COURSE SCHEME

FOR

BE (CIVIL with Computer Applications)

Approved in 114th Senate Meeting held on May 7, 2025

Break-up of Credits

SEMESTER	CREDITS
I	18.0
II	18.0
III	25.0
IV	21.5
V	25.5
VI	23.0
VII	15.0
VIII	23.5
TOTAL	**169.5**

Nature of course and code

Nature of the course	CODE**
Basic Science Courses	BSC
Engineering Science Courses	ESC
Humanities and Social Science Courses	HSS
Professional Core Courses	PCC
Professional Elective Courses	PEC
Open Elective Courses	OEC
Project	PRJ

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SEMESTER-I

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UPH013	APPLIED PHYSICS	BSC	3	1	2	**4.5**
2.	UES101	ENGINEERING DRAWING	ESC	2	4	0	**4.0**
3.	UHU003	PROFESSIONAL COMMUNICATION	HSS	2	0	2	**3.0**
4.	UES102	MANUFACTURING PROCESSES	ESC	2	0	2	**3.0**
5.	UMA022	CALCULUS FOR ENGINEERS	BSC	3	1	0	**3.5**
		TOTAL		12	6	6	**18.0**

SEMESTER-II

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UCB009	APPLIED CHEMISTRY	BSC	3	0	2	**4.0**
2.	UES103	PROGRAMMING FOR PROBLEM SOLVING	ESC	3	0	2	**4.0**
3.	UES013	ELECTRICAL & ELECTRONICS ENGINEERING	BSC	3	1	2	**4.5**
4.	UEN008	ENERGY AND ENVIRONMENT	BSC	2	0	0	**2.0**
5.	UMA023	DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA	BSC	3	1	0	**3.5**
		TOTAL		14	2	6	**18.0**

SEMESTER-III

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UCC301	SOLID MECHANICS	ESC	3	1	2*	**4.0**
2.	UCC302	CIVIL ENGINEERING MATERIALS	PCC	3	0	2	**4.0**
3.	UCC303	FLUID MECHANICS	PCC	3	1	2*	**4.0**
4.	UCC304	ARTIFICIAL INTELLIGENCE	ESC	3	0	2	**4.0**
5.	UCE306	ARCHITECTURAL DRAWING AND BUILDING CONSTRUCTION	PCC	2	0	2	**3.0**
6.	UMA303	OPTIMIZATION TECHNIQUES IN CIVIL ENGINEERING	BSC	3	0	2	**4.0**
7.	UTD003	APTITUDE BUILDING SKILLS	HSS	2	0	0	**2.0**
		TOTAL		19	2	10	**25.0**

SEMESTER-IV

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UCC401	STRUCTRUAL ANALYSIS	PCC	3	1	2*	**4.0**
2.	UCC402	GEOINFORMATICS	PCC	3	0	3	**4.5**
3.	UCC403	DESIGN OF CONCRETE STRUCTURES	PCC	3	1	2*	**4.0**
4.	UCC404	FUNDAMENTALS OF DATA SCIENCE	ESC	3	0	2	**4.0**
5.	UMA012	NUMERICAL AND STATISTICAL COMPUTATIONS	BSC	3	0	2	**4.0**
6.	UHU050	EVOULTIONARY PSYCHOLOGY	HSS	1	0	0	**1.0**
		TOTAL		16	2	10	**21.5**

SEMESTER-V

S. No.	Course Code	Course Name	CODE **	L	T	P	Cr
1.	UCC501	GEOTECHNICAL ENGINEERING-I	PCC	3	1	2	4.5
2.	UCC503	DESIGN OF STEEL STRUCTURES	PCC	3	1	0	3.5
3.	UCC502	TRANSPORTATION ENGINEERING	PCC	3	0	2	4.0
4.	UCC505	DATABASE MANAGEMENT SYSTEMS	PCC	3	0	2	4.0
5.	UCC504	SURFACE HYDROLOGY	PCC	3	1	0	3.5
6.	UTA025	INNOVATION ANDENTREPRENEURSHIP*(3SELF-EFFORTHOURS)	HSS	1	0	2*	3.0
7.	UCE592	SURVEY PROJECT	PRJ	-	-	-	3.0
8.	UCE693	GROUP DESIGN PROJECT (START)	PRJ	-	-	2	-
		TOTAL		**16**	**3**	**9**	**25.5**

SEMESTER–VI

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UCC601	GEOTECHNICAL ENGINEERING-II	PCC	3	0	2	4.0
2.	UCC602	ENVIRONMENTAL ENGINEERING	PCC	3	1	2	4.5
3.	UCE513	CONSTRUCTION MANAGEMENT	PCC	3	0	2	4.0
4.		ELECTIVE-I	PEC	3	1	0	3.5
5.	UCC603	MACHINE LEARNING	PCC	3	0	2	4.0
6.	UCE693	GROUP DESIGN PROJECT (2 SELF-EFFORT HOURS)	PRJ	1	0	2	3.0
7.	UCE892	CAPSTONE PROJECT(START)	PRJ	1*	-	2	-
		TOTAL		**13.5**	**2**	**10**	**23.0**

SEMESTER –VII

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UCE799	PROJECT SEMESTER**	PRJ	-	-	-	15.0

****To be carried out in Industry/ Research Institution**

OR

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UCE702	ADVANCED CONSTRUCTION TECHNOLOGY	PCC	3	1	0	3.5
2.	UCE725	ADVANCED CONSTRUCTION MATERIALS AND TECHNIQUES	PCC	3	0	0	3.5
3.	UCE800	PROJECT (06 SELF-EFFORT HOURS)	PRJ	-	-	2	4.0
4.	UCE796	PRACTICALTRAINING (SIX WEEKS)	PRJ				4.0
TOTAL				**6**	**1**	**2**	**15.0**

OR

S. No.	Course Code	Course Name	CODE**	L	T	P
1.	UCE798	**START UP SEMESTER****	-	-	-	15.0

****Based on hands-on work on Innovations and Entrepreneurship***

SEMESTER –VIII

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UCC801	EARTHQUAKE ENGINEERING & SIMULATION	PCC	3	0	2*	3.5
2.		ELECTIVE-II	PCC	3	1	0	3.5
3.		ELECTIVE-III	PCC	3	1	0	3.5
4.	UHU005	HUMANITIES FOR ENGINEERS	HSS	2	0	2	3.0
5.	UCE892	CAPSTONE PROJECT (INCLUDES8 SELF-EFFORT HOURS)	PRJ	0	0	2	8.0
6.		GENERIC ELECTIVE	OEC	2	0	0	2.0
TOTAL				**13**	**2**	**5**	**23.5**

List of Professional Electives (PEC)

Elective-I

S. No.	Course Code	Course Name	L	T	P	Cr
1	UCC611	Building Information Modeling in Construction	1	1	4	**3.5**
2	UCE831	Bridge Engineering	3	1	0	**3.5**
3	UCC612	Railway and Airport Engineering	3	1	0	**3.5**
4	UCE803	Irrigation Engineering	3	1	0	**3.5**
5	UCE616	Advanced Concrete Design	3	1	0	**3.5**

Elective-II

S. No.	Course Code	Course Name	L	T	P	Cr
1	UCE837	Sustainable & Smart Materials	3	1	0	**3.5**
2	UCE838	Prestressed Concrete	3	1	0	**3.5**
3	UCE852	IoT and Smart Cities	3	1	0	**3.5**
4	UCE857	Integrated Watershed Management	3	1	0	**3.5**
5	UCE824	Geotechnices for Underground Structures	3	1	0	**3.5**

Elective-III

S. No.	Course Code	Course Name	L	T	P	Cr
1	UCE854	Advanced Steel Structure Design	3	1	0	**3.5**
2	UCE855	Design of Reinforced Earth Structures	3	1	0	**3.5**
3	UCC821	Advanced Transportation Engineering	3	1	0	**3.5**
4	UCE825	Life Cycle Assessment	3	1	0	**3.5**
5	UCC822	Remote Sensing and GIS in water and environmental projects	3	1	0	**3.5**

GENERIC ELECTIVE (GE)

S. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UHU016	INTRODUCTORY COURSE IN FRENCH	2	0	0	2.0
2	UCS002	INTRODUCTION TO CYBER SECURITY	2	0	0	2.0
3.	UTD002	EMPLOYABILITY DEVELOPMENT SKILL	2	0	0	2.0
4.	UHU017	INTRODUCTION TO COGNITIVE SCIENCE	2	0	0	2.0
5.	UHU018	INTRODUCTION TO CORPORATE FINANCE	2	0	0	2.0
6.	UEN006	TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT	2	0	0	2.0
7.	UPH064	NANO SCIENCE AND NANO-MATERIALS	2	0	0	2.0
8.	UMA069	GRAPH THEORY AND APPLICATIONS	2	0	0	2.0
9.	UMA070	ADVANCED NUMERICAL METHODS	2	0	0	2.0
10.	UBT510	BIOLOGY FOR ENGINEERS	2	0	0	2.0

Focus Areas (over and above the basic course scheme)

Focus Elective-I in Vth Sem

Focus Electives-II and III in VIIIth Sem

	FOCUS AREAS		
Electives	**Structural Engineering, Smart and Sustainable Materials**	**Smart Cities**	**Infrastructure Development and Management**
Focus Elective-I	Bridge Engineering (UCE831)	Design of Smart Transportation Systems (UCE851)	Infrastructure Planning & Design (UCE861)
Focus Elective-II	Sustainable & Smart Materials (UCE837)	Internet of Things (IoT) & Smart Cities (UCE852)	Building Infrastructures & Construction Practices (UCE862)
Focus Elective-III	Prestressed Concrete Structures (UCE838)	Sustainable & Smart Materials (UCE837)	Infrastructure Contracts & Risk Management (UCE863)

The students of BE Civil with Computer Applications can do a specialization in a focus area by studying courses of that particular focus area over and above the normal BE courses

1. Students must choose any one focus area at the start of Semester V
2. The students who clear all courses of a particular focus area will be awarded a certificate of specialization in addition to BE Civil with Computer Applications.

