management	3	0	0	3.0
4.	CE3204	Environmental Engg-II	3	1	0	4.0
5.	CE3205	Water Resources Engineering - II	3	0	2	4.0
6.	CE3206	Transportation Engineering - II	3	0	0	3.0
TOTAL			16	4	2	21.0

Course	CE3201 Design of Steel Structures
Course Credit (L-T-P-C)	3-1-0-4
Course Title	Design of Steel Structures
Learning Mode	Lectures & Tutorials
Learning Objectives	Lectures: Complies with PLO-1, 2, 3 and 4 1. Understand the structural load calculation and design process of components of steel structures as per Indian standards/ codes (IS 875 and IS 800: 2007). 2. Provide scientific and technical knowledge for planning, analysis, and design procedure of steel truss and steel building. Tutorials: Complies with PLO- 1, 3 and 4 1. To equip the students with the analysis and design of steel structures using advance analysis and design software. 2. To equip the students with basic understanding of detailing of structural steel elements.
Course Description	Designing industrial steel structures is the focus of this course, and it covers all the relevant topics, such as material specifications, connections, and the basic design and detailing of structural components. The design will be carried out in accordance with IS 800.
Course Outline	Introduction: Steel structures, material properties, Limit states and design philosophies. Loads, partial safety factors and load combinations. Section classification. Design of tension and compression members. Effective length factor: Sway and Non-sway frames, Built-up columns - Battens and lacing. Design of laterally supported and unsupported beams, built-up beams, Plate girders and design of stiffeners. Design of beam-column of members: effect of axial load on flexure behaviour, P-M interaction and moment amplification, and bi-axial bending. Connections: Structural fasteners - rivets, bolts and welds, strength under combined stresses, simple and eccentric connections. Detailing of axial members, beams, plate girders and columns. Case study of steel buildings.
Learning Outcome	At the end of the course, student would be able to: Lectures: 1. Understand behaviour of structural steel members 2. Estimation of various design loads including wind loads 3. Identify and interpret the appropriate relevant design codes 4. Familiar with design and fabrication of steel members Tutorials: 1. Apply the knowledge of design to detail connections. 2. Analyse, design and detail structural elements in the steel buildings and truss using a commercially available software.
Assessment Method	Assignments, Quizzes, Project work, Mid-semester examination and End-semester examination.

Textbooks/ Reference books:

1. Subramanian, N. (2018). Steel Structures: Design and Practice, Oxford University Press.
2. Duggal, S.K. (2019). Limit State Design of Steel Structures, 3rd edition, McGraw Hill.
3. Bhavikatti, S. S. (2017). Design of Steel Structures (by Limit State Method as Per IS: 800—2007), 5th edition, IK International.
4. Shiyekar, M. R. (2013). Limit State Design of Steel Structures, PHI Learning.
5. Sai Ram, K. S. (2020). Design of Steel Structures, 3rd ed., Pearson Education.
6. Gambhir, M. L. (2013). Fundamentals of Structural Steel Design, McGraw Hill.
7. Segui, W.T. (2017). Design of Steel Structures, 6th ed., Cengage Learning.
8. Galambos, T. V. and Surovek, A. E. (2008). Structural Stability of Steel: Concepts and Applications for Structural Engineers, Wiley.
9. IS 800: Indian Standard General Construction in Steel — Code of Practice, BIS, New Delhi.
10. IS 875: Part 3: Design Loads (Other than Earthquake) for Buildings and Structures - Code of Practice Part 3 Wind Loads, BIS, New Delhi.

Course	CE3202: Infrastructure Drawing and Estimation
Course Credit (L-T-P-C)	1-2-0-3
Course Title	Infrastructure Drawing and Estimation
Learning Mode	Lectures & Tutorials
Learning Objectives	Complies with PLO- number 2 & 4 1. The course also aims at giving the students an idea on keeping cost of material and labour into consideration while designing a building. 2. The course shall provide the students an ability to read and interpret drawings and cost estimates.
Course Description	This course is aimed at providing the students a critical understanding of building planning from foundation level to the rooms, orientation, facade design and overall estimation of the cost. This course is aimed at giving the students an ability to read and interpret the building layouts, blueprints and budget estimates so that they can design structurally strong and cost-effective buildings in future.
Course Outline	Components of buildings: plan, elevation and section of buildings; Drawing of various details of residential buildings; Types of building: residential, industrial; brick masonry. Estimation: types of estimates, plinth area estimate, cubical content estimate, unit rate estimate, central line method, short wall - long wall method; estimate of other structures- estimate of bituminous and cement concrete roads, estimating of septic tank, estimating of irrigation works – aqueduct, syphon, etc., modes of measurement, estimation of buildings, specifications and analysis of rates.
Learning Outcome	At the end of the course, student would be able to: 1. Prepare drawing and layout of single, multi roomed and single to multi storeyed buildings. 2. Read and interpret building layouts. 3. Understand the costing and estimation issues involved in building design and planning and other structures.
Assessment Method	Assignment, Quizzes, Mid-semester examination and End-semester examination.

Text books:

- B. N. Dutta, Estimating and Costing in Civil Engineering, UBS Publishers & Distributors Pvt. Ltd., 2003.
- S. S. Bhavikatti, M. V. Chitawa, Building Planning and Drawing, I K International Publishing House Pvt. Ltd, 2014.
- M.G Shah, C.M Kale, Principles of Building Drawing, Macmillan Publishers India Limited, 2000.
- N. Kumara Swamy, A. Kameswara Rao, Building Planning and Drawing, Charotar Publishing House Pvt. Ltd. - Anand; 7th Revised edition (2013).
- D.D. Kohli, and R.C. Kohli, A Text Book of Estimating and Costing (Civil), S.Chand & Company Ltd., 2004

Reference Book:

- H. Banz, Building Construct. Details Prac. Drawings, CBS; 1ST edition, 2005.
- G. H. Cooper, Building Construction and Estimating, McGraw-Hill, 1971.
- B.P. Verma, Civil Engineering Drawing& House Planning, Khanna Publishers, 2010.
- Latest version of DSR

Course	CE3203: Construction Planning and Management
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Construction Planning and Management
Learning Mode	Lectures
Learning Objectives	1. Study the role and responsibilities of civil engineer as project manager. 2. 3. Study the life cycle of a construction project and the key activities in each phase. 4. Study various types of contracts and bidding procedure. 5. Study planning techniques such as Gantt charts, CPM, and PERT to construction projects. 6. Identify, assess, and mitigate risks in construction projects. 7. Apply principles and practices of quality control in construction. 8. Understand the legal and ethical considerations in construction management.
Course Description	This course introduces undergraduate students to the fundamental concepts and techniques of construction planning and management. It covers a broad range of topics, including project life cycle, planning techniques, resource management, and risk analysis. The course aims to equip students with the skills necessary to effectively plan, coordinate, and control construction projects from inception to completion.
Course Outline	Construction as industry and its challenges, Role of construction management, Methods of construction managements, Basic requirements of construction management: Learning structures, Life cycle of construction projects: Examples of real projects and its learning requirements. Contracts: Different types of contracts, notice inviting tenders, contract document, departmental method of construction, rate list, security deposit and earnest money, conditions of contract, arbitration, administrative approval, technical sanction; contract laws and handling of contracts, commissioning of project. Time management tools: Lists, bar chats, CPM and PERT. Introduction to network-based project management techniques: Defining activities and their interdependence, activity duration estimation: resource driven estimates, duration driven estimates; drawing of network using AOA and AON methods, calculation of project duration and critical path; fast tracking, crashing. Quality Management and Construction safety, Use of information technology in construction industries, Automation in construction industry: a general discussion.
Learning Outcome	Upon successful completion of this course, students will be able to: • Understand various phases in life cycle of a project • Understand the difference between different types of contracts • Understand how to award the contract • Identify activities in a project and estimate activity durations • Understand planning techniques such as Gantt charts, CPM, and PERT to construction projects. • Apply quality control principles to ensure the quality of construction projects. • Navigate legal and ethical issues in construction management.
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.

Textbooks

5. F. Harris, R. McCaffer and F. Edum-Fotwe, Modern Construction Management, Blackwell Publishing, 2006.
6. C. J. Schexnayder and R. E. Mayo, Construction Management Fundamentals, McGraw Hill, New Delhi, 2003.
7. K.K. Chitkara, Construction project management: planning, scheduling and controlling, Tata McGraw-Hill, 2008.

Reference books

1. J. Singh, Heavy Constructon-Planning, equipment and methods, Oxford & IBH Publishing Co. Pvt 1993.

2. R.L. Peurifoy & C.J. Schexnayder, Construction planning and equipment, and methods, 6th ed, McGraw-Hill, 2006.
3. D.S. Berrie and B.C. Paulson, Professional construction management including C.M., Design construct and general contracting, Third edition, McGraw Hill International edition, 1992.
4. L.S. Srinath, PERT and CPM principles and Applications, Third edition, Affiliated east-west press Pvt Ltd, 2001.
5. D.G. Carmichael, Construction engineering Networks: Techniques, planning and management, Ellis Horwood Publishers Chichester 1989.
6. Relevant Govt. manual and guidelines.

Course	CE3204: Environmental Engineering - II
Course Credit (L-T-P-C)	3-1-0-4
Course Title	Environmental Engineering - II
Learning Mode	Lectures and Tutorials
Learning Objectives	Complies with PLOs 1, 2 and 5 1. Design and implement key water treatment units. 2. Understand and design the preliminary, primary and secondary wastewater treatment systems. 3. Apply principles for wastewater stabilization and sludge treatment. 4. Enhance practical knowledge through site visits to treatment facilities.
Course Description	This course covers the design and operation of water and wastewater treatment systems, including physico-chemical processes, filtration, disinfection, and sludge treatment. Students will learn to implement treatment technologies and apply principles of stabilization and pollution control. Practical knowledge is enhanced through site visits to treatment facilities.
Course Outline	Water Treatment: Engineering design of physico-chemical processes. Sedimentation, coagulation, and flocculation techniques. Granular media filtration systems. Disinfection methods. Water softening processes. Manganese and iron removal methods. Adsorption and ion exchange technologies. Wastewater Treatment: Preliminary, primary, and secondary treatment units. Aerobic and anaerobic processes. Objectives, theoretical foundations, and design principles of aeration units. Sludge treatment and disposal methodologies. Design and operation of wastewater stabilization ponds, aerated ponds, and oxidation ditches. Site-visits to Water and Wastewater Treatment Works.
Learning Outcome	• Recognise the common physical, chemical and biological unit operations encountered in treatment processes. • Illustrate the fundamentals of water and wastewater treatment. • Able to apply key theories and principles for the design and selection of appropriate technology in water and wastewater treatment. • Integrate theory with practice through site visits to understand real-world applications.
Assessment Method	Assignments, Quizzes, Mid-semester examination, and End-semester examination.

Text Books:

- H. S. Peavy, D. R. Rowe and George Tchobanoglous, Environmental Engineering, McGraw-Hill International Ed., 1985.
- J. M. Montgomery, Water Treatment Principles and Design, John Wiley & Sons, 1985.
- M. L. Davis and D. A. Cornwell, Introduction to Environmental Engineering, McGraw-Hill, Inc., 2014.
- T. J. McGhee, Water Supply and Sewerage, McGraw-Hill Inc., 1991.
- Garg, S.K., Environmental Engineering (Vol. I) Water Supply Engineering, Khanna Publishers, 37th edition, 2024
- Garg, S.K., Environmental Engineering (Vol. II) Sewage Waste Disposal and Air Pollution Engineering, Khanna Publishers, 40th edition, 2024

Reference Books:

- Metcalf & Eddy, Wastewater Engineering- Treatment and Reuse (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill, 4th Edn., 2004.
- S. J. Arceivala and S. R. Asolekar, Wastewater Treatment for Pollution Control and Reuse, Tata McGraw Hill, 2006.
- Manual on Sewerage and Sewage Treatment Systems, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 2013.
- Manual on Water Supply and Treatment Systems (Drink from Tap): Revised and Updated, Ministry of Housing and Urban Affairs, Govt. of India, 2024.