Approved in 114th Meeting of Senate held on March 7, 2025

Table 3: Total Credit Score for specific Nature of course/s

Nature of the course	CODE	Total Credits	Semester and Course Name
Basic Science Courses	BSC	*30.0*	Applied Physics, Semester I Mathematics-I, Semester I Applied Chemistry, Semester II Electrical and Electronics Engineering, Semester II Energy and Environment, Semester II Mathematics-II, Semester II Optimization Techniques in Civil Engineering, Semester III Numerical and Statistical Computations, Semester IV
Engineering Science Courses	ESC	*23.0*	Engineering Drawing, Semester I Manufacturing Processes, Semester I Programming for Problem Solving, Semester II Solid Mechanics, Semester III Engineering Materials, Semester III Artificial Intelligence, Semester III Fundamentals of Data Science, Semester IV
Humanities and Social Science Courses	HSS	*12.0*	Professional Communication, Semester I Aptitude Skills Building, Semester III Evolutionary Psychology, Semester IV Innovation and Entrepreneurship, Semester V Humanities for Engineers, Semester VIII
Professional Core Courses	PCC	*63.0*	Fluid Mechanics, Semester III Architectural Drawing and Building Construction, Semester III Building Materials, Semester III Structural Analysis, Semester IV Geoinformatics, Semester IV Design of Concrete Structures, Semester IV Geotechnical Engineering-I, Semester V Surface Hydrology, Semester V Design of Steel Structures, Semester V Transportation Engineering, Semester V Database Management Systems, Semester V Geotechnical Engineering-II, Semester VI Environmental Engineering, Semester VI Construction Management, Semester VI Machine Learning, Semester VI Earthquake Engineering and Similation, Semester VIII

Nature of the course	CODE	Total Credits	Semester and Course Name
Professional Elective Courses	PEC	*10.5/21.0**	Elective-I, Semester V Elective-II, Semester VIII Elective-III, Semester VIII *: Focus Area Elective-I, Semester V *: Focus Area Elective-II, Semester VIII *: Focus Area Elective-III, Semester VIII
Open Elective Courses	OEC	*2.0*	Generic Elective, Semester VIII
Project	PRJ	*29.0*	Survey Project, End of Semester IV and to be graded in Semester V Group Design Project, Semesters V & VI Project Semester, Semester VII Capstone Project, Semester VIII

***: These credits include the additional focus area electives, over and above the standard scheme**

SEMESTER-I

Approved in the 109th Senate held on March 16, 2023

UPH013: Physics

L	T	P	Cr
3	1	2	4.5

Course Objective: To introduce the student to the basic physical laws of oscillators, acoustics of buildings, ultrasonics, electromagnetic waves, wave optics, lasers, and quantum mechanics and demonstrate their applications in technology. To introduce the student to measurement principles and their application to investigate physical phenomena

Syllabus

Oscillations and Waves: Oscillatory motion and damping, Applications - Electromagnetic damping – eddy current; ***Acoustics:*** Reverberation time, absorption coefficient, Sabine's and Eyring's formulae (Qualitative idea), Applications - Designing of hall for speech, concert, and opera; ***Ultrasonics:*** Production and Detection of Ultrasonic waves, Applications - green energy, sound signaling, dispersion of fog, remote sensing, Car's airbag sensor.

Electromagnetic Waves: Scalar and vector fields; Gradient, divergence, and curl; Stokes' and Green's theorems; Concept of Displacement current; Maxwell's equations; Electromagnetic wave equations in free space and conducting media, Application - skin depth.

Optics: ***Interference:*** Parallel and wedge-shaped thin films, Newton rings, Applications as Non-reflecting coatings, Measurement of wavelength and refractive index. ***Diffraction:*** Single and Double slit diffraction, and Diffraction grating, Applications - Dispersive and Resolving Powers. ***Polarization:*** Production, detection, Applications – Anti-glare automobile headlights, Adjustable tint windows. ***Lasers:*** Basic concepts, Laser properties, Ruby, HeNe, and Semiconductor lasers, Applications – Optical communication and Optical alignment.

Quantum Mechanics: Wave function, Steady State Schrodinger wave equation, Expectation value, Infinite potential well, Tunneling effect (Qualitative idea), Application - Quantum computing.

Laboratory Work

1. Determination of damping effect on oscillatory motion due to various media.
2. Determination of velocity of ultrasonic waves in liquids by stationary wave method.
3. Determination of wavelength of sodium light using Newton's rings method.
4. Determination of dispersive power of sodium-D lines using diffraction grating.
5. Determination of specific rotation of cane sugar solution.
6. Study and proof of Malus' law in polarization.
7. Determination of beam divergence and beam intensity of a given laser.
8. Determination of displacement and conducting currents through a dielectric.
9. Determination of Planck's constant.

Micro Project:

Students will be given physics-based projects/assignments using computer simulations, etc.

Course Learning Objectives (CLO)

The students will be able to:

1. understand damped and simple harmonic motion, the role of reverberation in designing a hall and generation and detection of ultrasonic waves.
2. use Maxwell's equations to describe propagation of EM waves in a medium.
3. demonstrate interference, diffraction and polarization of light.
4. explain the working principle of Lasers.
5. use the concept of wave function to find probability of a particle confined in a box.
6. perform an experiment, collect data, tabulate and report them and interpret the results with error analysis.

Text Books

1. Beiser, A., Concept of Modern Physics, Tata McGraw Hill (2007) 6th ed.
2. Griffiths, D.J., Introduction to Electrodynamics, Prentice Hall of India (1999) 3rd ed.
3. Jenkins, F.A. and White, H.E., Fundamentals of Optics, McGraw Hill (2001) 4th ed.

Reference Books

1. Wehr, M.R, Richards, J.A., Adair, T.W., Physics of The Atom, Narosa Publishing House (1990) 4th ed.
2. Verma, N.K., Physics for Engineers, Prentice Hall of India (2014)1st ed.
3. Pedrotti, Frank L., Pedrotti, Leno S., and Pedrotti, Leno M., Introduction to Optics, Pearson Prentice HallTM (2008) 3rd ed.

Evaluation Scheme

Sr. No.	**Evaluation elements**	**Weightage (%)**
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UES101: Engineering Drawing

L	T	P	Cr
2	4	0	4.0

Course Objective: This module is dedicated to graphics and includes two sections: 2D drafting and 3D modelling of solid objects. This course is aimed at making the student understand the concepts of projection systems, learn how to create projections of solid objects using first and third angle orthographic projection as well as isometric and auxiliary projection, concept of sectioning, to interpret the meaning and intent of toleranced dimensions and to create/edit drawings using drafting software. In addition, this course shall give an insight on the basic 3D modelling concepts like extrude, revolve, sweep, construction of complex solids.

Syllabus

Engineering Drawing Concepts

1. Introduction to Engineering Drawing
2. Projection systems: First angle and third angle projection system
3. Orthographic Projection: Points, Lines, Solid objects
4. Isometric Projections
5. Auxiliary Projections
6. Development of surfaces
7. Section of solids
8. Limits, fits and tolerances

2D Drafting

1. Management of screen menus commands
2. Creating basic drawing entities
3. Co-ordinate systems: Cartesian, polar and relative coordinates
4. Drawing limits, units of measurement and scale
5. Layering: organizing and maintaining the integrity of drawings
6. Design of prototype drawings as templates.
7. Editing/modifying drawing entities: selection of objects, object snap modes, editing commands,
8. Dimensioning: use of annotations, dimension types, properties and placement, adding text to
drawing

3D Modelling

1. Management of screen menus commands
2. Introduction to basic 3D modelling commands such as extrude, revolve, sweep etc.
3. Creation of 2D drawings from a 3D model

Micro Projects /Assignments:

1. Completing the views - Identification and drawing of missing lines and views in the projection of objects

2. Projects related to orthographic and isometric projections Using wax blocks/soap bars/any soft material to develop three dimensional object from given orthographic projections

3. a. 3D modelling of complex machine components
   b. Development of production drawings of individual components from the model

Course Learning Objectives (CLO)

The students will be able to:

1. creatively comprehend the geometrical details of common engineering objects
2. draw dimensioned orthographic and isometric projections of simple engineering objects
3. interpret the meaning and intent of limits, fits and tolerances in the drawing
4. create/edit the engineering drawings for simple engineering objects using 2D drafting software
5. create/edit 3D models of engineering components using 3D modelling software

Text Books

1. Jolhe, D.A., Engineering Drawing, Tata McGraw Hill, 2008
2. Davies, B. L., Yarwood, A., Engineering Drawing and Computer Graphics, Van Nostrand Reinhold (UK), 1986

Reference Books

1. Gill, P.S., Geometrical Drawings, S.K. Kataria & Sons, Delhi (2008).
2. Gill, P.S., Machine Drawings, S.K. Kataria & Sons, Delhi (2013).
3. Mohan, K.R., Engineering Graphics, Dhanpat Rai Publishing Company (P) Ltd, Delhi (2002).
4. French, T. E., Vierck, C. J. and Foster, R. J., Fundamental of Engineering Drawing & Graphics Technology, McGraw Hill Book Company, New Delhi (1986).
5. Rowan, J. and Sidwell , E. H., Graphics for Engineers, Edward Arnold, London (1968).
6. Mastering AutoCAD 2021 and AutoCAD LT 2021, Brian C. Benton, George Omura, Sybex - John Wiley and Sons, Indiana (2021).

Evaluation Scheme

Course Component	**Weightage**
AutoCAD tutorials/SolidWorks/Project work*	35
MST (1.5 hours-CAD based)**	20
EST (2 hours-CAD based)**	45

***Students are required to bring their personal computers for the** tutorial work.*
**Availability of institute server resources for sharing the software licences with the student community.*
***Institute computational resources in collaboration with other academic units / departments for conducting the mid semester and end semester test.*

UHU003: Professional Communication

L	T	P	Cr
2	0	2	3.0

Course Objective: The course is designed to develop the interpersonal, written, and oral as well as the non- verbal communication skills of the students. The course begins by building up on the theoretical concepts and then practicing on the applicability of the various elements. Since the course has very high applicability content, the students are advised to practice in class as well as off class. A very high level of interaction is expected of the students in the class.

Syllabus

Fundamentals of Communication: Meaning, Types and Characteristics of communication, Applicability of Transactional Analysis and Johari Window for enhancing interpersonal communication skills. Seven Cs of Effective Communication, Barriers to Effective Communication.

Effective Oral Communication: Understanding Principles of Oral communication, Formal and Informal Oral Communication, Oral Communication and Behavioral Patterns, Advantages and Disadvantages of Oral Communication.

Effective Listening: Listening vs Hearing, Active Listening techniques, Barriers to Listening.

Effective non-verbal communication: Meaning and Importance of Non-Verbal Communication, Different Types of Non-verbal Communication, Interpretation of Non-verbal Cues.

Effective written Communication: Characteristics of Good Writing, Choice of Words, Sentence Construction, Paragraph development, Forms of writing.

Business Communication: Technical Report Writing, Designing Resumes and Cover Letters for effective job application, E-mail writing and e-mail etiquette.

Organizational Communication: Directional communication: Downward, Upward and Horizontal Communication, Grapevine.

Reading: The following texts (one from each of the two categories listed below) are required to be read by the students in the semester:
Category 1: Animal Farm by George Orwell, Lord of the Flies by William Golding, Life of Pi by Yann Martel
Category 2: The Namesake by Jhumpa Lahiri, The God of Small Things by Arundhati Roy, Q&A by Vikas Swarup

Laboratory Work

1. Needs-assessment of spoken and written communication with feedback.
2. Training for Group Discussions through simulations and role plays.
3. Technical report writing on survey-based projects.
4. Project-based team presentations.

Course Learning Objectives (CLO)

The students will be able to:

1. Apply communication concepts for effective interpersonal communication.
2. Speak assertively and effectively.
3. Interpret non-verbal cues in professional communication.
4. Write objectively, purposefully and effectively.
5. Design effective resumes and reports.

Text Books

1. Mukherjee H.S..Business Communication: Connecting at Work. Oxford University Press.(2013)
2. Lesikar R.V, and Flately M.E., Basic Business Communication Skills for empowering the internet generation.(2006)
3. Raman, M.,and Singh ,P, Business Communication . Oxford . University Press (2008).