Course	CE3205 Water Resources Engineering - II
Course Credit (L-T-P-C)	3-0-2-4
Course Title	Water Resources Engineering - II
Learning Mode	Lectures and Practical
Learning Objectives	Complies with PLOs 1, 2 and 5 8. To elucidate the importance of water resources. 9. To provide a basic understanding of the occurrence, distribution, and movement of water in the earth-atmosphere system. 10. To understand the principles of hydro-meteorological data and its measurements.
Course Description	This course offers a comprehensive overview of the various components of the hydrologic cycle and the techniques for hydro-metrological observations. Through this course, students will understand the fundamentals of quantitative assessment of water resources and apply water budget concepts required in designing irrigation and flood control structures.
Course Outline	Introduction: Water as a resource, Hydrologic cycle, water budget, world water quantities. Hydrometeorology: Constituents of atmosphere, general circulation and hydro-metrological observations. Catchment: Stream pattern, description of basin, classification of watersheds and streams. Precipitation and Abstractions: Forms of precipitation, data analysis, rain gauge networks; Infiltration process, infiltration indices and Horton's equation; Evaporation and Evapotranspiration, Pan evaporation, empirical equations for estimating evaporation and evapotranspiration; Transpiration. Runoff and Hydrographs: Rainfall-runoff relations, time area concept, flow duration curve, mass curve, flow hydrograph, Unit Hydrograph (UH), its analysis, S-curve hydrograph. Floods and Routing: Concepts of return period, flood frequency analysis, Gumbel's and Log Pearson Type I & II distributions, Rational method, risk, reliability, and safety factor; Hydrologic storage routing Groundwater Hydrology: Types of aquifers and properties, Darcy's law, steady flow in a confined and unconfined aquifer. Irrigation Engineering: Crop water requirements, Irrigation methods.
Learning Objectives	Practical: Complies with PLOs 1, 2, 3 and 5 2. Hands-on experience in the measurement of hydro-meteorological data and environmental parameters influencing water resources. Students will learn to analyze and interpret the environmental data and understand the controls in hydraulic structures.
Course Description	This course exposes the students to experimental setups for measuring environmental parameters influencing water resources. It also gives exposure to the physical modelling of hydraulic structures and associated measurements related to the control of these hydraulic structures.
Course Outline	Rainfall measurement; Groundwater sampling and groundwater level measurement; Infiltration test; Evaporation test. Flow line Visualization; Flood Hydrograph; Groundwater Abstraction, Open Channel Flow; Hydraulic Jump; Flow over Weirs (Broad Crested, Sharp crested, Crump); Forces on a sluice gate; Critical Depth and discharge measurement

Learning Outcome	At the end of the course, students would be able to understand: 11. Importance of water as a critical resource 12. Various components of the hydrologic cycle that affect the movement of water in the earth-atmosphere system. 13. The techniques for taking hydro-meteorological observations. 14. Applications of the hydro-meteorological observations and concepts in the management of water resources and its applications.
Assessment Method	Assignments, Quizzes, Mid-semester examination, and End-semester examination

Text Books/ Reference Book:

1. K Subramaniya, Engineering Hydrology, McGraw Hill, 4th Edition, 2015.
2. Ven Te Chow, David R. Maidment, Larry W. Mays, Applied Hydrology, McGraw Hill, 1998.
3. P Jaya Rami Reddy, A Textbook of Hydrology, University Science Press, 3rd Edition, 2023.
4. Todd D.K., Ground Water Hydrology, John Wiley and Sons, 2000.
5. Tim Davie, Nevil Wyndham Quinn, Fundamentals of Hydrology, Routledge, 2019.

Course	CE3206: Transportation Engineering - II
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Transportation Engineering - II
Learning Mode	Lectures
Learning Objectives	Complies with PLO number – 1, 2, and 4 1. Understand the fundamentals of urban transportation planning 2. Gain knowledge of railway engineering principles. 3. Introduce students to the field of Airport Engineering. 4. Understand airport markings and air traffic control lighting and signing.
Course Description	This course provides an introduction to urban transportation planning, railway engineering and airport engineering.
Course Outline	Transportation Planning: Introduction to urban transportation planning; Urban transportation planning process; Introduction to urban transportation model system; Evaluation of Transportation Systems: Economic analysis; Environmental impact assessment; Financial analysis. Railway Engineering: Introduction to railway engineering, History of Indian Railways, Nomenclature of locomotives, Track capacity, Track modulus, Railway alignment; Axle load and dynamic augmentation factor, Components of railway track structure and its functions; Geometric design. Airport Engineering: Introduction to Airport Engineering, Site selection, Geometric designs, Air traffic control lighting and signing, Runway and Taxiway signs and markings, Airport pavement design, Maintenance and Evaluation of pavements.
Learning Outcome	At the end of the course, student would be able to: 1. Describe the key components of urban transportation planning. 2. Calculate track capacity and understand track modulus. 3. Apply geometric design principles to railway alignment. 4. Design runways and taxiways.
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.

References:

1. L. R. Kadiyali Traffic Engineering and Transport Planning
2. Coenraad Esveld., “Modern Rail Track Design”, MRT productions.
3. Buddhima Indraratna, Wadud Salim, Chalachat Rujikiatkamjorn, “Advanced Rail Geotechnology - Ballasted Track”, CRC Press, 2011.
4. S.C. and Arora.S.P, “A Text Book of Railway Engineering”, Dhanpat Rail Publications, 2013
5. J. S. Mundrey, Railway track engineering. Mc. Graw Hill.
6. Saxena, S.C., "Airport Engineering – Planning and Design", CBS Publishers.
7. Horonjeff R., McKelvey F.X., Sproule W., Young S. "Planning and Design of Airports", 5th Ed. New York: McGraw-Hill.
8. Y. H. Huang, Pavement Analysis and Design (2nd Edition), Pearson Education, India
9. A.T. Papagiannakis and E.A. Masad, Pavement Design and Materials, John Wiley & Sons, Inc.

Sl. No.	Subject Code	SEMESTER VII	L	T	P	C
1.	CE41XX	Departmental Elective – I	3	0	0	3.0
2.	CE41XX	Departmental Elective – II	3	0	0	3.0
3.	XX41PQ	IDE-III	3	0	0	3.0
4.	HS41XX	HSS Elective II	3	0	0	3.0
5.	CE4198	Summer Internship*	0	0	12	3.0
6.	CE4199	Project – I	0	0	12	6.0
TOTAL			12	0	24	21.0

Department Elective-I						
Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE4101	Introduction to Bridge Engineering	3	0	0	3
2.	CE4102	Prestressed and Precast Concrete Structures	3	0	0	3
3.	CE4103	Fundamentals of Solid Mechanics	3	0	0	3
4.	CE4104	Matrix Method for Structural Analysis	3	0	0	3

Course	CE4101 Introduction to Bridge Engineering
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Introduction to Bridge Engineering
Learning Mode	Lectures
Learning Objectives	Lectures: Complies with PLO-1, 2, 3 and 4 3. Apply the fundamental principles of bridge engineering, including load distribution, dead and live load analyses etc. to evaluate the performance of different types of bridges. 4. Design of various bridge components following various Indian as well as international standards and safety regulations. 5. To become proficient in using advanced computational tools and software for the modelling, simulation considering dynamic loading like wind and earthquake.
Course Description	This course offers a comprehensive exploration of bridge engineering and design, covering fundamental principles, methodologies, and practical applications. This course covers key aspects including structural analysis, material selection, construction techniques, and environmental considerations.
Course Outline	Introduction: Classification of Bridges, General Features of Design, IRC Loading (viz. 70R, Class AA tracked and wheeled vehicle), Design Codes, Working Stress Method, Limit State Method of Design as per IS456 and IRC 112; Analysis & Design: Consideration of various loading (dead load, vehicular load etc.), Slab bridge, Box Culvert, T-beam bridge, Box Girder bridge.
Learning Outcome	At the end of the course, student would be able to Lectures: 5. Understand behaviour of structural steel members. 6. Estimation of various design loads including wind loads. 7. Identify and interpret the appropriate relevant design codes. 8. Familiar with design and fabrication of steel members.
Assessment Method	Assignments, Quizzes, Project work, Mid-semester examination and End-semester examination.

Textbooks/ Reference books:

1. Swami Saran, Analysis and Design of Substructures: Limit State Design, 28 February 2018.
2. K. K. Rakshit, Design and Construction and Highway Bridges.
3. Raju N. K, Design of Bridges, 5Ed (Pb 2019) – 1 January 2019.
4. Daniel J. Inman, Charles R. Farrar, Vicente Lopes Junior, Valder Steffen Junior, Damage Prognosis: For Aerospace, Civil and Mechanical Systems, John Wiley & Sons, 2005.
5. Latest version of relevant IRC (viz. IRC6, IRC112 etc.) and IS (viz. IS456, IS800 etc.) codes.

Course	CE4102 Prestressed and Precast Concrete Structures
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Prestressed and Precast Concrete Structures
Learning Mode	Lectures
Learning Objectives	Lectures: Complies with PLO-1, 2, 3 and 4 1. Familiarize with the concept of pre-stressed concrete and design of pre-stressed concrete structures. 2. Analyse prestressed concrete structural members and estimate the losses of prestress.
Course Description	The course deals with the design of pre-stressed concrete structures for various types of loading and will provides an understanding of behaviour of pre-stressed concrete members under various action of forces.
Course Outline	Analysis and design of beams - Rectangular, Flanged and I section, for limit state of flexure. Analysis and design of end blocks in post tensional members -primary and secondary distribution zones, Bursting and spalling tensions. Shear strength of prestressed concrete beams and design of shear reinforcement. Bond in prestressed concrete. Analysis and design of prestressed concrete structures such as concrete pipes and sleepers. Precast Structural Building components such as slab panels, beams, columns. Prefabricated building using precast load bearing and non-load bearing wall panels. Prefab systems, structural schemes, and their classification including design considerations. Joints - requirements of structural joints and their design considerations.
Learning Outcome	At the end of the course, student would be able to Lectures: 1. Become familiar with basic of pre-stressed concrete structure. 2. Understand the behaviour of pre-stressed concrete structural members structures under flexure, shear, axial forces, combined flexure and axial forces, and in-plane shear forces. 3. Learn the methods of pre-stressed concrete construction and detailing practices.
Assessment Method	Assignments, Quizzes, Project work, Mid-semester examination and End-semester examination.

Textbooks/ Reference books:

1. IS 1343: Code of Practice for Prestressed Concrete by Bureau of Indian Standards.
2. Guyon Y.: Prestressed Concrete, Vol. I & II, John Wiley and Sons, New York.
3. Krishna Raju, N.: Prestressed Concrete, Tata McGraw Hill Publications Company, New Delhi.
4. Lin T. Y.: Prestressed Concrete, Tata McGraw Hill, New Delhi.
5. Dayaratnam P. and Sarah P.: Prestressed Concrete Structures.
6. Elliott K. S.: Precast Concrete Structures, CRC Press; 2nd edition, 2019.