Reference Books

1. Riordan, G.R. Technical Communication. Cengage Learning India Private Ltd. (2012)
2. Butterfield, Jeff., Soft Skills for everyone, Cengage Learning New Delhi, (2013).
3. Robbins, S.P., & Hunsaker, P.L., Training in Interpersonal Skills, Prentice Hall of India, New Delhi, (2008).
4. Orwell, G., Animal Farm, Fingerprint Publishing, New Delhi, (2017).
5. Golding, W, Lord of the Flies, Faber & Faber; Export edition (1999)
6. Martel,Y., Life of Pi, RHC, New Delhi, (2012).
7. Lahiri,J., The Namesake, Harpercollins (2007)
8. Arundhati Roy,A., The God of Small Things, Penguin India, (2002).
9. Swarup,V., Q&A, Black Swan,(2009).

Evaluation Scheme

Sr. No.	**Evaluation elements**	**Weightage (%)**
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UES102: MANUFACTURING PROCESSES

L	T	P	Cr
2	0	2	3.0

Course Objectives: This course introduces the basic concepts of manufacturing via machining, forming, casting and joining, enabling the students to develop a basic knowledge of the mechanics, operation and limitations of basic machining tools along with metrology and measurement of parts. The course also introduces the concept of smart manufacturing.

Machining Processes: Principles of metal cutting, Cutting tools, Cutting tool materials and applications, Geometry of single point cutting tool, Introduction to computerized numerical control (CNC) machines, G and M code programming for simple turning and milling operations, introduction of canned cycles.

Metal Casting: Introduction & Principles of sand casting, Requisites of a sound casting, Permanent mold casting processes, casting defects

Metal Forming: Hot & cold metal working, Forging, Rolling, Sheet Metal operations.

Joining Processes: Method of joining, type of electric arc welding processes, Methods of shielding, Power source characteristics, Resistance welding, Soldering, Brazing.

Smart Manufacturing: IoT and ML in manufacturing, Introduction to Additive Manufacturing, Robotics and Automation in manufacturing.

Laboratory Work:

Relevant shop floor exercises involving practices in Sand casting, Machining, Welding, Sheet metal fabrication techniques, CNC turning and milling exercises, Experiments on basic engineering metrology and measurements to include measurements for circularity, ovality, linear dimensions, profiles, radius, angular measurements, measurement of threads, surface roughness. Basic knowledge and derivations related to above measurements, uncertainties, statistical approaches to estimate uncertainties, Line fitting, static and dynamic characteristics of instruments will be discussed in laboratory classes.

Assignments: Assignments for this course will include the topics: Manufacturing of micro-chips used in IT and electronics industry and use of touch screens. Another assignment will be given to practice numerical exercises on topics listed in the syllabus. Case study related to smart manufacturing.

Micro Project: Fabrication of multi-operational jobs using the above processes as per requirement by teams consisting of 4 -6 members. Quality check should be using the equipment available in metrology lab.

Course Learning Outcomes (CLO):

After the completion of this module, students will be able to:

- identify & analyse various machining processes/operations for manufacturing of industrial components
- apply the basic principle of bulk and sheet metal forming operations
- apply the knowledge of metal casting for different requirements.
- identify and analyse the requirements for achieving a sound welded joint
- apply the concept of smart manufacturing in industrial domain

Text books:

1. Degarmo, E. P., Kohser, Ronald A. and Black, J. T., Materials and Processes in• Manufacturing, Prentice Hall of India (2008) 8thed.
2. Kalpakjian, S. and Schmid, S. R., Manufacturing Processes for Engineering Materials,• Dorling Kingsley (2006) 4thed.

Reference Books:

1. Martin, S.I., Chapman, W.A.J. , Workshop Technology, Vol.1 & II, Viva Books (2006) 4 th ed.
2. Zimmer, E.W. and Groover, M.P., CAD/CAM - Computer Aided Designing and Manufacturing, Dorling Kingsley (2008).
3. Pandey, P.C. and Shan, H. S., Modern Machining Processes, Tata McGraw Hill (2008).
4. Mishra, P. K., Non-Conventional Machining, Narosa Publications (2006).
5. Campbell, J.S., Principles of Manufacturing, Materials and Processes, Tata McGraw Hill Company (1999).
6. Lindberg, Roy A., Processes and Materials of Manufacture, Prentice Hall of India (2008) 4th ed.

Evaluation Scheme:

Sr. No.	Evaluation elements	Weightage (%)
1	MST	35
2	EST	35
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UMA022: Calculus for Engineers

L	T	P	Cr
3	1	0	3.5

Course Objective: To provide students with skills and knowledge in sequence and series, advanced calculus, calculus of several variables and complex analysis which would enable them to devise solutions for given situations they may encounter in their engineering profession.

Syllabus

Sequences and Series: Introduction to sequences and infinite series, Tests for convergence/divergence, Limit comparison test, Ratio test, Root test, Cauchy integral test, Alternating series, Absolute convergence, and conditional convergence.

Series Expansions: Power series, Taylor series, Convergence of Taylor series, Error estimates, Term by term differentiation and integration.

Partial Differentiation: Functions of several variables, Limits and continuity, Chain rule, Change of variables, Partial differentiation of implicit functions, Directional derivatives and its properties, Maxima and minima by using second order derivatives.

Multiple Integrals: Double integral (Cartesian), Change of order of integration in double integral, Polar coordinates, Graphing of polar curves, Change of variables (Cartesian to polar), Applications of double integrals to areas and volumes, Evaluation of triple integral (Cartesian).

Complex analysis: Introduction to complex numbers, Geometrical interpretation, Functions of complex variables, Examples of elementary functions like exponential, trigonometric and hyperbolic functions, Elementary calculus on the complex plane (limits, continuity, differentiability), Cauchy – Riemann equations, Analytic functions, Harmonic functions.

Course Learning Objectives (CLO)

The students will be able to:

1. determine the convergence/divergence of infinite series, approximation of functions using power and Taylor's series expansion and error estimation.
2. examine functions of several variables, define and compute partial derivatives, directional derivatives, and their use in finding maxima and minima in some engineering problems.
3. evaluate multiple integrals in Cartesian and Polar coordinates, and their applications to engineering problems.
4. represent complex numbers in Cartesian and Polar forms and test the analyticity of complex functions by using Cauchy – Riemann equations.

Text Books

1. Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry, Pearson Education (2007), 9th ed.
2. Stewart James, Essential Calculus; Thomson Publishers (2007), 6th ed.
3. Kasana, H.S., Complex Variables: Theory and Applications, Prentice Hall India, 2005

(2nd edition).

Reference Books

1. Wider David V, Advanced Calculus: Early Transcendentals, Cengage Learning (2007).
2. Apostol Tom M, Calculus, Vol I and II, John Wiley (2003).
3. Brown J.W and Churchill R.V, Complex variables and applications, McGraw Hill, (7th edition)

Evaluation Scheme

Sr. No.	**Evaluation elements**	**Weightage (%)**
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

SEMESTER-II

Approved in the 109th Senate held on March 16, 2023

UCB009: Chemistry

L	T	P	Cr
3	0	2	4.0

Course Objective: The course aims at elucidating principles of applied chemistry in industrial systems, water treatment, engineering materials, computational and analytical techniques.

Syllabus

Atomic and Molecular spectroscopy: Introduction to spectroscopy, principles of atomic absorption, flame emission spectrophotometry and ICP-AES (Inductively Coupled Plasma- Atomic Emission Spectroscopy), Quantification by calibration method, Jablonski diagram, fluorescence and phosphorescence, Beer-Lambert's Law, principle and applications of UV-Vis and IR spectroscopy.

Electrochemistry: Background of electrochemistry, Ionic mobility, Conductometric titrations, Modern Batteries: Pb-acid and Li ion battery, Corrosion and its protection.

Water Treatment and Analysis: Physiochemical parameters of water quality, External and internal methods of Softening of water: carbonate, phosphate, calgon and colloidal conditioning, Zeolite process, Ion exchange process, treatment of water for domestic use, Desalination of brackish water: Reverse osmosis & Electrodialysis.

Fuels: Classification of fuels, Calorific value, Cetane and Octane number, alternative fuels: biodiesel, Power alcohol, synthetic petrol, Fuel cells: H2 production and storage, Water splitting, Rocket propellant.

Chemistry of Polymers: Classification of polymers, tacticity of polymers, molecular weight calculations, Polymers in daily life, conducting, inorganic and biodegradable polymers.

Computers in Chemistry: Introduction to SMILES (Simplified Molecular Input Line-Entry System): Methodology and encoding rules, SMILES notation-chemical structure interconversions and its applications.

Laboratory Work

Electrochemical measurements: Experiments involving use of pH meter, conductivity meter, potentiometer, Spectroscopic technique, Volumetric titrations: Determination of mixture of bases, hardness, alkalinity, chloride and iron content, Application of polymers and SMILES Language.

Course Learning Objectives (CLO)

The students will be able to:

1. recognize principles and applications of atomic and molecular spectroscopy.
2. explain the concepts of conductometric titrations, modern batteries and corrosion.
3. apply and execute water quality parameter and treatment methods.

4. discuss the concept of alternative fuels, application of polymers and SMILES.
5. execute laboratory techniques like pH metry, potentiometry, spectrophotometry, conductometry and volumetry.

Text Books

1. Engineering Chemistry, S. Vairam and S. Ramesh, Wiley India 1st ed, 2014.
2. Engineering Chemistry, K. S. Maheswaramma, and M. Chugh. Pearson, 2016.

Reference Books

1. Engineering Chemistry, B. Sivasankar, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 2008.
2. Engineering Chemistry, M.J. Shulz, Cengage Learnings, 2007.
3. J. Chem. Inf. Comput. Sci., D. Weininger, Vol. 28, 1988, 31-36.

Evaluation Scheme

Sr. No.	**Evaluation elements**	**Weightage (%)**
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UES103: Programming for Problem Solving

L	T	P	Cr
3	0	2	4.0

Course Objectives: This course is designed to solve and explore the problems using the art of computer programming with the help of C Language. Students will be able to apply these problem solving concepts in real life applications.

Syllabus

Introduction to Computer Fundamentals- Computer Memory Hierarchy, Types of Software Binary number system, Algorithm, Flowchart, Formulate simple algorithms for logical and arithmetic problems.

Basics of C Programming: Structure and Life cycle of a C Program, Data types, Identifiers, Variables, Keywords, Constants, input/output statements, Operators, Type conversion and type casting. Translate the algorithms to code snippets.

Decision Making and Iterative Statements- Decision making- if, if-else, Nested if-else, Multiple if, else if, switch, Ternary Operator, **Loops-** (while, do-while, for), Nesting of Loops, break, continue and goto. Implement the switch () to solve the basic functions of scientific calculator.

Functions: Function prototype, Definition and Call, Type of Functions, Scope of variables in (Block, Function, Program, File), Storage classes (Auto, Register, Static and Extern), Recursion (with the introduction of Stack), Implementation of recursion to solve the problem of Tower of Hanoi.

Arrays and Strings- One-dimensional array its operations (Traversal, Linear Search, Insertion, Deletion, Bubble Sort), Two-dimensional and its operations (Addition, Transpose and Multiplication), Passing of array into a function (row and entire array), Input and output of a string, string inbuilt functions, 2-D Character array.

Pointers: Introduction to Pointers, Pointer arithmetic, Passing arguments to a function using pointer (understanding of call by value and call by reference), Accessing arrays using pointers Dynamic memory allocation (malloc(), calloc(), realloc() and free()), Pointer and Functions.