Course	CE4103 Fundamentals of Solid Mechanics
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Fundamentals of Solid Mechanics
Learning Mode	Lectures
Learning Objectives	Lectures: Complies with PLO-1, 2, 3 and 4 1. Understand the concept of deformation, linear and nonlinear measures of strain and stress. 2. Introduce failure theory of different materials. 3. Predict the behaviour elastic solids under different loading.
Course Description	The course deals with analysis of deformable bodies. This course provides the students an exposure for linear and non-linear analysis of solids, analysis of stress and strain, fundamental physical principles, constitutive relation of materials, and two-dimensional electrostatics problems.
Course Outline	Introduction: Suffix notation system, tensor algebra; Strain analysis: deformation and velocity gradients, Lagrangian and Eulerian description of strain, principal strains and strain invariants, compatibility conditions; Stress analysis: forces and moments, theory of stress, energetically conjugate stress and strain measures, plane stress and plane strain, principal stresses and stress invariants, compatibility equations, equilibrium equations; Fundamental physical principles: conservation of mass, linear momentum, angular momentum, and energy; Constitutive theory: St. Venant's principal, linear elasticity and generalized Hook's law, stress, strain and energy based failure theory, yield criteria; Introduction to elasticity: two-dimensional problems, torsion, buckling.
Learning Outcome	At the end of the course, student would be able to Lectures: 1. Understand the concept of deformation mechanisms in solid and different measures of strain and stress. 2. Gain knowledge on material model of liner elastic solid body. 3. Analysis of problem in elastic deformable body.
Assessment Method	Assignments, Quizzes, Project work, Mid-semester examination and End-semester examination.

Textbook/ Reference book:

1. S. Timoshenko and J.N. Goodier, Theory of Elasticity, McGraw Hill Book Company, International Ed, 1970.
2. L. S. Srinath. Advanced Mechanics of Solids, McGraw Hill Education, 2010.
3. Allan F. Bower. Applied Mechanics of Soilds, CRC Press, 2010.
4. Irving H. Shames and Francs A. Cozzarelli. Elastic and Inelastic Stress Analysis, Taylor & Francis Group; Revised edition, 1997.
5. Romesh C. Batra. Element of Continuum Mechanics, AIAA, 2012.

Course	CE4104 Matrix Methods of Structural Analysis
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Matrix Methods of Structural Analysis
Learning Mode	Lectures
Learning Objectives	Objective for learning this course are Lecture: - Understand the analysis and design different type of structural elements under static loading. - Predict nonlinear behaviour of different structures and structural components under static loading.
Course Description	The course deals with advanced analysis methods of structures. This course provides the students an exposure for linear and non-linear analysis of structures.
Course Outline	Introduction Structures, loads and response; determinate and indeterminate structures; stiffness and flexibility; Analysis of Indeterminate structures; Force and displacement methods; Mathematical preliminaries; Matrix algebra; stiffness and flexibility matrices; Analysis of Trusses; Analysis of Beams; Analysis of plane frames; Implementation issues; Beyond matrix method: Introduction to nonlinear analysis.
Learning Outcome	At the end of the course, student would be able to Lecture: - Analyse structures for designing them. - Should be able to understand various types of elements used for structural analysis.
Assessment Method	Assignments, Quizzes, Project work, Lab report, Mid-semester examination and End-semester examination.

Textbooks/ Reference books:

1. R C Hibbeler, Structural Analysis, Ninth Edition, Pearson, 2017.
2. W. McGuire, R. H. Gallagher and R. D. Ziemian, Matrix Structural Analysis, Second Edition, Wiley, 2015.
3. D. Menon, Advanced Structural Analysis. Narosa, 2015.
4. Amin Ghali, Adam M Neville and Tom G Brown, ""Structural Analysis:A Unified Classical and Matrix Approach"", Sixth Edition, 2007, Chapman & Hall.

Department Elective-II						
Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE4105	Stochastic Hydrology	3	0	0	3
2.	CE4106	Irrigation Engineering and Hydraulic Structures	3	0	0	3
3.	CE4107	Elementary Soil Behaviour	3	0	0	3
4.	CE4108	Fundamentals of Geoenvironmental Engg.	3	0	0	3
5.	CE4109	Biogeotechnical Engineering	3	0	0	3
6.	CE4110	Pavement Geotechnology	3	0	0	3

Course	CE4105 Stochastic Hydrology
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Stochastic Hydrology
Learning Mode	Lectures
Learning Objectives	Complies with PLOs 1, 2, 3, 4 and 5 This course is designed to present an understanding of statistical tools applied to hydrologic problems. The objective of this course is to introduce the concepts of probability theory and stochastic processes with applications in hydrologic analysis and design.
Course Description	The course covers the modelling of hydrologic time series with specific techniques for data generation and hydrologic forecasting. Case study applications will be discussed.
Course Outline	Statistical methods in hydrology, probability distribution of hydrologic variables, hypothesis testing and goodness of fit, flood frequency analysis, single and multiple regression analysis, classification of time series, characteristics of hydrologic time series, statistical principles and techniques for hydrologic time series modelling, time series modelling of annual and periodic hydrologic time series (including AR, ARMA, ARIMA, and DARMA models), multivariate modelling of hydrologic time series, practical considerations in time series modelling applications.
Learning Outcome	By taking this course, students will be able to: 1. Analyse hydrological and climatological data using advanced statistical methods and characterize water resources and hydrometeorological data. 2. Analyse hydrologic time series, and perform frequency analysis to estimate the magnitude of an event, frequency of occurrence and associated uncertainty.
Assessment Method	Assignments, Quizzes, Mid-semester examination, and End-semester examination

Text Books/ Reference Book:

1. Haan, C.T., Statistical Methods in Hydrology, First East-West Press Edition, New Delhi, 1995.
2. Bras, R.L. and Rodriguez-Iturbe, Random Functions and Hydrology, Dover Publications, New York, USA, 1993.
3. Clarke, R.T., Statistical Models in Hydrology, John Wiley, Chinchester, 1994.
4. Kite, G.W., Frequency and Risk Analyses in Hydrology, Water Resources Publications, Fort Collins, CO, 1977.
5. Yevjevich V., Probability and statistics in Hydrology, Water Resources Publications, Colorado, 1972.
6. Ang, A.H.S. and Tang, W.H., Probabilistic concepts in Engineering Planning Design, Vol. 1, Wiley, New York, 1975.

Course	CE4106 Irrigation Engineering and Hydraulic Structures
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Irrigation Engineering and Hydraulic Structures
Learning Mode	Lectures
Learning Objectives	Complies with PLOs 1, 2, 3, 4 and 5 11. Students will understand the soil-water-crop management and the role of irrigation system. 12. The students will be exposed to the various irrigation and flood control structure and their design principles.
Course Description	This course offers an introduction to irrigation practices and the development, conservation, regulation and use of water resources through the design of hydraulic structures.
Course Outline	Introduction to irrigation: Necessity and scope, irrigation practices, soil-crop-water requirement. Water resource Development: reservoir planning. Dams: Types of dams, their function and design. Design of Spillways. Diversion work. Distribution System: Flow irrigation canal, theory and design of canals, canal outlet, canal regulation work, cross drainage work, canal head work. Introduction to river engineering.
Learning Outcome	At the end of the course, students would be able to understand: 15. The soil-water-crop relation and the need for irrigation. 16. The principles of design of hydraulic structures.
Assessment Method	Assignments, Quizzes, Mid-semester examination, and End-semester examination

Text Books/ Reference Book:

9. Modi P.N. Irrigation Water Resources And Water Power Engineering, Rajsons Publications, New Delhi 2013
10. Punamia, B. C., & Lal, B..Irrigation and water power engineering. 17th Edition, Laxmi Publications
11. Santosh Kumar Garg, Irrigation Engineering and Hydraulic Structure, Khanna publishers, 2023
12. R. N. Reddy , Irrigation Engineering, Daya Publishing House, 2010
13. P. Novak, A.I.B. Moffat, C. Nalluri, R. Narayanan, Hydraulic Structures, CRC Press, 2017
14. Relevant IS codes

	CE4107 Elementary Soil Behaviour
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Elementary Soil Behaviour
Learning Mode	Lectures
Learning Objectives	Complies with PLO- number 1, 3, 4, and 5. The objectives of this course are to 1. Understand the significance of different clay mineral in behaviour of soils and its determination. 2. Comprehend the arrangement of soil particles and its relevance in behaviour of soils. 3. Analyse the mechanism behind the physio-chemical interactions within soils. 4. Develop an understanding of the factors determining and controlling the engineering properties and behaviour of soils.
Course Description	This course is offered as an elective course in department. This course basically comprises with several topics which should be covered to deal with basics of soil behaviour subjected to variation in climatic changes. Board topics are different clay mineral in behaviour of soils and its determination, arrangement of soil particles and its relevance in behaviour of soils, mechanism behind the physio-chemical interactions within soils, and factors determining and controlling the engineering properties and behaviour of soils under different conditions.
Course Outline	Identification and Classification of Clay Minerals; Origin and description of clay minerals; Determination of soil composition and fabric; Physio-Chemical Behaviour of Soil; Soil-chemical interactions; Microbially Induced Calcite Precipitation (MICP); Effective, Inter-granular and Total stress; Water–Air interactions in soils; Volume Change, Shear Strength and Deformation Behaviour.
Learning Outcome	At the end of the course, student would be able to: 1. Recognize the significance of different clay mineral in behaviour of soils and its determination. 2. Understand the arrangement of soil particles and its relevance in behaviour of soils. 3. Analyse the mechanism behind the physio-chemical interactions within soils. 4. Apply knowledge for determining and controlling the engineering properties and behaviour of soils under different conditions, with an emphasis on Why they are What they are for research/professional perspectives as well as for societal needs.
Assessment Method	Assignments , Quizzes , Term-paper project, Mid-semester examination and End-semester examination.

Textbooks:

1. Mitchell, J. K. and Soga, K. Fundamentals of soil behaviour, Wiley, New York, 2005.
2. Yong, R. N. and Warkentin, B. P. Soil properties and behaviour, Elsevier, 2012.
3. Lambe, T.W. and Whitman, R.V. Soil mechanics, John Wiley and Sons, New York, 1979.

Reference books:

1. Grim, R. E. Applied clay mineralogy, McGraw Hill, New York, 1966.
2. Fredlund, D. G., Rahardjo, H. and Fredlund, M. D. Unsaturated soil mechanics in engineering practice, Wiley, 2012.
3. Malcom, D. Bolton A guide to soil mechanics, University Press (India) Pvt. Ltd., 2003.
4. All relevant codes and research papers.

	CE4108 Fundamentals of Geoenvironmental Engineering
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Fundamentals of Geoenvironmental Engineering
Learning Mode	Lectures
Learning Objectives	Complies with PLO- number 1, 2, 3, and 4 1. Understanding methods of waste management and disposal 2. Learning methods of contaminated site characterisation 3. Learning methods of remedial measures of a contaminated site
Course Description	The course covers the source of various types of waste and its proper disposal, remediation of contamination sites. Municipal solid waste and industrial waste disposal techniques. Role of compacted unsaturated clay as liner material in landfill.
Course Outline	Production and classification of wastes, contaminated site characterization, Selection of waste disposal sites, selection criteria. Design of various landfill components such as liners, covers, leachate collection and removal, gas generation and management, ground water monitoring, stability analysis. Ash disposal facilities, dry disposal, wet disposal, design of ash containment system, stability of ash dykes, mine tailings. Planning, source control, soil washing, bioremediation, stabilization of contaminated soils and risk assessment approaches
Learning Outcome	At the end of the course, student would be able to: 1. Able to manage and dispose particular type of waste 2. Should be able to characterize contaminated site 3. Should be able to take appropriate remedial measures for a contaminated site
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.

Textbooks:

1. H D Sharma and K R Reddy, “Geoenvironmental Engineering: Site Remediation, waste containment, and emerging waste management technologies”, John Willey and Sons, 2004.
2. R N. Yong, “Geoenvironmental Engineering: Contaminated Ground: Fate of Pollutions and Remediation”, Thomson Telford, 2000.
3. D. G. Fredlund and H. Rahardjo, “Soil Mechanics for Unsaturated soils”, Wiley Publication, 1993.

Reference books:

1. R Kerry Rowe, R M Quigley, Richard W I Brachman and John R Booker, “Barrier Systems for Waste Disposal Facilities”, 2nd edn, CRC press, 2019.
2. L N Reddy and H.I. Inyang, “Geoenvironmental Engineering: Principles and Applications”, Marcel Dekker, 2000
3. James K Mitechell, K Soga, “Fundamentals of soil behaviour”, Wiley Publication, 2005.
4. Charles W.W.Ng, B Menzies, “Advanced unsaturated soil mechanics and engineering”, CRC Press, 2014.
5. All relevant IS and International Codes.

	CE4109 Biogeotechnical Engineering
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Biogeotechnical Engineering
Learning Mode	Lectures
Learning Objectives	Complies with PLO- number 1, 3, and 5. The objectives of this course are to 1. Understand the significance of geomicrobiology in geotechnical engineering. 2. Comprehend various biological process in ground/soil improvement. 3. Apply the knowledge for upscaling to develop sustainable geomaterials.
Course Description	This course combines the principles of environmental biotechnology and geotechnical engineering. Geotechnical engineers design, build, and maintain structures in the subsurface. This course will be able to provide combine and apply basic theory and concepts from soil mechanics and biology in engineering applications. This course also brings an understanding about various geomicrobiological process for soil improvement.
Course Outline	Introduction to Biogeotechnics, Biological process of the subsurface materials, Stoichiometry and kinetics of bio-chemical reactions, Microbially Induced Calcite Precipitation (MICP), Root-Inspired Foundations, Enzymatically Induced Calcite Precipitation (EICP), Self-healing materials, Termite mounds-, Snake- and Ant-Inspired Excavations, Microbial Ecology, Biofilms, and Zeolite Sorption, Production of bio-cements. Instrumentation and testing for evaluating biological process and geotechnical material behaviour, Upscaled model tests and field trails.
Learning Outcome	At the end of the course, student would be able to: 1. Understand the importance of geomicrobiology in geotechnical engineering. 2. Comprehend various bio-chemical reactions and their application in biological process for ground/soil improvement. 3. Investigate biological process and geotechnical behaviour. 4. Apply the knowledge for upscaling to develop sustainable geomaterials.
Assessment Method	Assignments , Quizzes , Term-paper project, Mid-semester examination and End-semester examination.

Textbooks:

4. Ehrlich, H., Newman, D. Geomicrobiology (5th ed.). Boca Raton: CRC Press (2021).
5. Hemond, Harold F., and Elizabeth J. Fechner. Chemical fate and transport in the environment. academic press, 2022.
6. Rittmann, Bruce E., and Perry L. McCarty. "Environmental biotechnology: principles and applications." (No Title) (2001).

Reference books:

5. Coduto, Donald P., Man-chu Ronald Yeung, and William A. Kitch. "Geotechnical engineering: principles and practices." (No Title) (2011).
6. Zheng, Chunmiao, and Gordon D. Bennett. Applied contaminant transport modeling. Vol. 2. New York: Wiley-Interscience, 2002.
7. All relevant codes and research papers

Course Number	CE4110: Pavement Geotechnology
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Pavement Geotechnology
Learning Mode	Lectures
Learning Objectives	Complies with program learning outcome 1a; 3a 1. Equip the students with a strong foundation and strengthen their knowledge in pavement geotechnics. 2. The student will be able to apply advanced theory and analysis for problem-solving in pavement geotechnics. 3. The student will prepare for further research and graduate study by critical thinking and improving research skills. 4. The student will be able to apply fundamentals in identifying, formulating, and solving complex engineering problems in pavement geotechnics.
Course Description	This coursework will provide practical insights for students in the field of Pavement Geotechnics. The students will be taught the recent developments and design principles to face current and future highway problems in relevance with pavement geotechnics.
Course Content	Geotechnical properties of geomaterials such as soil, rock, soil-rock mixture, and alternative geomaterials. Introduction to stabilized geomaterials. Introduction to various types of pavement, subgrades, materials, subbase, base, and asphalt concrete materials relevant to pavement Geotechnics, Elastic theories and stress distribution in pavements, Geosynthetic stabilized pavements, geotechnical parametric studies for AASHTO, MEPDG, and IRC designs.
Learning Outcome	Students would be able to learn the core principles of pavement designs and advanced sustainable pavement techniques. Exploration of alternative materials, design approaches, and innovation in pavement geotechnics will be disseminated through this course.

Textbooks:

1. Huang, Y. H. (2004). Pavement analysis and design, Second edition, Upper Saddle River, NJ: Pearson Prentice Hall.
2. Yoder, E. J., & Witczak, M. W. (1991). Principles of pavement design. John Wiley & Sons.
3. Mallick, R. B., & El-Korchi, T. (2008). Pavement engineering: principles and practice. CRC Press.
4. Frost, M. W., Jefferson, I., Faragher, E., Roff, T. E. J., & Fleming, P. R. (Eds.). (2003). Transportation Geotechnics: Proceedings of the Symposium Held at The Nottingham Trent University School of Property and Construction on 11 September 2003. Thomas Telford Publishing.
5. Ellis, E., Yu, H. S., McDowell, G., Dawson, A. R., & Thom, N. (Eds.). (2008). Advances in Transportation Geotechnics: Proceedings of the International Conference Held in Nottingham, UK, 25-27 August 2008. CRC Press.
6. Miura, S., Ishikawa, T., Yoshida, N., Hisari, Y., & Abe, N. (Eds.). (2012). Advances in Transportation Geotechnics 2. CRC Press.

Reference books:

1. Ferguson, B. K., & Ferguson, B. K. (2005). Porous pavements. Boca Raton, FL: Taylor & Francis.
2. Rogers, M., & Enright, B. (2016). Highway engineering. John Wiley & Sons.
3. Nikolaides, A. (2014). Highway engineering: Pavements, materials and control of quality. CRC Press.
4. Babu, G. L. S., Kandhal, P. S., Kottayi, N. M., Mallick, R. B., & Veeraragavan, A. (2019). Pavement Drainage: Theory and Practice. CRC Press.
5. Babu, G.L.S., (2006). An Introduction to Soil Reinforcement and Geosynthetics, Universities Press (India) Pvt. Ltd.
6. All relevant codes and standards

Sl. No.	Subject Code	SEMESTER VIII	L	T	P	C
1.	CE42PQ	Departmental Elective – III	3	0	0	3.0
2.	CE42PQ	Departmental Elective – IV	3	0	0	3.0
3.	CE42PQ	Departmental Elective – V	3	0	0	3.0
4.	CE4299	Project – II	0	0	16	8.0
TOTAL			9	0	16	17.0
GRAND TOTAL (including Semester I & II)			167.0			

Department Elective-III						
Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE4201	Elements of Remote Sensing and GIS	3	0	0	3
2.	CE4202	Introduction to Soil Structure Interaction	3	0	0	3
3.	CE4203	Introduction to Underground Excavation	3	0	0	3
4.	CE4204	Multiphysical Processes in fractured rocks	3	0	0	3
5	CE4205	Rock Engineering for Hydropower Projects	3	0	0	3
6	CE4206	Fundamentals of Forensic Geotech Engineering	3	0	0	3
7	CE4207	Ground Improvement for Civil Engineering Structures	3	0	0	3

Course Number	CE4201: Elements of Remote Sensing and GIS
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Elements of Remote Sensing and GIS
Learning Mode	Lectures
Learning Objectives	Complies with PLO 1, 3 and 4
Course Description	This course shall give the 3 rd year B. Tech students of Civil & Environmental Engineering an insight of the emerging trends in remote sensing and GIS apart from the very basics of remote sensing and GIS to the data and sensor types and some hands on in utilization of remote sensing and GIS tools.
Course Content	Lecture: Remote sensing – history & development, definition, concept and principles. Energy resources, radiation principles, EM Radiation and EM Spectrum. Interaction of EMR with atmosphere and earth's surface. Platforms – types and their characteristics Satellites and their characteristics – geo-stationary and sun-synchronous Earth Resources Satellites - LANDSAT, SPOT, IRS, IKONOS satellite series Meteorological satellites – INSAT, NOAA, GOES. Sensors – types and their characteristics, across track (whiskbroom) and along track (pushbroom) scanning Optical mechanical scanners – MSS, TM, LISS, WiFS, PAN Concept of resolution – spatial, spectral, temporal, radiometric Basic concept and principles of thermal, microwave and hyperspectral sensing. Fundamentals of GIS, open source GIS tools, Network analysis, raster and vector data formats, cartography.
Learning Outcome	After completion of course, students will be able to: • Describe various sources and characteristics of remote sensing data. • Explain application of remote sensing data in different domains such as urban, agriculture, disaster management etc. • Understand the remote sensing data processing techniques. • Apply the knowledge for economic, environmental and sustainable infrastructure development.
Assessment Method	Quiz, Class Test, Term-paper project and Examination

Books Recommended

- Campbell, J.B. 2002: Introduction to Remote Sensing. Taylor & Francis Publications
- Drury, S.A., 1987: Image Interpretation in Geology.
- Allen and Unwin Gupta, R.P., 1990: Remote Sensing Geology.
- Springer Verlag Jensen, J.R. 2000: Remote Sensing of the Environment: An Earth Resource Perspective. Prentice Hall.
- Joseph George, 2003: Fundamentals of Remote Sensing. Oxford Universities Press
- Lillesand, T.M., and Kieffer, R.M., 1987: Remote Sensing and Image Interpretation, John Wiley.

	CE4202 Introduction to Soil Structure Interaction
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Introduction to Soil-Structure Interaction
Learning Mode	Lectures
Learning Objectives	Complies with PLO- number 1, 2, 3, and 4 1. To provide the knowledge of the basic concept of soil and structural interaction. 2. Equip the students with a basic foundation in civil engineering for both research and industrial scenarios. 3. Prepares the students to apply knowledge in policy and decision making related to civil engineering infrastructure under dynamic loading.
Course Description	This course intends to bridge the basic concepts with the advanced topics related to geotechnical engineering. Topics ranging from general concept of soil-structure interaction, beams on elastic foundation, modern concept of analysis of piles and pile groups are covered.
Course Outline	General soil-structure interaction problems. Contact pressures and soil-structure interaction for shallow foundations. Concept of sub grade modulus, Beams on elastic foundation concept, Curved failure surfaces, their utility and analytical/graphical predictions from Mohr-Coulomb envelope and circle of stresses. Earth pressure computations by friction circle method. Earth pressures on sheet piles, braced excavations. Design of supporting system of excavations. Arching in soils. Elastic and plastic analysis of stress distribution on yielding bases. Modern concept of analysis of piles and pile groups. Axially, laterally loaded piles and groups. Elastic continuum and elasto-plastic analysis of piles and pile groups. Non-linear load-deflection response.
Learning Outcome	At the end of the course, student would be able to: 5. Apply beam on elastic foundation concept in analysis and design of various problem related to geotechnical engineering. 6. Determine ultimate lateral resistance of piles by various approaches.
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.

Textbooks:

1. J. P. Wolf, Dynamic Soil-Structure Interaction, Prentice-Hall, 1985.

Reference books:

1. H. G. Poulos, and E. H. Davis, Pile Foundation Analysis and Design, Krieger Pub Co., 1990.
2. Structure Soil Interaction- State of Art Report, Institution of Structural Engineers, 1978.
3. All relevant IS and International Codes.