Structures and Union: Structure declaration, Initialization of structures, Structure variables, Accessing structure elements using (.) operator, Array of structure variables, Passing structure variable to a function (individual and entire structure), Structure pointer, Comparison of Structure and Union.

File Handling: Introduction of Files (streams in C), using File (Declaring, Opening and Closing), Operations on File (Reading, Writing and appending), and Random Access of a

file, command line argument.

Laboratory Work
To implement programs for various kinds of real life applications in C Language.

Course Learning Outcomes (CLOs) /Course Objectives (COs):

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

1. Comprehend and analyze the concepts of number system, memory, compilation and debugging of the programs in C language.
2. Analyze the control & iterative statements to solve the problems with C language source codes.
3. Design and create programs for problem solving involving arrays, strings and pointers.
4. Evaluate and analyze the programming concepts based on user define data types and file handling using C language.

Text Books
1. C Programming Language, Brian W. Kernighan Dennis M. Ritchie, 2nd ed, 2012.
2. Programming in ANSI C, Balagurusamy G., 8th ed., 2019

Reference Books
1. Let Us C, Kanetkar Y., 16th ed., 2017
2. Programming with C, Byron S Gottfried, McGraw Hill Education, Forth edition, 2018

UES013: Electrical and Electronics Engineering

L	T	P	Cr
3	1	2	4.5

Course Objective: To introduce the basic concepts of electrical and electronics engineering.

Syllabus

DC Circuits: Introduction to circuit elements; rms and average values for different wave shapes, independent and dependent current and voltage sources; Kirchhoff's laws; mesh and node analysis; source transformations; network theorems: Superposition theorem, Thevenin's and Norton's theorem, Maximum power transfer theorem; star-delta transformation; steady state and transient response of R-L and R-C and R-L-C circuits.
AC Circuits: Concept of phasor, phasor representation of circuit elements; analysis of series and parallel AC circuits; concept of real, reactive and apparent powers; resonance in RLC series and parallel circuits; balanced three phase circuits: voltage, current and power relations for star and delta arrangement; analysis of balanced and unbalanced circuits; three phase power measurement using two-wattmeter and one-wattmeter methods.
Magnetic circuits: analogy between electric and magnetic circuits; series and parallel magnetic circuits; operating principles of electrical appliances: single-phase transformer and rotating machines; tests and performance of single-phase transformer.

Digital Logic Design: Digital signals, Number systems, Positive and negative representation of numbers, Signed-number representation, Binary arithmetic, Postulates and theorems of Boolean Algebra, Algebraic simplification, Sum of products and product of sums formulations (SOP and POS), Gate primitives, Logic Gates and Universal Gates, Minimization of logic functions, Karnaugh Maps, Logic implementation using Gates, Decoder, MUX, Flip-Flops, Asynchronous up/down counters.

Electronic Devices: p- n junction diode: V-I characteristics of diode, Operation of Bipolar Junction Transistor, CB and CE configuration, Transistor as a switch, Operation of SCR, DIAC and TRIAC.

Operational Amplifier Circuits: The ideal operational amplifier, the inverting, non-inverting amplifiers, Op-Amp Characteristics, Applications of Op-amp: summing amplifier, differentiator and integrator.

Laboratory Work: Kirchhoff's laws, network theorems, ac series and parallel circuit, three phase power measurement, magnetic circuit, tests on transformer, resonance in AC circuit, combinational circuits, flip flops, shift register and binary counters, asynchronous and synchronous up/down counters, BJT characteristics.

Course Learning Objectives (CLO)
The students will be able to:

1. apply various networks laws and theorems to solve dc circuits
2. compute different ac quantities with phasor representation
3. comprehend the operation in magnetic circuits, single phase transformer and rotating machines
4. recognize and apply the number systems and Boolean algebra.
5. reduce and simplify Boolean expressions and implement them with logic gates.

6. discuss and explain the working of diode, transistor and operational amplifier, their configurations and applications.

Text Books

1. Hughes, E., Smith, I.M., Hiley, J. and Brown, K., Electrical and Electronic Technology, Prentice Hall (2008) 10th ed.
2. Nagrath, I.J. and Kothari, D.P., Basic Electrical Engineering, Tata McGraw Hill (2002).
3. Boylestad, R.L. and Nashelsky, L., Electronic Devices & Circuit Theory, Perason (2009).
4. Mano M. M. and Ciletti, M.D., Digital Design, Pearson, Prentice Hall, (2013).

Reference Books

1. 1. Chakraborti, A., Basic Electrical Engineering, Tata McGraw−Hill (2008).
2. Del Toro, V., Electrical Engineering Fundamentals, Prentice−Hall of India Private Limited (2004).
3. David Bell, Electronics Devices and Circuits, Oxford Publications (2009).

Evaluation Scheme

Sr. No.	**Evaluation elements**	**Weightage (%)**
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UEN008: Energy and Environment

L	T	P	Cr
2	0	0	2.0

Course Objective: The exposure to this course would facilitate the students in understanding the terms, definitions and scope of environmental and energy issues pertaining to current global scenario; understanding the need of sustainability in addressing the current environmental & energy challenges.

Syllabus

Introduction: Concept of sustainability and sustainable use of natural resources, Climate Change & its related aspects.

Air Pollution: Origin, Sources and effects of air pollution; Primary and secondary meteorological parameters; wind roses; Atmospheric stability; Source reduction and Air Pollution Control Devices for particulates and gaseous pollutants in stationary sources.

Water Pollution: Origin, Sources of water pollution, Category of water pollutants, Physicochemical characteristics, Components of wastewater treatment systems.

Solid waste management: Introduction to solid waste management, Sources, characteristics of municipal solid waste, Solid waste management methods: Incineration, composting, landfilling.

Energy Resources: Classification of Energy Resources; Non-conventional energy resources-Biomass energy, Thermo-chemical conversion and biochemical conversion route; Solar energy-active and passive solar energy absorption systems; Type of collectors; Thermal and photo conversion applications.

Course Learning Objectives (CLO)
The students will be able to:

1. comprehend the interdisciplinary context of environmental issues with reference to sustainability
2. assess the impact of anthropogenic activities on the various elements of environment and apply suitable techniques to mitigate their impact.
3. demonstrate the application of technology in real time assessment and control of pollutants.
4. correlate environmental concerns with the conventional energy sources associated and assess the uses and limitations of non-conventional energy technologies

Text Books

1. Moaveni, S., Energy, Environment and Sustainability, Cengage (2018)
2. Rajagopalan, R., Environmental Studies, Oxford University Press (2018)
3. O'Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).

Reference Books

1. Peavy H.S., Rowe D.S., and Tchobanoglous, G. (2013) Environmental Engineering, McGraw Hill.
2. Rao, M.N. and Rao, H.V.N. (2014) Air Pollution, McGraw Hill.
3. Metcalf and Eddy. (2003) Wastewater Engineering: Treatment and Reuse, FourthEdition, McGraw Hill.
4. Rai, G.D. (2014) Non-conventional Energy Resources, Khanna Publishers.

Evaluation Scheme

Sr. No.	**Evaluation elements**	**Weightage (%)**
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UMA023: Differential Equations and Linear Algebra

L	T	P	Cr
3	1	0	3.5

Course Objective: To introduce students the theory and concepts of differential equations, linear algebra, Laplace transformations and Fourier series which will equip them with adequate knowledge of mathematics to formulate and solve problems analytically.

Syllabus

Ordinary Differential Equations: Review of first order differential equations, Exact differential equations, Second and higher order differential equations, Solution techniques using one known solution, Cauchy - Euler equation, Method of undetermined coefficients, Variation of parameters method, Engineering applications of differential equations.

Laplace Transform: Definition and existence of Laplace transforms and its inverse, Properties of the Laplace transforms, Unit step function, Impulse function, Applications to solve initial and boundary value problems.

Fourier Series: Introduction, Fourier series on arbitrary intervals, Half range expansions, Applications of Fourier series to solve wave equation and heat equation.

Linear Algebra: Row reduced echelon form, Solution of system of linear equations, Matrix inversion, Linear spaces, Subspaces, Basis and dimension, Linear transformation and its matrix representation, Eigen-values, Eigen-vectors and Diagonalisation, Inner product spaces and Gram-Schmidt orthogonalisation process.

Course Learning Objectives (CLO)
The students will be able to:

1. solve the differential equations of first and 2nd order and basic application problems described by these equations.
2. find the Laplace transformations and inverse Laplace transformations for various functions. Using the concept of Laplace transform students will be able to solve the initial value and boundary value problems.
3. find the Fourier series expansions of periodic functions and subsequently will be able to solve heat and wave equations.
4. solve systems of linear equations by using elementary row operations.
5. identify the vector spaces/subspaces and to compute their bases/orthonormal bases. Further, students will be able to express linear transformation in terms of matrix and find the eigenvalues and eigenvectors.

Text Books

1. Simmons, G.F., Differential Equations (With Applications and Historical Notes), Tata McGraw Hill (2009).
2. Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., An introduction to Linear Algebra, Affiliated East West Press (1976).

Reference Books

1. Kreyszig Erwin, Advanced Engineering Mathematics, John Wiley (2006), 8th edition.
2. Jain, R.K. and Iyenger, S.R.K., Advanced Engineering Mathematics, Narosa Publishing House (2011), 4th edition.

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

SEMESTER-III

Approved in the 109th Senate held on March 16, 2023

UCC301: **SOLID MECHANICS**

L	T	P	Cr
3	1	2	4.5

Course Objective: This subject introduces fundamental concepts of structural mechanics to solve general engineering mechanics problems. It aims to develop an understanding of the stresses and strains that develop in solid materials when they are subjected to different types of loading and to develop an understanding of the conditions at failure of such materials.

Introduction of equilibrium of bodies: Free-body diagrams, conditions of equilibrium, torque due to a force, static determinacy.

Plane Trusses: Forces in members of a truss by method of joints and method of sections.

Axial Stress and Strain: Concept of stress, strain, elasticity and plasticity; one-dimensional stress-strain relationships; statically determinate and indeterminate problems, compound and composite bars, thermal stresses, concept of factor of safety.

Shear Force and Bending Moment Diagrams: Types of load on beams, classification of beams; axial, shear force and bending moment diagrams: simply supported, overhung and cantilever beams subjected to any combination of point loads, uniformly distributed and varying load and moment.

Properties of Plane Surfaces: Concept of first moment of area, centroid and second moment of area.

Bending & Shear Stresses in beams: Derivation of flexural formula for straight beams, bending stress calculation for beams of simple and built- up sections, flitched beams. Shear stress formula for beams, shear stress distribution in beams.

Deformations: Governing differential equation for deflection of straight beams having constant flexural rigidity, Double Integration Method and Macaulay's for determining slopes and deflection in beams

LABORATORY WORK

1. Calculation of **Tensile Strength** of materials
2. To determine the **Hardness** of various materials.
3. Experimental Verification of Theory of **Bending** (Calculation of bending stress and deflections at various points in the beam theoretically and verifying the same experimentally) and indirect evaluation of the modulus of elasticity
4. Determine the **Impact Strength** of Brittle and Ductile Materials
5. **Torsion:** Study the behaviour of circular shafts under torsion (**Destructive)** and analysis of failure of brittle and ductile materials and indirect evaluation of the modulus of rigidity.

EXPERIMENTAL PROJECT ASSIGNMENT

Students in groups of 4/5 will do project on Model Bridge Experiment: This will involve construction of a model bridge using steel wire and wood.

Course Learning Objectives (CLO)

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

1. Identify and quantify all forces associated with a static framework/plane force system.
2. Evaluate axial forces in trusses and axial stresses and strains in various determinate and indeterminate structural systems.
3. Draw shear force diagram and bending moment diagram in various kinds of beams subjected to different kinds of loads,
4. Evaluate bending and shear stresses in such beams.
5. Determine deformations and rotations at various locations in determinate beams.

Text Books

1. Engineering Mechanics of Solids,E.P. Popov and T.A. Balan, Pearson India Education Services, 2018.
2. Strength of Materials, D.K. Singh, Springer International Publishing, Fourth edition, 2020.\

Approved in the 109th Senate held on March 16, 2023

Reference Books

1. Mechanics of materials, R. C. Hibbeler, Pearson, Tenth edition, 2016.
2. Mechanics of materials, F.P. Beer, E.R. Johnston, D. Mazurek, McGraw-Hill Higher Education, 2011.

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional: (May include the following) Assignment, Regular Lab assessmentand Quizzes, Project (Including report, presentation etc.)	40

UCC302: CIVIL ENGINEERING MATERIALS

L	T	P	Cr
3	0	2	4.0

Course Objective: To expose students to the various building and general construction products and their associated quality, durability and availability.

Cement: Manufacturing, raw ingredients, chemical and mineralogical composition, types of cement, and chemistry of cement hydration

Aggregates: Classification and mechanical properties of aggregate, gradation, effect aggregate type on concrete properties, light weight aggregates

Cement mortar and concrete: Classification, properties and applications, water cement ratio, fresh, mechanical and durability properties of concrete. Production of concrete and mix design.

Chemical and Mineral admixtures: Supplementary Cementitious materials (Fly ash, GGBS, Metakoline**,** Silica Fume)**, Admixtures:** accelerating admixture, water reducing admixture, retarding admixture, air-entraining admixture.

Characterization of cementitious composites (cement and concrete): Characterization techniques with their meaning and uses, microstructure investigation methods including X-ray diffraction, scanning electron microscopy and Thermo-Gravimetric Analysis

Bricks and blocks: Classification and characteristics of bricks, AAC blocks, hollow concrete blocks.

Steel: Market forms of steel, classification and mechanical properties of steel.

Composites materials and nanomaterials in Civil engineering: Introduction to composite laminates – FRP and their use in civil engineering applications. Different types of Nanomaterials in Civil Engineering Applications

Laboratory Work

1. Tests on cement (fineness, specific gravity, consistency and strength test).
2. Tests on fine and coarse aggregates (gradation, specific gravity, water absorption).
3. Design of concrete mix for required grade of concrete.
4. Tests on fresh concrete (workability test).
5. Tests on hardened concrete (compressive strength, flexural strength and split tensile strength).
6. Characterization of cementitious composites using SEM and XRD

Experiential Learning (ELC) Activity

Casting of concrete canoe using innovative lightweight concrete.

Course Learning Objectives (CLO)

The students will be able to:

1. Design the mix proportions for required grade of concrete.
2. Perform various quality control tests for the civil engineering materials in the laboratory
3. Characterize cementitious composites (identify hydration products of cement, interfacial zones in concrete).
4. Evaluate the mechanical properties of steel using uniaxial stress-strain curve

Text Books

1. Gambhir M. L., Concrete Technology, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2013.
2. Rangawala S. C., Engineering Materials, Charotar Publishing House, Anand, 2005.
3. Chaudhary S. C., Patel K. A., Testing & Evaluation of Civil Engineering Materials, All India Council for Technical Education (AICTE), 2023.

Reference Books

1. Shetty M. S., Concrete Technology: Theory and Practice, S. Chand & Company, 2019.
2. Mehta and Monterio, Concrete Microstructure, Properties and Materials, McGraw-Hill Publishers, 2017.

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessional: (May include the following) Assignment, Regular Lab assessmentand Quizzes, Project (Including report, presentation etc.)	30

UCC303: **Fluid Mechanics**

L	T	P	Cr
3	1	2	4.5

Course Objective: To understand basic concepts of fluid flow and their applications in solving engineering problems

Introduction: Definition of a fluid and its properties, Types of fluids
Fluid statics: Differential equation of pressure field, Pascal law, Measurement of fluid pressure, force on submerged surfaces, Buoyancy and Flotation
Fluid kinematics: Methods of describing fluid motion, Velocity and acceleration of a fluid particle, Type of fluid flows, Displacement of a fluid particle, Continuity equation, Velocity potential and stream function, Flow net.
Fluid dynamics: Euler's equation; Bernoulli's equation; Momentum equation; Applications
Flow though pipes: Energy losses, Hydraulic gradient line and total energy line, Concept of equivalent pipe, Pipes in series and parallel, Flow through a siphon, Transmission of power
Flow measuring devices: Venturimeter, Orificemeter, orifice, Pitot tube, Notch, Time of emptying tanks of different cross-sections.
Dimensional analysis: Methods of dimensional analysis, Model studies
Application of computational techniques in fluid mechanics problems

Laboratory Work

1. Verification of Bernoulli's Theorem
2. Calibration of venturimeter/orifice meter.
3. Determination of hydrostatic force and its location on a vertically immersed surface.
4. Determination of friction factor for pipes of different materials
5. Determination of hydraulic coefficients of an orifice
6. Verification of momentum equation
7. Visualization of laminar and turbulent flow.

Course Learning Objectives (CLO)

The students will be able to:

1. Analyze and solve problems of simple fluid based engineering systems including pressures and forces on submerged surfaces.
2. Analyze fluid flow problems with the application of the mass, momentum and energy equations
3. Evaluate practical problems associated with pipe flow systems
4. Analyze the significant variables in hydraulic problems and to predict the performance of hydraulic prototypes.

Text Books

1. Fluid Mechanics, *Streeter*, V.L., *Wylie* E. B. and Bedford, K.W., McGraw Hill Book Company, 9th Edition, 2017.
2. Fluid Mechanics and Fluid Power Engineering, Kumar D.S., S. K. Kataria, 9th Edition, 2015.

Reference Books

1. Theory and Application of Fluid Mechanics, Subramanya, K., Tata McGraw Hill, 1st Edition, 2010.
2. Hydraulics and Fluid Mechanics *Modi* P.N. and *Seth* S.M., Standard Book House, 22nd Edition, 2019.
3. Mechanics of Fluid Shames I. H., McGraw Hill, 4th Edition, 2002.
4. Introduction to Fluid Mechanics, Fox, R.W. and McDonald A.T., John Wiley and Sons. 10th Edition, 2020

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessional: (May include the following) Assignment, Regular Lab assessmentand Quizzes, Project (Including report, presentation etc.)	35

UCC304: **Artificial Intelligence**

L	T	P	Cr
3	0	2	4.0

Course Objective: This course introduces students to the fundamental concepts, techniques, and applications of Artificial Intelligence (AI). Students will gain theoretical knowledge and practical skills in areas such as problem-solving using search techniques, machine learning and designing intelligent agents for solving particular engineering problems

Introduction to Artificial Intelligence: Foundations, scope, types of AI, problems, and approaches of AI
Intelligent agents: Structure of agents, Types of agent programs: reflux, model-based, goal-driven, utility-driven, and learning agents
Problem spaces: State Space Representation, Representation of problems as state space, problem characteristics, sample applications
Uninformed Search Algorithms: Brute Force search, Depth-First Search, Breadth-First search, Depth-Limited Search, Uniform Cost Search, Bidirectional Search
Informed search algorithms: Heuristic Functions, Best-First search, Beam Search, Hill Climbing, A* algorithm, AO graph, stochastic search algorithms: Simulated Annealing and Genetic Algorithm
Game playing: Minimax algorithm, alpha-beta pruning, iterative deepening
Introduction to Machine Learning: Well-Posed learning problems, Basic concepts, Designing a learning system, Types of machine learning: Supervised learning, Unsupervised learning, Semi-supervised Learning and Reinforcement learning, Types of data: structured and unstructured data. **Supervised Learning:** Introduction to supervised learning tasks, Tree induction algorithms: split algorithm based on Information Gain (ID3), split algorithm based on Gain Ratio (C4.5), split algorithm based on Gini Index (CART), Instance based algorithms: K Nearest Neighbours (K-NN), Probabilistic algorithms: Naïve Bayes algorithm, Evaluation metrics
Unsupervised Learning: Introduction to supervised learning tasks, Partitioning-based methods

Laboratory Work (if applicable): Basics of Python programming language: Data Types, Data Structures, Flow Control, Functions, Basic Data Science packages: NumPy, Pandas, SciPy
Implementing Search algorithms in C/C++/Java/Python: Depth first, Breadth first, Hill climbing, best first, A* algorithm, Implementation of games: 8-puzzle, Tic-Tac-Toe, tower of Hanoi and water jug problem using heuristic search
Implementing Machine Learning algorithms: Tree-based methods, K-NN, Naïve-Bayes algorithms, K-Means (from scratch and using sklearn library)

Course Learning Objectives (CLO)
The students will be able to:
1. Analyze methods and theories in the field of Artificial Intelligence and categorize various problem domains.
2. Design intelligent agents for concrete computational problems.
3. Analyze and apply different problem-solving strategies and search algorithms.
4. Implement and evaluate machine learning algorithms for various real-world tasks

Text Books

1. Russel S., Norvig P., Artificial Intelligence: A Modern Approach, Prentice Hall (2014) 3rd ed
2. Murphy, Kevin P. Machine learning: a probabilistic perspective. MIT press, (2012) 3rd ed.

Reference Books

1. Rich E., Knight K. and Nair B. S., Artificial Intelligence, Tata McGraw Hills (2009) 3rd ed.
2. Luger F. G., Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education Asia (2009) 6th ed.

UCE306: ARCHITECTURE DRAWING AND BUILDING CONSTRUCTION

L	T	P	Cr
2	0	2	3.0

Course Objective: To expose students to the concepts of architectural drawings and building construction.

Introduction to Architecture Drawing: Proportion, orientation, building bye laws, site plan, building layout, Architectural and structural working drawings, Modular co-ordination and drawing on modules,

Building structures: Various building components in load bearing and framed structures.

Building information modelling (BIM): Introduction to BIM and basics of modelling.

Foundations: *Shallow foundations:* Continuous, spread, arch, combined, cantilevered, Raft, Grillage, *Deep foundations:* Piles & wells, Footings in block cotton soil, Basement & Retaining walls

Masonry: Stone, Brick & Concrete Block masonry, Bonds and junctions, Walling, Mud wall, Sun-dried bricks, burnt bricks, stones walling, load bearing & non load bearing brick masonry, panel wall and reinforced masonry for multi-storied construction.

Special treatments: Damp Proof Course, points of its requirement in buildings, D.P.C. at Plinth level, in basement and roof tops etc., waterproofing treatments, anti-termite treatment, heat and acoustic insulation of buildings

Lintels & Arches: Location and construction details in wood, brick, stone and R.C.C.