	CE4203: Introduction to Underground Excavation
Course Credit (L-T-P-C)	3-0-0-3.0
Course Title	Introduction to Underground Excavation
Learning Mode	Lectures and practical
Learning Objectives	Complies with PLO- number 1, 2 and 3. 1. Understand the principles of underground excavation design, including site investigation and geological mapping. 2. Gain proficiency in analyzing rock mass behavior and selecting appropriate support systems. 3. Learn excavation methods, tunnelling techniques, and their applications in various geological conditions. 4. Develop skills to design safe, cost-effective, and sustainable underground structures while considering geological, geotechnical, and structural factors.
Course Description	This course covers principles of underground excavation including rock mechanics, support systems, and excavation methods. Topics include ground behavior, stability analysis, tunnelling methods, and practical design considerations.
Course Outline	Introduction to Underground Excavations, Rock Mechanics Fundamentals, Site Investigation and Geotechnical Data Collection, Excavation Methods, Support Systems for Underground Excavations.
Learning Outcome	At the end of the course, student would be able to: 1. Understanding principles of rock mechanics for underground openings. 2. Ability to analyze and design support systems for stability and safety. 3. Proficiency in assessing geological conditions and their impact on excavation design. 4. Skill development in designing underground excavations for various engineering purposes like tunnels, mines, or underground structures.
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.

Textbooks:

1. Goodman, R. E. Introduction to rock mechanics, John Wiley and Sons, 1989.
2. Hoek, E., & Bray, J. D. Rock slope engineering, CRC Press, 1981.
3. Hoek, E. & Brown, E. Underground excavations in rock, CRC Press, 1980.

References:

1. Singh, B., & Goel, R. K. Engineering rock mass classification, Elsevier, 2011.
2. Jaeger, J. C., Cook, N. G., & Zimmerman, R. Fundamentals of rock mechanics, John Wiley & Sons, 2009.
3. Debasis, D., & Kumar, V. A. Fundamentals and applications of rock mechanics, PHI Learning Pvt. Ltd. New Delhi, India, 2016.
4. All relevant IS and international codes.

	CE4204: Multiphysical Processes in Fractured Rocks
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Multiphysical Processes in Fractured Rocks
Learning Mode	Lectures and practical
Learning Objectives	Complies with PLO- number 1, 2 and 3 1. Understand the coupling mechanisms between various processes (e.g., fluid flow, heat transfer, and mechanical deformation) in fractured geological media. 2. Analyze the impact of fractures on the behavior of fluid flow, heat transfer, and mechanical deformation in geological formations. 3. Apply numerical modeling techniques to simulate coupled processes in fractured media and predict their behavior under different conditions. 4. Develop strategies for managing and controlling coupled processes to optimize resource extraction, geological storage, or environmental remediation in fractured geological environments.
Course Description	The Coupled Processes in Fractured Geological Media course delves into the complex interactions occurring within fractured rock formations. Students explore coupled hydro-mechanical-chemical processes occurring in subsurface environments.
Course Outline	Introduction to Fractured Geological Media, Rock Mechanics Fundamentals, Hydrological Processes in Fractured Media, Thermal-Hydrological-Mechanical (THM) Coupling, Geomechanical-Fluid Interaction
Learning Outcome	At the end of the course, student would be able to: 1. Grasp the complex interactions between fluid flow, heat transfer, and mechanical deformation in fractured geological formations. 2. Analyze coupled processes influencing subsurface systems such as groundwater flow, geothermal energy, and hydrocarbon reservoirs. 3. Develop skills to model and simulate coupled phenomena to solve real-world problems in fractured media.
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.

Textbooks:

1. Goodman, R. E. Introduction to rock mechanics, John Wiley and Sons, 1989.
2. R. Pusch. Waste Disposal in Rock. Elsevier. 1994
3. Coupled Processes Associated with Nuclear Waste Repositories" by Jacques Delay, Peter A. Witherspoon, François X. Dégerine
4. Randall F. Barron and Brian R. Barron. Design for Thermal Stresses. Wiley, 2011
5. Fractured Rock Hydrogeology" by John M. Sharp Jr.

References:

1. Hoek, E., & Bray, J. D. Rock slope engineering, CRC Press, 1981.
2. Hoek, E, & Brown, E. Underground excavations in rock, CRC Press, 1980.
3. Singh, B., & Goel, R. K. Engineering rock mass classification, Elsevier, 2011.
4. "Coupled Processes in Subsurface Deformation, Flow, and Transport" edited by George Pinder, Catherine A. Peters

	CE4205: Rock Engineering for Hydropower Projects
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Rock Engineering for Hydropower Projects
Learning Mode	Lectures
Learning Objectives	Complies with PLO- number 1, 2 and 3 1. Understand the geological processes shaping river valleys and the behavior of rock masses within them. 2. Analyze and assess geological hazards such as landslides, rockfalls, and erosion affecting river valley infrastructure. 3. Develop skills in rock slope stability analysis, support design, and mitigation measures specific to river valley environments.
Course Description	Rock Engineering for Hydropower Projects covers the geotechnical aspects of river valley infrastructure. Students learn about slope stability, rock mechanics, and foundation design tailored to river environments.
Course Outline	Introduction to Hydropower Projects, Rock mechanics principles, Geological Considerations, Rock Mechanics Fundamentals, Design of hydropower Structures, Case Studies, Instrumentation and Monitoring
Learning Outcome	At the end of the course, student would be able to: 1. Understand principles of rock mechanics relevant to river valley projects. 2. Analyze geological conditions to design stable structures for dams, tunnels, and slopes. 3. Apply engineering techniques for rock stabilization and slope reinforcement.
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.

Textbooks:

1. Goodman, R. E. Introduction to rock mechanics, John Wiley and Sons, 1989.
2. Hoek, E., & Bray, J. D. Rock slope engineering, CRC Press, 1981.
3. Hoek, E, & Brown, E. Underground excavations in rock, CRC Press, 1980.

References:

1. Singh, B., & Goel, R. K. Engineering rock mass classification, Elsevier, 2011.
2. Jaeger, J. C., Cook, N. G., & Zimmerman, R. Fundamentals of rock mechanics, John Wiley & Sons, 2009.
3. Debasis, D., & Kumar, V. A. Fundamentals and applications of rock mechanics, PHI Learning Pvt. Ltd. New Delhi, India, 2016.
4. All relevant IS and International Codes.

	CE4206 Fundamentals of Forensic Geotechnical Engineering
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Fundamentals of Forensic Geotechnical Engineering
Learning Mode	Lectures
Learning Objectives	Complies with PLO- number 1, 3, 4 & 5. The learning objectives of this course are as follows: 1. To deal with investigations of different failures of engineered projects or facilities or structures related to civil engineering. 2. To analyze failures related to civil engineering, geotechnical, geoenvironmental and geological domains for professional practice, codes of analysis and design and implementation.
Course Description	This course is designed to understand and examine the various failures of civil engineering project due to different physical, environmental and geological causes. Further, knowledge gathered from this course will help in improving professional practice, developing code provision and design and implementation.
Course Outline	Introduction, Types of failure and damages, Preliminary investigations and information, Interaction between neighboring Structures, Planning the investigations, Site investigations, Settlement and failures of sub structures due to physical and environmental causes, Foundation design in difficult soil and climatic conditions, Ground water moisture related problems of substructures, Repairs and crack diagnosis, Case studies of Leaning Instability, Bearing Capacity Failure etc.
Learning Outcome	At the end of the course, student would be able to: 1. Understand the necessity and importance of forensic investigation in geotechnical engineering for various projects. 2. To deal with investigations of different failures of engineered projects or facilities or structures related to civil engineering. 3. To comprehend the techniques for mitigation of the failure damage. 4. To analyze failures related to civil engineering, geotechnical, geoenvironmental and geological domains for professional practice, codes of analysis and design and implementation.
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.

Textbooks:

1. Rao, V. V. S., and GL Sivakumar Babu, eds. Forensic Geotechnical Engineering. India: Springer India, 2016.
2. Puzrin, Alexander M., Eduardo E. Alonso, and Núria M. Pinyol. Geomechanics of failures. Dordrecht, The Netherlands: Springer, 2010.
3. Iwasaki, Y. Instrumentation and Monitoring for Forensic Geotechnical Engineering. Forensic Geotechnical Engineering (2016): 145-163.

Reference books:

1. Day, Robert W. Forensic geotechnical and foundation engineering. McGraw-Hill, 2011.
2. Alonso, Eduardo E., Núria M. Pinyol, and Alexander M. Puzrin. Geomechanics of failures: advanced topics. Vol. 277. Berlin: Springer, 2010.
3. Lacasse, Suzanne. Forensic geotechnical engineering theory and practice. Forensic Geotechnical Engineering (2016): 17-37.
4. Franck, Harold, and Darren Franck. Forensic engineering fundamentals. Boca Raton, FL: CRC Press, 2013.
5. All relevant IS and international codes and research articles and reports.

	CE4207 Ground Improvement for Civil Engineering Structures
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Ground Improvement for Civil Engineering Structures
Learning Mode	Lectures
Learning Objectives	Complies with PLO- number 1, 3, 4 & 5 1. Understand the necessity and importance of ground improvement for various projects. 2. Identify the soils and select a suitable ground improvement technique. 3. Analysis and design the various ground improvement techniques. 4. Comprehend the construction methodology, equipment and quality control aspects 5. Introduction and application to national and international codal guidelines and provisions.
Course Description	Construction in weak and problematic soil is inevitable nowadays. The course addresses various ground improvement techniques along with principles, design issues and construction procedures.
Course Outline	Introduction and importance for ground improvements; Geotechnical materials, testing and design; Mechanical modifications; Preloading and vertical drains; Soil stabilization using additives; Grouting; Vibro techniques; Drainage and dewatering; Soil nailing; Underpinning, Introduction to geo-synthetics and reinforced earth; Behaviour of Reinforced earth walls; Geosynthetics in landfill system; Use of jute, coir, natural geotextiles, waste products as reinforcing material.
Learning Outcome	At the end of the course, student would be able to: 5. Understand the importance of ground improvement for various projects. 6. Recognize the problematic soil and select a suitable ground improvement technique. 7. Design the various ground improvement techniques. 8. Understand the construction methodology, equipment and quality control aspects. 9. Know the national and international codal guidelines and provisions.
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.

Textbooks:

1. Manfred R. Hausmann, Engineering Principles of Ground Modification, McGraw-Hill Pub, Co., 1990.
2. Koerner, R.M. Designing with Geosynthetics, Prentice Hall, New Jersey, USA, 4th edition, 1999.

Reference books:

1. Jie Han, Principles and Practice of Ground Improvement, Wiley Publishers, 2015.
2. B.M. Das, Principle of Geotechnical Engineering, Cengage Learning, eighth Edition, 2013.
3. V. N. S. Murthy, Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, CRC Press, Taylor & Francis Group, Third Indian Reprint, 2013.
4. All relevant IS and International Codes.

Department Elective-IV						
Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE4208	Solid Waste Engineering	3	0	0	3
2.	CE4209	Air Pollution Engineering	3	0	0	3
3.	CE4210	Pavement Evaluation and Management	3	0	0	3
4.	CE4211	Pavement Materials	3	0	0	3
5.	CE4212	Introduction to Traffic Flow Modelling and Intelligent Transportation systems	3	0	0	3
6.	CE4213	Design of Transportation Facilities and Safety	3	0	0	3

Course Number	CE4208 - Solid Waste Engineering
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Solid Waste Engineering
Learning Mode	Lectures
Learning Objectives	Complies with PLOs 2 and 3 1. To impart knowledge and develop understanding of integrated solid waste management by technological interventions 2. To train students to comprehend, understand, plan, and design various steps and processes in an integrated solid waste management framework 3. To provide scientific and technical knowledge, to prepare students to address current issues and challenges for integrated solid waste management in field
Course Description	This course will discuss fundamental concepts and engineering practices involved in integrated solid waste management. The course will provide a deeper understanding of municipal solid waste generation and influencing factors, composition, segregation and collection, processing and disposal techniques for integrated solid waste management with theory and real-life practices.
Course Content	Sources, composition and properties of municipal solid waste, Generation of solid waste, Rates of generation and factors affecting them; Specific waste streams: construction and demolition (C&D) waste, electronic waste (e-waste), etc.; Hazardous wastes and characteristics; Environmental legislations; Sustainable development goals (SDGs), Urban mining and circular economy concepts; Solid wastes management: Generation, on-site storage and processing including segregation, collection, separation, processing and disposal; On-site storage methods: containers, their type, size and location; Collection systems: Vehicles, routing, route balancing and transfer stations, Processing technique and equipment, Recovery of resources, Conversion products and energy, Biological digestion, Composting and vermicomposting, Recycling, Incineration and pyrolysis, Disposal of solid waste including sanitary landfill, Planning, site and design aspects of solid waste engineering.
Learning Outcome	At the end of the course, students would be able to: 1. Understand about the municipal solid waste generation and composition with the influencing factors 2. Comprehend and understand steps and processes involved in the solid waste management 3. Analyze and understand the current issues and challenges for solid waste management 4. Comprehend, understand and apply various processing and disposal techniques for solid waste management
Assessment Method	Assignments, Quizzes, Mid Semester Examination and End Semester Examination

Text Books:

- CPHEEO, Manual on Municipal Solid Waste Management, Central Public Health & Environmental Engineering Organisation (CPHEEO), Ministry of Housing and Urban Affairs, Govt. of India, 2016.
- Vesilind, P., Worrel, W. and Ludwig, C., Solid Waste Engineering: A Global Perspective, CL Engineering, First Edition, 2016.
- LaGrega, M., Buckingham, P. and Evans, J., Hazardous Waste Management, Medtech, 2015.

Reference Books:

- Tchobanoglous, G., Theisen, H. and Vigil, S.A., Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill, 2014.
- Charles A. Wentz, Hazardous Waste Management, McGraw-Hill, 1995.

Course Number	CE4209 - Air Pollution Engineering
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Air Pollution Engineering
Learning Mode	Lectures
Learning Objectives	Complies with PLOs 2,3 and 5: 1. To provide insights into causes and effects of air pollution 2. To understand the relationship of meteorological parameters and dispersion of pollutants 3. To equip students to address current issues and challenges in field of air pollution control
Course Description	The course will provide a deeper understanding of air pollutants and their fate and dispersion, measurements, monitoring and modelling on the backdrop of meteorology and environmental legislations. The course also helps to understand the impacts of air pollution on human health and various technological interventions for the improvement of air quality in real-life scenario.
Course Outline	Fundamentals of Atmosphere, Air Pollution, Classification of pollutants, Effects on human health and environment, Sources of Pollutants, Fate and transport of pollutants, Criteria pollutants, Photochemical smog, Greenhouse gases, Global warming and climate change, Indoor air pollution. Meteorology: Elemental properties of atmosphere, Influence of meteorological parameters on air quality, Effect of atmospheric pollutant on meteorological parameters, Dispersion of air pollutants, Atmospheric modelling, Box model, Gaussian plume dispersion model, Atmospheric cleansing processes. Air quality and emission standards. Air quality index (AQI) and health risk.
Learning Outcome	At the end of the course, students would be able to: • Understand the atmosphere and origin, fate and transport of air pollutants • Comprehend and understand the influence of meteorological factors • Understand the concept of causes and effects of air pollution with the dispersion modelling of the pollutants
Assessment Method	Assignments, Quizzes, Mid-semester and End-semester Examination

Text books:

- Davis, W.T., Fu, J.S. and Godish, T., Air Quality, CRC Press, 2021.
- de Nevers, N., Air Pollution Control Engineering, Waveland Press, 2016.
- H. S. Peavy, D. R. Rowe and George Tchobanoglous, Environmental Engineering, McGraw-Hill International Ed., 1985.
- Wark, K., Warner, C.F. and Davis, W., Air Pollution: Its Origin and Control, Pearson, 1998.

Reference Books:

- Pandis, S.N. and Seinfeld, J.H., Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, Wiley, 2016.
- Stull, R.B., Meteorology for Scientist and Engineers, Third Edition, Brooks/Cole, 2015.
- Cooper, C.D. and Alley, F.C., Air Pollution Control: A Design Approach, Waveland Press, 2010.
- Introduction to Atmospheric Chemistry, Daniel J. Jacob, Princeton University Press, 1999.
- IPCC, 2007 Fourth Assessment Report, Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change

Course	CE4210
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Pavement Evaluation and Management
Learning Mode	Lectures
Learning Objectives	Complies with PLO number – 1, 2, and 4 1. To gain a thorough understanding of the key activities involved in pavement management within a highway organization. 2. To develop practical skills in the collection and analysis of data essential for effective pavement management. 3. To learn the fundamental practices and strategies required for managing highway pavements.
Course Description	The course will enable the students to learn the concepts and principles of pavement management system and principles, the use of cutting-edge equipment for performance data collection, and the application of tools and techniques for road asset management. Through various case studies and practical experience with big data analytics in asset management, students will gain comprehensive knowledge in this field.
Course Outline	Introduction to pavement management systems; Components of pavement management systems; Pavement distress mechanisms and surveys; Pavement performance prediction - concepts, modelling techniques, Comparison of different deterioration models; Pavement maintenance and rehabilitation strategies; Rehabilitation budget planning; Ranking and optimisation methodologies; Alternate pavement design strategies and economic evaluation; Reliability concepts in pavement engineering; life cycle costing; emerging trends in road asset management; Case Studies on Construction, maintenance, rehabilitation, reconstruction strategies.
Learning Outcome	At the end of the course, student would be able to: 1. Understand the fundamentals of the pavement management systems and the state of art equipment for performance data collection, tools, and techniques. 2. Know the strategic programming for pavement performance, rehabilitation, and maintenance. 3. Appreciate the concept of pavement preservation techniques and cost analysis. 4. Understand the process of implementing a pavement management system for highways.

Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.
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Textbooks:

1. Ralph Haas and Ronald. W. Hudson with Lynne Cowe Falls, 'Pavement Asset Management', Scrivener Publishing, Wiley, 2015.
2. Huang, Y. H. "Pavement analysis and design." Pearson, 2004.
3. Papagianna, A. T. and Masad, E. A. "Pavement Design and Materials." John Wiley & Sons, Inc., 2008.

Reference books:

1. Relevant publications/codes from IRC, AASHTO, Transportation Research Board, National Institute of Standards and Technology and US Army Corps of Engineers.
2. Miller, John S., and William Y. Bellinger. Distress identification manual for the long-term pavement performance program. No. FHWA-RD-03-031. United States. Federal Highway Administration. Office of Infrastructure Research and Development, 2003.

Course	CE4211
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Pavement Materials
Learning Mode	Lectures
Learning Objectives	Complies with PLO number – 1, 2, and 4 1. To understand the characteristic properties of materials used in road construction. 2. To learn techniques for evaluating the performance of road construction materials. 3. To gain knowledge in the design of asphalt and concrete mixes. 4. To understand alternative materials used in road construction..
Course Description	The course provides a foundational understanding of the behavior of various materials used in pavement construction. It covers the characterization, testing, and engineering properties of these materials, emphasizing their practical applications in the field. Additionally, the course will explore current practices and future trends in pavement materials.
Course Outline	Soil: Introduction to soil as a highway material; Classification of soils; Consistency Limits; Soil compaction and role of moisture; Mechanical properties of soil; Introduction to expansive soils, relevant tests, and soil stabilization techniques; Aggregates: Aggregate origin, types, production, and quarrying operation; Classification of aggregates; Aggregate gradation and gradation parameters; Theories of aggregate blending; Minerology of aggregates and its importance; Aggregate shape and texture: quantification and importance; Aggregate strength properties, and relevant tests; Bituminous Materials: Production of bitumen; Physical and rheological properties of bitumen; Introduction to viscoelasticity; Chemistry of bitumen; Ageing of bitumen; Grading of bitumen, and relevant tests; Bitumen modification; Introduction of bitumen emulsion; Introduction to cutback bitumen. Bituminous Mixtures: Production of bituminous mixtures: Laboratory and Plant; Role of bituminous mixture and desirable properties; Volumetrics of bituminous mixture; Mix design of bituminous mixture: Marshall and Superpave methods; Mechanical tests and characterization of bituminous mixtures; Introduction to performance based mix design concepts; Mix design of cold bituminous mixtures; Mix design of hot recycled mixtures; Cement: Production of cement; Theory of hydration and importance of different hydration products; Physical and chemical properties of cement; Types of cement; Pozzolanic and geopolymer materials as alternate cement; Concrete Mix Design: Concrete proportioning and importance of various constituents; Introduction and mix design of pavement quality concrete, Dry

	lean concrete and Pervious concrete; Alternative Pavement Materials: State of the art on various alternative materials for construction of flexible and rigid pavements.
Learning Outcome	At the end of the course, student would be able to: 1. Understand various conventional and recycled materials utilized in pavement construction. 2. Develop the ability to select and design appropriate materials for road construction. 3. Assess pavement materials based on their performance-related properties.
Assessment Method	Assignments, Project Work, Quizzes, Mid-semester examination and End-semester examination.

Textbooks:

1. Athanassios Nikolaides. "Highway Engineering: Pavements, Materials and Control of Quality". CRC Press, T&F, 2015.
2. Papagianna, A. T. and Masad, E. A. "Pavement Design and Materials." John Wiley & Sons, Inc., 2008.
3. Brown, Kandhal, Roberts, Kim, Lee and Kennedy Hot Mix Asphalt Materials, Mixture Design, and Construction, NCAT (Third Edition).
4. Bituminous Road Construction in India, Prithvi Singh Kandhal, PHI publications.

Reference books:

1. Relevant codes/standards from Indian Roads Congress (IRC), Bureau of Indian Standards (BIS), American Society of Testing Materials (ASTM), and American Association of State Highway and Transportation Officials (AASHTO).

MORTH. "Ministry of Road Transportation & Highways Specifications for Road and Bridge Works." 2013.

Course Number	CE4212
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Introduction to Traffic Flow Modelling and Intelligent Transportation systems
Learning Mode	Lectures
Learning Objectives	To gain insight into theory and modeling of traffic flow operations To understand various data collection strategies of ITS To understand evaluation of the ITS applications To apply latest technologies in solving congestion related problems
Course Description	The purpose of this subject is to introduce students to the basic elements of intelligent transportation systems (ITS), focusing on technological, systems and institutional aspects.
Course Content	Traffic Characteristics: Macroscopic variables, microscopic variables, Relationships between micro and macroscopic variables; Microscopic Traffic Flow Models, Static/Equilibrium Traffic Stream Models, Dynamic Traffic Flow Models. Introduction to ITS; Advanced traveler information systems; transportation network operations; commercial vehicle operations and intermodal freight; public transportation applications; ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS and sustainable mobility, travel demand management, electronic toll collection, and ITS and road-pricing.
Learning Outcome	At the end of the course, the student will be able to gather the information on 1. Identify differences between microscopic and macroscopic variables 2. Learn how macroscopic models are derived from microscopic principles 3. Differences between intrusive and non-intrusive technologies 4. Various performance evaluation strategies of ITS applications, 5. Relevance of ITS in the context of developing countries especially with the national mission of smart cities, 6. Understand the differences between various functional areas of ITS etc.
Assessment Method	Assignments, Term Projects, Technical paper presentations, quizzes, mid-semester examination and end-semester examination

References:

1. Adolf D. May. Traffic Flow Fundamentals. Prentice-Hall International (1990)
2. Daganzo, C.F. Fundamentals of transportation and traffic operations. Vol. 30. Oxford: Pergamon, 1997.
3. Daiheng Ni, Traffic Flow Theory, PHI 5. Partha Chakraborty, Animesh Das: Principles of Transportation Engineering, 2nd Edition by PHI.
4. Henry Lieu. Revised Monograph on Traffic Flow Theory, Federal Highway Administration Research and Technology, 2017.
5. Joseph S. Sussman: Perspectives on Intelligent Transportation Systems (ITS), Springer; 2005th edition (April 7, 2005)
6. Robert Gordon, Intelligent Transportation Systems: Functional Design for Effective Traffic Management, Springer 2016.