Stairs & Stair cases: Suitability of location, stairs in multistoried buildings, Residential and public buildings, Fire escape, Stairs in timber, stone, brick, RCC and Metal Drawings in Plan elevation and sections. Hand rail & railings, description and sketches of lifts escalators.

Doors & Windows: Details, Location in buildings, sizes, Door-window schedule & construction for wooden & metal, Battened braced, framed, flush and paneled, sliding, folding telescopic, with louvers, collapsible, Revolving doors, Aluminum doors, etc. Windows in timber, aluminium frame & metal casement, double hung, Dormer, Corner, Fanlight, skylight, clear storey etc., and low-cost ideas.

Roofing and Flooring: Types of flooring, Flat roofs: Waffle floor, wooden flooring, channels, cored units etc, inclined roofs.

Miscellaneous: Formwork, scaffolding, underpinning.

Precast and Prefabricated Elements: Pre-engineered buildings (PEB), Prefabricated Prefinished Volumetric Construction (PPVC), Prefabricated components, Assembly at site, joints in prefabricated construction, low-cost housing & hollow blocks.

Laboratory Work

Modelling of building layout and building components in BIM based software

- A two-storey building plan with three/four rooms: Plan, Elevations & Section (Modular), Site Plan (Application of Bye laws), Foundation for walls – Construction details, Proposed doors and windows – Construction details, Roof & floor – details, in construction Stair case details
- Drawings of all the above building components e.g. Brick masonry bonds and junctions, DPC, Lintels and Arches, Stairs, Doors & Windows, Roof &roof coverings
- Drawing and detailing of typical building components

Course Learning Objectives (CLO)

The students will be able to:

1. Plan and draw constructional details of different building components
2. Capable of working with an architect and contractor
3. Prepare building plans and other components for a project
4. Capable of supervising building constructions

Text Books

1. Building Construction and Materials, Singh, Gurcharan, Standard Book House (2019).
2. Building Construction, Sharma, S. K., S. Chand and Company (2012).

Reference Books

3. Building Construction, Kumar, Sushil, Standard Publisher and Distributors (2020).
4. Building Construction, Punmia, B. C., Laxmi Publishing House (2016).
5. National Building Code, Volume-I and Volume-II, Bureau of Indian Standards (2016)
6. IS 962: 2001 Code of Practice for Architectural and Building Drawings, Bureau of Indian Standards

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional: (May include the following) Assignment, Regular Lab assessmentand Quizzes, Project (Including report, presentation etc.)	40

UMA303: **OPTIMIZATION TECHNIQUES IN CIVIL ENGINEERING**

L	T	P	Cr
3	0	2	4.0

Course Objective: The primary objective of the course is to provide students with a comprehensive understanding of optimization techniques applicable to civil engineering problems. The course aims to introduce the fundamentals of optimization methods and delve into the theory of non-advance optimization techniques and algorithms designed for addressing diverse civil engineering optimization challenges. By the end of the course, students will be proficient in applying optimization methods using computational tools

Scope of optimization techniques in civil engineering: Introduction to linear and non-linear programming formulation of different models and it use in civil engineering problems such as structural design, mix-design of concrete, transportation engineering, traffic flow management, route planning, and transportation network design, water distribution/pipe flow, construction planning and scheduling.

Linear Programming: Basics of the geometry of linear programming, graphical method, linear programming (LP) in standard form, solution of LP by simplex method, exceptional cases in LP, duality theory, dual simplex method.

Integer Programming: Branch and bound technique.

Network Models: Transportation problems, assignment problem, construction of networks, network computations, free floats, critical path method (CPM), optimal scheduling (crashing).

Multi-objective Programming: Introduction to multi-objective linear programming, efficient solution, efficient frontier.

Nonlinear Programming: Single-variable, multivariable, unconstrained optimization: unimodal functions, fibonacci search method, gradient method, constrained Optimization: concept of convexity and concavity, Maxima and minima of functions of n-variables, lagrange multipliers, Karush-Kuhn-Tucker conditions for constrained optimization.

Advanced Topics in Optimization: Introduction to evolutionary algorithms for optimization and applications in civil engineering (case study related to optimization methods use in water resources planning & management, water infrastructures, and irrigation and hydropower projects).

Laboratory Work: Lab experiments will be set in consonance with materials covered in the theory using scientific computational techniques

Laboratory Work

1. To determine optimal water flow through each pipe of a water supply network while minimizing the pumping cost
2. To design a steel truss to carry a certain load while minimizing the self-weight and material cost
3. To optimize the design of a concrete mix while minimizing the cost
4. To evaluate the mean speed of vehicles on a highway while satisfying various constraints
5. Case studies related to Optimization techniques commonly used in water resources planning & management, water infrastructures, and irrigation and hydropower projects

Course Learning Objectives (CLO)

The students will be able to:

1. Formulate linear programming problems in civil engineering
2. Solve linear programming problems using simplex methods and its variants
3. Construct and optimize network models and apply it to project management in civil engineering
4. Formulate and solve non-linear programming problems in civil engineering

Text Books

1. S.S. Rao, "Engineering Optimization: Theory and Practice", New Age International Pvt Ltd., New Delhi, 2019.
2. G. Hadley, "Linear programming", Narosa Publishing House, New Delhi, 2002.
3. H.A. Taha, "Operations Research: An Introduction", 9th Edition, Pearson, 2017.
4. K. Deb, "Optimization for Engineering Design- Algorithms and Examples", Prentice-Hall of India Pvt. Ltd., New Delhi, 2006

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessional: (May include the following) Assignment, Regular Lab assessmentand Quizzes, Project (Including report, presentation etc.)	25

Approved in the 109th Senate held on March 16, 2023

SEMESTER-IV

Approved in the 109th Senate held on March 16, 2023

UCC401 : **STRUCTURAL ANALYSIS**

L	T	P	Cr
3	1	2	4.5

Course Objective: This course aims to develop an understanding of techniques of structural analysis to calculate displacements of statically determinate and indeterminate structures. This subject also introduces the concept of drawing influence line diagrams for determinate structures.

Displacements: Geometric Method**:** Conjugate Beam Method**,**Energy Methods: Strain energy in members, Betti's and Maxwell's Laws of reciprocal deflections, Castigliano's theorems, Unit load method for 2D-frames and trusses, Simulation of Unit Load Method for Trusses using Computer Programs

Indeterminate structures: Introduction, Static and Kinematic indeterminacies, Stability of structures, internal forces in two and three-dimensional structure

Analysis of Indeterminate Beams and Frames: Classical Methods: Methods of consistent deformation, Conventional methods of Analysis of rigid frames: Slope deflection method and Moment Distribution Method.

Matrix Methods: Introduction to and Formulation of Stiffness and Flexibility Matrices, Simulation of Stiffness and Flexibility Matrices and their application to Analysis of Structures using Computer Programs

Moving Loads and Influence Line Diagrams for Statically Determinate Beams: Bending moment and shear force diagrams due to single and multiple concentrated rolling loads and uniformly distributed moving loads, equivalent UDL, Muller Breslau principle**:** Influence lines for beams, calculations of the maximum and absolute maximum shear force and bending moment , SF and BM envelopes.

Laboratory Work:

List of experiments:

1. To study the variation of BM at different locations in a simply supported beam.
2. To plot the deflected shape of a simply supported beam and cantilever beam
3. To find the deflection of a pin connected truss
4. To analyze a portal frame with and without sway
5. Simulation of Unit Load Method for Trusses using Computer Programs
6. Simulation of Matrix Methods for analysis of Framed Structures
7. Development and Application of Influence Line Diagram for beams using computer programs

Project: Analysis and Design of Truss structure using software

Course Learning Objectives (CLO)

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

1. Calculate deformation of statically determinate structures
2. Analyze statically indeterminate beams using classical and conventional methods.
3. Develop qualitative diagrams showing the deformed shape, bending moment and shear force diagram for an indeterminate plane frame.
4. Draw influence line diagrams for statically determinate beams
5. Analyze the structures for static and moving loads using computer programs

Text Books

1. Structural Analysis, R. C. Hibbler (9^{th} ed.), Prentice Hall Publishers, 2017.
2. Basic Structural Analysis, C.S. Reddy, Tata McGraw Hill Publishers, 2017
3. Wang, C. K., Indeterminate Structural Analysis, Tata McGraw-Hill Education Pvt. Ltd (2017).

Reference Books

1. Adavnced Structural Analysis, P. Dayaratnam, McGraw Hill Publishers, 2020.
2. Theory of Structures, B.C. Punmia and A.K. Jain, Luxmi Publications 2017.

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional: (May include the following) Assignment/Lab evaluations)	25
4	Project	15

UCC402: GEOINFORMATICS

L	T	P	Cr
3	0	3	4.5

Course Objective: Surveying as a subject in civil engineering aims to provide basic knowledge about the principles of surveying for a location and its application in the design and construction of engineering projects. The students develop skills using surveying instruments, including measuring tapes, theodolites, and advanced measurement equipment, such as laboratory stations, GPS, and drones.

Introduction to Surveying: Definition, classification of surveys, Principle, distorted or shrunk scales, precision in surveying, different types of errors.

Linear Measurements:

(a) Chain and Tape Surveying: Chain surveying, tapes, ranging–direct & indirect, chaining on sloping ground, corrections for linear measurements, offsets

(b) Leveling: Definitions of terms used in leveling, different types of levels, temporary adjustments, benchmarks, booking and reducing the levels, rise and fall method, line of collimation method, errors in leveling, permanent adjustments, corrections to curvature and refraction, setting out grades.

(c) Tacheometry: Definitions and terms used in tacheometry, determination of constants, angular tacheometry with staff vertical and staff inclined, Merits and Demerits; Analytic lens, tangential method of tachometry.

(d) Contours: Definition, representation of reliefs, horizontal equivalent, contour interval, characteristics of contours, methods of contouring, contour gradient, uses of contour maps.

Angular Measurements:

(a) Compass Traversing: Types of compasses, bearings, meridians, declination, the dip of the magnetic needle, bearing of lines from included angles, local attraction.

(b) Theodolite: Types of theodolites, measurement of angles, temporary and permanent adjustments, closed and open traverse, consecutive and independent coordinates, advantages and disadvantages of traversing closing error, Gale's traverse table.

Curve Setting: Types of curves, calculations for simple circular curve and tangential curve, Rankine's method of tangential angle measurements.

Total Station: Working principle and survey with total station

Global Positioning Systems (GPS): Working Principle, Types of GPS, Application of GPS, DGPS-working Principle, DGPS errors (RT & PP).

Remote Sensing and GIS: Introduction to Remote sensing and electromagnetic spectrum, types of sensors, image interpretation-visual and digital, map, scale, and projections.

Photogrammetric surveys: Basic concepts, principles, and applications of photogrammetry,concepts, and applications for map preparation.

Drone Surveying: Introduction to drones, comparison of surveying drone and its accuracy;techniques of controlling errors

Laboratory Work

1. Measurement of distances/offsets, and bearings with chain and tape, and compass
2. Levelling to calculate RLs of various points
3. Measurement of vertical and horizontal angles with theodolite
4. Tacheometric Survey and determination of tacheometric constants
5. Surveying with Total Station
6. Survey with GPS and DGPS
7. Introduction to GIS software

Course Learning Objectives (CLO)

The students will be able to:

1. Survey an area under various topography and obstructions using various instruments
2. Prepare the plan or map of the area surveyed.
3. Set out curve and building layout.
4. Analyze and process satellite data and retrieve information

Text Books

1. Anderson and Mikhail. Surveying Theory and Practice, 7th Edition, McGraw Hill Education (2012)
2. Duggal, S.K. Surveying, Vol.I and II, 5th Edition, (2019)
3. Subramanian,R. Surveying and Levelling,Oxford 2nd edition (2012)
4. Venkatramaiah,C.,ATextBookofSurveying,UniversitiesPress(2011)
5. PK Garg, Introduction to Unmanned Aerial Vehicles, New Age International Publishers New Age International Private Limited; First edition (1 October 2020); NEW AGE International Pvt Ltd.

Reference Books

1. Punmia, B.C., Jain, Ashok Kumar and Jain, Arun Kumar, Surveying Vol.I and II, Laxmi publications (2016)
2. Garvit Pandya, Basics of Unmanned Aerial Vehicles: Time to start working on Drone Technology, Notion Press (6 March 2021)
3. Kike Calvo, So You Want to Create Maps Using Drones?,Bluerb publication (2015)

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional: (May include the following) Assignment, Regular Lab assessmentand Quizzes	40

UCC403 :DESIGN OF CONCRETE STRUCTURES

L	T	P	Cr
3	1	2	4.5

Course Objective:To expose the students to design methodologies of various reinforced concrete elements using manual and programmable techniques

Introduction*:* Reinforced concrete, definition, properties of materials, grades of concrete and reinforcing steel, stress-strain curves, permissible stresses,design philosophies: working stress design, ultimate strength and limit state design method.

Limit State Design Method: Introduction, Limit States, Characteristic values, characteristic strength, service loads, design values for material strength and loads, factored loads.

Limit State of Collapse (Flexure): Types of failures, assumptions for analysis, design of singly rein reinforced, doubly reinforced sections, design of flanged beams, Design of one-way slabs and two-way rect

Limit State of Collapse (Shear, bond and torsion): Introduction - Design for shear, design of structural components subjected to torsion, design of rectangular beam section for torsion, development length, continuation of reinforcement (beyond cut-off points).

Limit State of Serviceability*:* Deflection, effective span to effective depth ratio, modification factors for singly reinforced, doubly reinforced and flanged beams

Limit State of Collapse (Compression): Columns and their classification, reinforcement in columns, assumptions, design of short (both tied and helical) columns subjected to axial load, uniaxial and biaxial bending using SP16 (1980) Interaction diagrams

Limit State Design of miscellaneous structures: Design of isolated footings, Design of staircases.

Detailing of Reinforcement using SP:34 (1987) and Ductile Detailing using IS 13920:2016

Laboratory Work

Project 1: Design of Concrete Mixes of Different Grades, Study of Strength Properties and Flexural Behaviour of RCC Beams

The students will be divided into 4-5 sub-groups. Each sub-group will be required to:

1. Design and development of Concrete Mix of a particular Grade of concrete and estimate its hardened properties and stress –strain curve at 28 days
2. Design under-reinforced RC beams using that particular grade of concrete
3. Test the casted RC beams under flexural loading

Project 2: Development of design Sheets for design of beams, rectangular slabs and short columns, and validation of the same using STAAD Pro. Detailing of the Reinforcement of structural elements using AutoCAD

Course Learning Objectives (CLO)

Upon completing this course, the students can:

1. Analyse the flexural members
2. Design and Detail the flexural member with consideration for deflection, shear, bond and torsion
3. Design and detail compression members
4. Design other elements such as footings, stair-case
5. Prepare programmable sheets for design of structural elements and detail the same

Text Books

1. Reinforced Concrete Design, Gambhir, M. L., Prentice Hall of India(2013).
2. Limit State Design of Reinforced Concrete, Jain, A. K.,Arun K. Jain, Dr. Punmia, Laxmi Publications (2016).
3. Limit State Design, Ram Chandra, Standard Book House(2014).
4. Limit State Design of Reinforced Concrete Structures, P. Dayaratnam, P Sarah, Meditech, 2nd Edition, (2017)
5. Design of Reinforced Concrete Structures, N. Subramanian, Oxford University Press, (2013)

Reference Books

1. Reinforced Concrete Design, Pillai &Menon, Tata McGraw Hill Publishers(2022).
2. Limit State Design of Reinforced Concrete, Varghese, P. C., Prentice Hall of India(2008).
3. Fundamentals of Reinforced Concrete, Sinha, S. N. and Roy, S Chand Publishers(2014)

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional: (May include the following) Assignment, Regular Lab assessmentand Quizzes, Project	40

UCC404: FUNDAMENTALS OF DATA SCIENCE

L	T	P	Cr
3	0	2	4.0

Course Objective: To elaborate the basics of data science and provide a foundation for understanding the challenges and applications in the field of civil engineering.

Data Science Introduction: Data and types, Big Data and Distributed Databases, Application and purpose of data, Data Science, The data science process.

Introduction to R and RStudio: Installing and configuring RStudio, R Packages, Basic syntax, variables, Operators, Data types, Control Flow, Sequence Generation (range function), StringOperations, Functions, Loop Functions and Debugging (lapply, apply, mapply, tapply, split, Diagnosing), Simulation & Profiling (Random Number, Linear Model, Random Sampling), File Handling in R (Reading different files in R), Introduction to Swirl, Regular Expression.

Data Cleaning and Summarization: Matrices, Factors, Data Frames, Vectors, Lists, Data Cleaning and reading data from different data source, Reading Large Tables, Subsetting and Sorting, Summarizing Data, Creating New Variables, Reshaping Data, Managing Data Frames with dplyr – Introduction, Managing Data Frames with dplyr - Basic Tools, Merging Data

Data Visualization in R: Setting Your Working Directory (Windows), Principles of Analytic Graphics, Lattice Plotting, Base Plotting System, Plotting using ggplot2/Matplotlib library (Histogram, Box Plot, Scatter Plot, Bar Graphs, Line Graph, etc). Data visualization in civil engineering.

Data Science Advance Topics in R: Basics of Correlation, Regression, Stochastic analysis, Working with Color in R Plots, Dimension Reduction:(Principle Component Analysis, Singular Value Decomposition), Model Evaluation Parameters.

Laboratory Work

Implementation of various data analysis techniques to civil engineering problems

Course Learning Objectives (CLO)

The students will be able to:

1. To manage, manipulate, clean, and analyze different types of data
2. To visualize data using different visualization techniques
3. To develop dashboards for real-time data sets
4. To understand data correlation, reduction, and summarization

Text Books

1. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining Concepts and Techniques, (4th Ed.), Morgan Kaufmann (2022)
2. Roger D. Peng, R Programming for Data Science, Leanpub (2016)

Reference Books

1. Trevor Hastie Robert, Tibshirani Jerome Friedman, The Elements of Statistical Learning, Springer (2017)

UMA012: NUMERICAL AND STATISTICAL COMPUTATIONS

L	T	P	Cr
3	0	2	4.0

Course Objective: The main objective of this course is to understand and implement various numerical and statistical methods to solve civil engineering problems.

Basic of Errors: Floating-point representation, rounding and chopping errors.
Non-Linear Equations: Bisection, Newton - method for simple and multiple roots and order ofconvergence.
Linear Systems and Eigen-Values: Gauss elimination method using partial pivoting, Gauss--Seidel method,
Rayleigh's power method for eigen-values and eigen-vectors of matrix.
Interpolation and Approximations: Lagrange (with error analysis), Newton's divided difference andforward difference interpolation formulas**.**
Numerical Integration: Newton-Cotes quadrature formulae (Trapezoidal and Simpson's rules) and theirerror analysis**.**
Differential Equations: Solution of initial value problems using Euler's, Modified Euler's and Runge-Kutta methods (fourth-order), Solution of boundary value problems using finite difference method.
Curve Fitting and Regression: Curve fitting by the method of least squares- fitting of straight lines, second
degree parabolas, Bivariate distribution, correlation coefficients, regression lines, formula for regressioncoefficients and rank correlation (only two variables).
Probability Distribution: Mathematical expectations, Definition of probability distribution (ProbabilityMass Function and Probability Density Function), Poisson, Binomial, Exponential, Uniform and Normaldistributions.
Laboratory Work: Lab experiments will be set in consonance with materials covered in the theory. Implementation of numerical and statistical techniques using computational software to solve following civil engineering problems:
1. Non Linear Equation: A simply supported beam problem to find the point (s) of zero shear and zero moments.
2. Linear System and Eigen Values: Column problem subjected to axial load and bi-axial moments and to find the principal normal stresses and the direction cosine of the normal principal stresses.
3. Interpolation and Approximation: Find the Water levels of reservoir at intermediate points.
4. Numerical Integration: Find the capacity of a reservoir.
5. Differential Equation: Finding the solution of a single degree of freedom (SDOF) subjected to free and forced vibration.
6. Curve Fitting: Annual rainfall and runoff Analysis to estimate annual runoff volume for a given annual rainfall value.
7. Probability Distribution: Transportation Engineering Problem to get the mean speed for highway design.

Course Learning Objectives (CLO)

The students will be able to:

1. Obtain numerical solution of nonlinear equations using bisection and Newton-Raphson methods.
2. solve system of linear equations numerically using direct and iterative methods.
3. construct interpolating polynomials with practical exposure and analyze the correlated data using linear regression models.
4. solve integration and initial value problems numerically. .
5. solve civil engineering problems using various probability distributions.

Text Books

1. E. Ward Cheney and David R. Kincaid, Numerical Mathematics and Computing, Cengage, 2013.

2. Walpole, Ronald E., Myers, Raymond H. Myers, and Sharon L. Myers, Probability and Statistics for Engineers and Scientists, 9th edition Pearson Education, 2012

Reference Books

1. Burden L. R., Faires D. J. and Burden A.M., Numerical Analysis, Brooks Cole, 10th edition, 2015.
2. Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers, McGraw-Hill Higher Education; 7th edition, 2016.
3. M.K. Jain, S.R.K. Iyengar, and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International, 2022.
4. Richards A. Johnson, Probability and Statistics for Engineers, 9th Edition, PHI Learning,2018

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessional: May include lab assignments/quizzes	15
4.	Laboratory evaluation	20

SEMESTER-V

Approved in 114th Meeting of the Senate held on March 7, 2025

UCC501: GEOTECHNICAL ENGINEERING-I

	L	T	P	Cr
Prerequisite(s): NIL	**3**	**1**	**2**	**4.5**

Course Objectives: This subject aims to develop an understanding of soil as civil engineering material and to introduce the students about the basic concepts and principles of soil mechanics. Further they will be introduced to the concepts of compaction, consolidation and determination of shear strength of soil.

Introduction: Soil formation, various soil types.

Phase relationships: Index properties, sieve & hydrometer analysis, Atterberg's limits, sensitivity, thixotropy, and plasticity charts. Determination of engineering properties of soil. Indian standard and Unified classification systems of soils.

Clay Mineralogy: Introduction to Clay minerals their characteristics. Soil structure.

Seepage and Permeability: Darcy's law, validity of Darcy's Law, seepage velocity, factors affecting permeability, Laboratory and field determination of permeability. Flow net and its properties, Laplace equation, methods of drawing flownet, seepage through earth dams, exit gradient and seepage pressures, phenomenon of piping and heaving, filters. Anisotropy, Permeability of layered soils.