Course Number	CE4213
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Design of Transportation Facilities and Safety
Learning Mode	Lectures
Learning Objectives	To gain insights on how to design transportation facilities and to impart safety into them.
Course Description	The purpose of this subject is • To introduce the design concepts to develop transportation facilities • To introduce safety and accident data analysis
Course Content	Introduction to transportation facilities – considerations and requirements; Design of At-grade Inter-sections - sight distance consideration and principles of design, channelisation, mini round-about, layout and design of round-about; Design of signalised intersections, signal coordination, interchange design templates, entrance and exit ramps, acceleration and deceleration lanes, Bicycle and Pedestrian Facility Design; Parking Layout and Design; Terminal Layout and Design. Accident prevention through better planning, Designing for safety, Highway operation and accident counter measures, Road safety checklists, accident data analysis and its prediction models. Proof Check of IRC37-2018 with Actual Traffic Data and Soil Conditions using KENLAYER and IITPAVE; Proof Check of IRC58-2015 with Actual Traffic Data and Soil Conditions.
Learning Outcome	At the end of the course, the student will be able to gather the information on 1. Identify differences between microscopic and macroscopic variables 2. Learn how macroscopic models are derived from microscopic principles 3. Differences between intrusive and non-intrusive technologies 4. Various performance evaluation strategies of ITS applications, 5. Relevance of ITS in the context of developing countries especially with the national mission of smart cities, 6. Understand the differences between various functional areas of ITS etc.
Assessment Method	Assignments, Term Projects, Technical paper presentations, quizzes, mid-semester examination and end-semester examination

References:

1. Guidelines for the design of interchanges in urban areas (IRC:92-1985), The Indian Roads Congress.
2. Roadside design guide, American Association of State Highway Officials.
3. Manual of geometric design standards for Canadian roads, Transportation Associations of Canada.
4. Pline, J.L., Traffic Engineering Handbook, Institute of Transportation Engineers.
5. Manual on Uniform Traffic Control Devices, Federal Highway Administration.
6. Highway Capacity Manual 2010, Transportation Research Board.
7. S.K. Khanna and C.E.G. Justo, Highway Engineering, Khanna Publishers, Roorkee,
8. IRC 37-2018.
9. IRC 58-2015.

Department Elective-V						
Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE4214	Introduction to Geotechnical Earthquake Engineering	3	0	0	3
2.	CE4215	Structural Dynamics and Earthquake Engineering	3	0	0	3
3.	CE4216	Rehabilitation of Structures	3	0	0	3
4.	CE4217	Introduction to Structural Health Monitoring	3	0	0	3

	CE4214 Introduction to Geotechnical Earthquake Engineering
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Introduction to Geotechnical Earthquake Engineering
Learning Mode	Lectures
Learning Objectives	Complies with PLO- number 1, 2, 3, and 4 4. To provide the basic knowledge of the geotechnical earthquake engineering. 5. Equip the students with a strong foundation in civil engineering for both research and industrial scenarios. 6. Prepares the students to apply knowledge in policy and decision making related to civil engineering infrastructure. 7. Prepare students to attain leadership careers to meet the challenges and demands in civil engineering practice.
Course Description	This course intends to bridge the basic concepts with the advanced topics related to geotechnical engineering. Topics ranging from continental drift, seismic hazard analysis, wave propagation, liquefaction assessment, and seismic slope stability are covered. The course started with the basic knowledge regarding the wave propagation.
Course Outline	Introduction, Significant historical earthquakes, Continental drift and plate tectonics, Internal structure of earth, Sources of seismic activity, Size of the earthquake, Ground motion parameters, Seismic hazard analysis, Wave propagation, Dynamic soil properties and Measurement of dynamic soil properties, Ground response analysis, Local site effects, Evaluation of liquefaction hazards, and Seismic slope stability analysis.
Learning Outcome	At the end of the course, student would be able to: 10. Design earthquake resistant structure using various methods available along with the method suggested in the IS code. 11. Liquefaction potential assessment using IS code and other methods in practice. 12. Perform seismic hazard analysis for any site.
Assessment Method	Assignments, Quizzes, Mid-semester examination and End-semester examination.

Textbooks:

1. Kramar S.L, Geotechnical Earthquake Engineering, Prentice Hall International series, Pearson Education Pvt. Ltd.
2. J.E. Bowles, Foundation Analysis and Design, McGraw-Hill, 2001.

Reference books:

1. Ikuo Towhata, Geotechnical Earthquake Engineering, Springer series, 2008.
2. All relevant IS and International Codes.

Course	CE4215 Structural Dynamics and Earthquake Engineering
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Structural Dynamics and Earthquake Engineering
Learning Mode	Lectures
Learning Objectives	Lectures: Complies with PLO-1, 2, 3 and 4 6. To develop a fundamental technical understanding on engineering vibration and earthquake in general. 7. To learn the basics of dynamics analysis pertaining to the field of earthquake engineering. 8. To make familiar with various elementary concepts of earthquake-resistant design.
Course Description	The course aims at developing detailed understanding with the design of various structures against seismic loading. This course provides the students an exposure for earthquake resistant designing of structures which are not usually covered in undergraduate design courses.
Course Outline	Single Degree of Freedom System (SDOF): equation of motion, free undamped and damped response, undamped and damped response to harmonic loading, response to arbitrary periodic, step, pulse excitations and ground motion; Multi Degree of Freedom System (MDOF): equations of motion; stiffness matrix; lumped and consistent mass matrix; proportional and Rayleigh damping matrix; Earthquake Engineering: causes of earthquakes and seismic waves, magnitude, intensity and energy release, earthquake characteristics, liquefaction and seismic risk, EQ response of structures, single-degree-of freedom dynamics, concept of response spectra, design response spectrum, idealization of structures, response spectrum analysis, equivalent lateral force concepts, philosophy of EQ resistant design, ductility, redundancy & over-strength, damping, supplemented damping, EQ behaviour of concrete, steel and masonry structures.
Learning Outcome	At the end of the course, student would be able to Lectures: 9. Understand the fundamental principles of vibrational motion and the mathematical models used to describe it. 10. Analyse and solve vibration problems in single-degree-of-freedom (SDOF), multi-degree-of-freedom (MDOF) systems. 11. Develop essential understanding earthquake loading on structures and apply the knowledge of structural dynamics. 12. Learn seismic design practices in real-life applications and introduce various codes of practice.
Assessment Method	Assignments, Quizzes, Project work, Mid-semester examination and End-semester examination.

Textbooks/ Reference books:

6. R. Villaverde, Fundamental Concepts of Earthquake Engineering, CRC Press, 1st edition, 2009.
7. A. K. Chopra, Dynamics of Structures: Theory and Applications to Earthquake Engineering, Prentice Hall, 4th edition, 2015.
8. T. K. Datta, Seismic Analysis of Structures, Wiley, 1st edition, 2011.
9. S. K. Duggal, Earthquake Resistant Design of Structures, Oxford Univ. Press, 2013.
10. M. Shrikhande and P. Agarwal, Earthquake Resistant Design of Structures, Prentice hall India, 2006.
11. R. W. Clough and J. Penzien, Dynamics of Structures, McGraw-Hill, 1975, 2nd edition, 1992.
12. N. M. Newmark and E. Rosenblueth, Fundamentals of Earthquake Engineering, Prentice Hall, 1971.
13. D. Key, Earthquake Design Practice for Buildings, Thomas Telford, London, 1988.
14. T. Paulay, Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley & Sons Inc, 1st edition, 1992.
15. Latest Indian standards for seismic design: IS1893, IS13920, IS456.

Course	CE4216 Rehabilitation of Structures
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Rehabilitation of Structures
Learning Mode	Lectures
Learning Objectives	Lectures: Complies with PLO-1, 2, 3 and 4 3. Understand the background of condition assessment, repair, and strengthening of structures. 4. Attain knowledge of rehabilitation of existing building.
Course Description	The course deals with the evaluation and strengthening of existing structures. The students shall learn about various techniques for the strengthening of structures.
Course Outline	Distress identification and repair management: causes of distress in structures. Preliminary inspection: planning stage, visual inspection and detailed inspection; Evaluation of concrete buildings: destructive testing systems, non-destructive testing techniques, semi-destructive testing techniques, and estimation of damage. Evaluation of strength of existing structures and analysis necessary to identify critical sections; Surface repair and retrofitting techniques; Strengthening techniques: beam shear capacity strengthening, column strengthening, and flexural strengthening. Guidelines for seismic rehabilitation of existing buildings, seismic vulnerability and strategies for seismic retrofit.
Learning Outcome	At the end of the course, student would be able to Lectures: 4. Introduce the application of different techniques for evaluation and retrofitting of buildings. 5. Present fundamental principles and methodologies for the design of various retrofitting techniques. 6. NDT techniques for condition assessment of structures for identifying damages in structures. 7. Select retrofitting strategy suitable for distress and formulate guide lines for repair management of deteriorated structures.
Assessment Method	Assignments, Quizzes, Project work, Mid-semester examination and End-semester examination.

Textbooks/ Reference books:

1. ASCE/SEI 41-23 Seismic Evaluation and Retrofit of Existing Buildings. 2023.
2. Varghese P.C., "Maintenance, Repair & Rehabilitation and Minor Works of Buildings" 1st Edition, PHI Learning Private Ltd., New Delhi., 2014.
3. Santhakumar A.R., "Concrete Technology" Oxford University Press, 2007, New Delhi
4. CPWD Handbook on Repair and Rehabilitation of RCC buildings, Govt. of India Press, New Delhi.
5. Emmons, P.H., "Concrete Repair and Maintenance", Galgotia Publication. 2001.
6. Bungey, S., Lillard, G. and Grantham, M.G., "Testing of Concrete in Structures", Taylor and Francis. 2001.
7. Malhotra, V.M. and Carino, N.J., "Handbook on Non-destructive Testing of Concrete", CRC Press. 2004.
8. Bohni, H., "Corrosion in Concrete Structures", CRC Press. 2005.
9. ATC- 40: Seismic Evaluation and Retrofit of Concrete Buildings, Vol. 1 & 2. 1997.
10. M.J.N. Priestley, Seible, F. and Calvi, G.M., "Seismic Design and Retrofit of Bridges", John Wiley. 1996.

Course	CE4217 Introduction to Structural Health Monitoring
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Introduction to Structural Health Monitoring
Learning Mode	Lectures
Learning Objectives	Lectures: Complies with PLO-1, 2, 3 and 4 4. To learn the contingent need of structural monitoring in an infrastructurally heavy and old country like India. 5. To develop fundamental concepts on health monitoring of various structures. 6. To be familiar with some frequently used techniques in health monitoring.
Course Description	This course explores structural monitoring technologies for assessing the condition and performance of various structures. Some basic techniques are described. Non-destructive tests are focused. Some vibration-based methods are demonstrated. Moreover, the course covers emerging trends including sensor technology and data analytics for prognostic care.
Course Outline	Intro duction to Structural Health Monitoring (SHM): Definition & requirement for SHM, SHM of a bridge, monitoring historical buildings; Non-Destructive Testing (NDT): Classification of NDT procedures, visual inspection, half-cell electrical potential methods, Rebound Hammer Test, electro-magnetic methods, radiographic Testing, ultrasonic testing, Infra-Red thermography, ground penetrating radar etc; Vibration-based monitoring: Frequency-domain and time-domain analysis, Experimental modal analysis, application of damage detection methods on civil infrastructures.
Learning Outcome	At the end of the course, student would be able to Lectures: 4. Be fundamentally strong on structural condition assessment. 5. Be equipped with the work principle of various NDTs. 6. Develop proficiency in deploying sensor technologies and data acquisition systems to monitor the health of various structures. 7. To analyse collected data, detect structural damage, and make informed decisions regarding maintenance and safety measures.
Assessment Method	Assignments, Quizzes, Project work, Mid-semester examination and End-semester examination.

Textbooks/ Reference books:

1. Daniel J. Inman, Charles R. Farrar, Vicente Lopes Junior, Valder Steffen Junior, Damage Prognosis: For Aerospace, Civil and Mechanical Systems, John Wiley & Sons, 2005.
2. Chee-Kiong Soh, Yaowen Yang, Suresh Bhalla (Eds.), Smart Materials in Structural Health Monitoring, Control and Biomechanics, Springer, 2012.

IDE (Available to students of B. Tech. other than Dept. of Civil and Environmental Engineering)

Sl. No.	Subject Code	Subject	L	T	P	C
1.	CE2206	IDE I: Construction Technology and Management	3	0	0	3
2.	CE3105	IDE II: Green Building	3	0	0	3
3.	CE4111	IDE III: Smart Transportation	3	0	0	3
4.	CE4112	IDE III: Industrial Pollution and Control	3	0	0	3

Course	CE2206
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Construction Technology and Management
Learning Mode	Lectures
Learning Objectives	Complies with PLO- 2 1. To provide fundamental knowledge in construction technologies and material. 2. Provide scientific and technical knowledge to prepare students to address civil engineering materials-related challenges in the field. 3. Study the role and responsibilities of a construction manager. 4. Study the life cycle of a construction project and the key activities in each phase. 5. Study various types of contracts and bidding procedures
Course Description	This course will discuss fundamental concepts in construction technologies and civil engineering materials. The course will cover theory and real-world practices in materials used in construction industries, their operations, and execution.
Course Outline	Introduction to construction technologies and building materials. Properties of cement and aggregates and their types. Properties of fresh concrete and hardened concrete and design of concrete mix. Properties of bricks, masonry, timber, FRPs, structural steel and other building materials. Construction as industry and its challenges, Role of construction management, Methods of construction managements, Basic requirements of construction management, Life cycle of construction projects. Contracts and its types. Introduction to time management tools: List and Bar Charts, CPM and PERT. Quality Management and Construction safety, Use of information technology and automation in construction industries.
Learning Outcome	At the end of the course, student would be able to: 1. Understand the physical and engineering properties, principles, testing, and standards of civil engineering materials used in construction. 2. Understand various construction technologies 3. The use of different civil engineering materials subjected to different construction scenarios and needs. 4. Understand various phases in life cycle of a project 5. Understand the difference between different types of contracts and how to award the contract 6. Understand construction planning techniques and time management
Assessment Method	Assignment, Quizzes, Mid-semester examination and End-semester examination .

Textbooks:

1. S. Somayaji, Civil Engineering Materials, Prentice Hall, New Jersey, 2001.
2. M. S. Shetty, Concrete Technology, S. Chand and Company Ltd. 2005.
3. M. S. Mamlouk and J. P. Zaniewski, Materials for Civil and Construction Engineers, Pearson, Prentice Hall, Second edition, 2006.
4. P.C Varghese, Building Materials, Publisher: Prentice Hall India Learning Private Limited; 2nd edition (1 January 2015)
5. F. Harris, R. McCaffer and F. Edum-Fotwe, Modern Construction Management, Blackwell Publishing, 2006.
6. C. J. Schexnayder and R. E. Mayo, Construction Management Fundamentals, McGraw Hill, New Delhi, 2003

Reference books:

1. All relevant IS Codes.
2. N. Jackson and R. K. Dhir, Civil Engineering materials, Macmillan Fourth edition 1997.
3. Haimei Zhang, Building materials in civil engineering, Publisher: Woodhead Publishing (9 May 2011).
4. Parbin Singh, Civil engineering materials, Publisher : S K Kataria and Sons; Reprint 2013 edition.
5. S.K Duggal, Building Materials, New Age International Publisher, 4th edition.
6. D.S. Berrie and B.C. Paulson, Professional construction management including C.M., Design construct and general contracting, Third edition, McGraw Hill International edition, 1992.

Course Number	CE3110: Green Building
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Green Building
Learning Mode	Lectures
Learning Objectives	Complies with PLOs 2, 3,4 and 5: 1. Understand the principles of green building and sustainable design. 2. Learn about the various green building rating systems and certifications. 3. Gain knowledge of energy-efficient building systems and materials. 4. Explore sustainable construction practices and technologies.
Course Description	This course provides an in-depth understanding of green building principles, sustainable design, and construction practices. Students will explore the environmental, economic, and social impacts of buildings and learn how to design and construct buildings that are energy-efficient, environmentally friendly, and sustainable.
Course Outline	Introduction to Green Building, Sustainable Sites (Site Selection & Planning), Energy Efficiency in Buildings, Sustainable Materials and Resources, Waste Management and Recycling, Water Efficiency and Management, Indoor Environmental Quality, Sustainable Construction Practices, Green Building Rating Systems and Certifications, Case Studies and Future Trends.
Learning Outcome	By the end of this course, students will be able to: 1. Understand Green Building Concepts and Site Planning 2. Implement Energy, Resource, and Water Efficiency 3. Enhance Indoor Environmental Quality 4. Navigate Certifications and Analyze Case Studies
Assessment Method	Assignments, Quizzes, Mid-semester and End-semester Examination

Textbooks and Reference books:

1. IGBC, Introduction to Green Buildings & Built Environment, Indian Green Building Council, BS Publications / BSP Books, 2022.
2. G Harihara Iyer, Green Building Fundamentals, Notion Press, 2022.
3. Abe Kruger and Carl Seville, Green Building: Principles and Practices in Residential Construction, Delmar Cengage Learning, 2012.
4. Michael Bauer, Peter Möslle, and Michael Schwarz, Green Buildings: A Guide for Sustainable Architecture, Springer-Verlag Berlin Heidelberg, 2010.
5. India's Energy Conservation Building Code (ECBC), 2017.
6. TERI, Sustainable Building Design Manual, Volume 1 and 2, Energy and Resources Institute (TERI).
7. Ministry of Power, Energy Conservation Building Code 2018, Revised Version, Bureau of Energy Efficiency, 2018.
8. Indian Building Congress, Practical Handbook on Energy Conservation in Buildings, 1 st ed. Nabhi Publication, 2008.
9. Green Rating for Integrated Habitat Assessment (GRIHA).
10. IGBC Rating Systems.
11. Supplementary Materials: Articles, case studies, and industry reports on green building.

Course	CE4111
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Smart Transportation
Learning Mode	Lectures
Learning Objectives	1. Understand the fundamental concepts of smart transportation 2. Explore the technologies that enable smart transportation, including sensors, IoT, and AI. 3. Analyse the impact of autonomous vehicles and connected infrastructure. 4. Evaluate the role of data analytics in optimizing transportation systems.
Course Description	This course introduces undergraduate students to the fundamental concepts of smart transportation. It explores the technologies, methodologies, and innovations transforming transportation into more efficient, safer, and environmentally friendly systems. Students will learn about smart transportation systems, autonomous vehicles, smart infrastructure, data analytics in transportation, and the societal impacts of these advancements.
Course Outline	Introduction to Smart Transportation: Definition and significance, overview of traditional and smart transportation systems. Intelligent Transportation Systems (ITS) and its components. Sensors and IoT in Transportation, Data in Transportation: importance, basic methods of data collection, and data analysis tools and techniques; Introduction to Autonomous and Connected Vehicles; Smart Infrastructure and its components (smart traffic lights, smart roads), Smart traffic management solutions, Introduction to smart public transit systems, and innovations in public transportation (e.g., contactless payments, real-time tracking), Introduction to safety technologies in transportation, In-depth analysis of selected smart transportation projects.
Learning Outcome	At the end of the course, student would be able to: 1. Understand the difference between traditional and smart transportation systems 2. Understand various techniques used to collect automated traffic data 3. Understand various technologies deployed for improving the efficiency of traffic management and public transportation 4. Understand the difference between connected and autonomous vehicles and its implications in real world
Assessment Method	Assignment, Quizzes, Mid-semester examination and End-semester examination .

Textbooks:

1. "Smart Transport for Cities and Nations: The Rise of Self-Driving and Connected Transport" by Graeme A. Dandy
2. "Introduction to Intelligent Systems in Traffic and Transportation" by T. P. S. Sreejith, K. S. Easwarakumar
3. "The Fourth Industrial Revolution" by Klaus Schwab (for context on technological impacts)

Course Number	CE4112
Course Credit (L-T-P-C)	3-0-0-3
Course Title	Industrial Pollution and Control
Learning Mode	Lectures
Learning Objectives	Complies with PLOs 2 and 4 1. To learn about industrial manufacturing processes and associated industrial effluent and emission characteristics 2. To discuss various pollution control and treatment techniques with their applicability based on industrial effluent and emission characteristics 3. To devise a treatment chain to treat an industrial effluent and emission for a manufacturing industry 4. To discuss the best available technologies implemented for pollution control in manufacturing industries from real-life case studies
Course Description	This course will provide overview of manufacturing processes with material and water inputs along with the associated industrial waste and emission characteristics. Further, the course aims to cover pollution control techniques for industrial effluent and emission with real-life case studies.
Course Content	Industry types and associated industrial pollution, Industrial wastes and emissions, Characteristics of wastes including hazardous waste and emission; Process modifications and alternate raw materials, Cleaner production, Waste minimization, Recycle and reuse; Best available technology (BAT), Zero liquid discharge (ZLD), Effluent treatment plant (ETP) and common effluent treatment plant (CETP), Physico-chemical and biological treatment of industrial effluents, Industrial air pollution control techniques – gravity settler, cyclone separator, electrostatic precipitator, fabric filter, scrubbers; Environmental auditing and performance, Environmental management plan; Selected case studies of pollution control in manufacturing industries.
Learning Outcome	At the end of the course, students would be able to: 1. Understand about the manufacturing processes with raw materials water inputs and associated effluent and emission generation and characteristics 2. Analyze and understand the current issues and challenges in the industrial sector for pollution control in an interdisciplinary manner 3. Comprehend and implement effluent treatment and emission control techniques for manufacturing industries 4. Learn and apply various emerging industrial pollution control practices and techniques for sustainability
Assessment Method	Assignments, Quizzes, Mid Semester Examination and End Semester Examination

Text Books:

- de Nevers, N., *Air Pollution Control Engineering*, Waveland Press, 2010.
- Eckenfelder Jr., W.W., *Industrial Water Pollution Control*, 3rd Edition, McGraw-Hill, 2000.
- Wise, D.L. and Trantolo, D.J. (eds.), *Process Engineering for Pollution Control and Waste Minimization*, 1st Edition, Marcel Dekker, 1994.

Reference Books:

- Metcalf & Eddy, *Wastewater Engineering - Treatment and Reuse* (Revised by Tchobanoglous, G., Burton, F.L. and Stensel, H.D.), Tata McGrawHill, 2004.
- Wark, K. and Warner, C. F., *Air Pollution - Its Origin and Control*, Harper & Row, 1981.