Effective Stress Principle Capillarity, types of head, seepage forces, quick sand condition, and critical hydraulic gradient.

Compaction: Compaction tests as per IS code, OMC, factors affecting compaction, control of compaction, field compaction equipment and their suitability.

Stresses in Soils: Stresses beneath various loaded areas, Boussinesq and Westergarrd's formulae, pressure bulbs, Newmark's chart. Approximate methods.

Consolidation: Terzaghi's theory, time rate of consolidation, consolidation test, Compressibility & Coefficient of Consolidation, NC, OC soils, determination of pre-consolidation pressure, settlement analysis, secondary consolidation.

Shear Strength: Definition, Mohr's stress circle, Mohr-Columb strength theory, direct, triaxial, unconfined and vane shear tests. Drainage conditions, Concept of pore pressure coefficients, shear characteristics of normally consolidated, over consolidated clays and dense and loose sands, Dilatancy, residual strength.

Laboratory Work:

The students will be introduced to Index and Engineering properties of soils to complement the theory component of the course by performing experiments. They will perform related experiments as per BIS specifications.

1. Determination of field density by Core cutter & Sand replacement method
2. Grain size Analysis by Mechanical method.
3. Determination of Relative density of coarse grained soils in dry and saturated conditions.
4. Determination of Specific Gravity by Pycnometer.
5. Determination of Atterberg's limits.
6. Determination of Permeability by constant head & variable head permeameter.
7. Determination of Coefficient of Consolidation by Consolidation Test.
8. Determination of OMC and MDD by IS standard Compaction test.
9. Determination of Unconfined compressive strength

10. Determination ofshear strength Direct Shear Test.

Experimental Project/assignment/Micro Project: Students in groups of 4 to 6 will do the projects

1. Bringing soil samples from the field classify them by performing lab tests and then determining the optimum moisture content and maximum dry density.
2. Based on OMC and MDD they will prepare samples for determination of CBR.

Course Learning Outcome(CLO):

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

1. Determine the index and engineering properties of soil
2. Evaluate the influence of water on engineering properties of soil
3. Evaluate the compressibility characteristics of soils in engineering practices
4. Determine the shear strength of soils by various methods

Text Books:

1. *Gopal Ranjan& A.S.R. Rao, Basic and Applied Soil mechanics, New Age Publisher, New Delhi (2016)*
2. *V.N.S. Murthy, A text book on Soil Mechanics and Foundation Engineering, U.B.S. Publisher, New Delhi.(2005)*
3. *Parshotham Raj, Geotechnical Engg., Pearson , New Delhi.(2013)*

Reference Books:

1. *Das B.M., Principles of Soil Mechanics, Thomson Publisher, USA. (2015)*
2. *Venkatramaiah Geotechnical Engg., New Age Publisher, New Delhi. (2012)*
3. *Singh Alam Modern Geotechnical Engineering, CBS Publishers, New Delhi.(2014)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weights (%)
1.	MST	30
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UCC503: DESIGN OF STEEL STRUCTURES

L	T	P	Cr
3	1	0	3.5

Course Objectives: This subject aims to develop an understanding of the design of steel sections when subjected to various kinds of external loads. The basic structural members like tension member, compression member and beams along with their connection will be designed.

Introduction: Loads, structural steels and their specifications, structural elements, design specifications as per IS: 800, structural layout, strength and stiffness considerations, efficiency of cross-section, safety and serviceability considerations as per IS2062-2011

Bolted and Welded Connection: Types of Bolts, advantages and disadvantages of bolted connections, failure of bolted joints, design of concentric bolted joint, efficiency of a joint. Design of Eccentric bolted connections.

Welded Connection: Types of welded joints, design of welded joint subjected to axial loads.

Tension Members: Types of tension members, net area, net effective area for angles, tees, design of tension members, tension splice, and lug angles.

Compression Members: Axially loaded columns, effective length, slenderness ratio, allowable stresses, general specifications, design of axially loaded members, laced and battened columns and their design, built-up compression members.

Column Bases: Introduction, slab base.

Plastic Design: Introduction, advantages and disadvantages. theory of plastic bending, plastic hinge mechanism, collapse load analysis, static and mechanism method, distributed loading, design consideration.

Flexural Members (Beams): Design criteria, permissible stresses, laterally supported beams and their design laterally unsupported beams and their design, web buckling, web crippling.

Project/assignment/Micro Project: Students will be required to design a tension member in Excel and STAAD Pro.

Course Learning Outcomes (CLO): Upon completion of this course, the students will be able to: 1. Design tension members

2. Design the bolted and welded connections between various structural components
3. Design compression members and column bases with and without eccentric loading
4. Find out ultimate load of the structural systems using plastic analysis
5. Design flexural members

UCC502: TRANSPORTATION ENGINEERING

	L	T	P	Cr
Prerequisite(s): NIL	**3**	**0**	**2**	**4.0**

Course Objective: The objective of the course is to enable students' study different aspects of transportation engineering such as to analyze& design various road & airport pavement structures using various software's, to differentiate between the various types of pavement layers & to perform the detailed geometric design for road, railways & airport projects using various computing tools.

Geometric Design: Introduction, Highways Classification, right of way, Width of formation, Sight Distances, stopping site distance, overtaking sight distance, overtaking zones, camber, Road Curves, Transition Curves, Super elevation, Widening at curves, IRC codal recommendations for various geometric design parameters, Application of Mx-Road Software for the geometric design, Geometric design for railways & airport projects, Road Safety Audits, Highway capacity & Intersection design. Road user characteristics, Importance of traffic studies, spot speed, speed and delay and origin and destination studies.

Design & Construction: Factors affecting design of pavements, design principles & design procedures as per IRC 37 guidelines, Design of PQC pavements as per IRC 58 guidelines, Use of software's IITPAVE, KENPAVE for design of highway pavements, Design of airport pavements as per FAA guidelines, Application of FAARFIELD software for design of airport pavements. Specifications & construction method statements for various pavement layers & permanent way section. Importance & Principles of Drainage, Surface Drainage & Sub-Surface drainage

Failures of flexible and rigid pavements & Highway Maintenance: Causes of Failures and Remedial Measures, Maintenance of flexible and rigid pavements, pavement evaluation and its strengthening method, overlay design using IRC 81 & IRC115 guidelines, use of software's kgpback& ELMOD for overlay design of highway pavements, LCN-PCN concept for airport pavements, COMFAA software for airport pavements evaluation, concept of thin & ultrathin white toppings, design & scheduling of maintenances activities, development of Pavement maintenance management systems for different categories of roads, Economic Evaluation of Highway Projects and Life Cycle Costing Concept using HDM-4 software / any other soft computing techniques.

Laboratory Work*:* The students will perform various quality control tests as per Indian Road Congress (IRC) & Ministry of Road Transport & Highways (MORTH) specifications for the various layers of the pavement section. Paving bitumen & bituminous mix testing like penetration value, softening point, viscosity & binder rheology, ductility value, centrifugal extraction, aggregate strength tests, pavement layer gradation & mix designs for various pavement layers, Deflection studies for pavements.

Software's application for the course:

i IITPAVE
ii KENPAVE
iii KGPBACK
iv ELMOD
v FAARFIELD
vi COMFAA
vii Mx ROAD

Experimental Project/assignment/Micro Project: Students in groups of 4 to 6 will do the projects:

1. Design the flexible pavement as per IRC 37 guidelines for the given traffic data using various software's.
2. Design the rigid pavements as per the IRC 58 guidelines for the given traffic data using various software's.
3. Pavement Maintenance Management system using HDM-4 / other soft computing techniques.

Course learning Outcome (CLO):

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

1. Quantify the specifications for various construction materials / pavement layers / permanent way layers.
2. Perform geometric design for highways, railways & airport projects using various software's.
3. Perform analysis and design of flexible and rigid pavements for highway & airport pavements using various software's.
4. Develop the pavement maintenance management systems & perform the life cycle cost analysis of the highway / airport projects using HDM-4 / other soft computing techniques.

Text Books:

1. Khanna S.K. and C.E.G. Justo, HighwayEngineerin, Nemchand Bros (2017).
2. Kadyali L. R.; Highway Engineering, Nem Chand & Brothers, Roorkee (2018).

Reference Books:

1. Sharma & Sharma; Principle and Practice of Highway Engineering, Asia Publishing House, New Delhi (2010).
2. G.V.Rao, Tata McGraw Hill, New Delhi "Principles of Transportation and Highway Engineering" (1996)
3. Yoder E. J.; Principles of Pavement Design, John Wiley & Sons (2011)

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weights (%)
1.	MST	30
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UCC504: SURFACE HYDROLOGY

L	T	P	Cr
3	1	0	3.5

Course objective: The overall objective of this course is to impart knowledge of the engineeringaspects of the water science. The students will learn various components of hydrologic cycle, its processes, measurement and their engineering application. This course will also provide the exposure of software to students in solving the real-life problem.

Introduction: Hydrologic cycle, Scope and Applications.
Probability and Statistics in hydrology: Probability and random variables, Distribution function, Estimation of parameters, Correlation and Regression analysis using statistical softwares.
Precipitation*:* Measurement by rain gauge and other methods, estimation of missing data, consistency of records, optimum number of rain gauge station, mean precipitation, presentation and analysis of rainfall data.
Abstractions from Precipitation: Evaporation, factors affecting evaporation, measurement, infiltration, factors affecting infiltration, measurement, infiltration indices.
Stream flow: Run-off estimation, rainfall-runoff correlation, SCS-CN method, Stream flow measurement using various methods, flow duration curve, Flow mass curve, hydrographs, base flow separation, unit hydrographs and its application, synthetic unit hydrograph.
Floods Frequency analysis: Peak flood estimation, Flood frequency analysis, flood routing.
Software application: Watershed delineation and rainfall-runoff modeling using watershed model.

Course Learning Outcomes:

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

1. Perform analysis on different components of hydrological cycle.
2. Estimate the runoff generated from watershed using various methods/techniques.
3. Apply the principles of flood frequency analysis and flood routing to forecast floods.

Text Books:

1. *Subramanya, K., Engineering Hydrology, Tata McGraw-Hill Publication(2015)*
2. *Reddy, Jaya Rami., A textbook of Hydrology, University Science Press, New Delhi (2014)*
3. *Raghunath, H. M., Hydrology: Principles, analysis and Design, New Age International Publishers(2015)*

Reference Books:

1. *Chow, V.T., Maidment, D.R., and Mays, L.W., Applied Hydrology, Mc-Graw-Hill International Editions, New York (2006)*
2. *Misstear, B., Banks, D., and Clark, L., Water Wells and Boreholes, John Wiley& Sons Ltd, UK(2013)*
3. *Shaw, E.M., Beven, K.J., Chappell, N.A., and Lamb, R. , Hydrology in Practice, Spon Press, New York(2014)*
4. *Viessman, W. and Lewis, G.L., Introduction to Hydrology, Prentice Hall of India Pvt Limited, New Delhi (2012)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weights (%)
1.	MST	30
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

SEMESTER-VI

UCC601: GEOTECHNICAL ENGINEERING-II

L	T	P	Cr
3	0	2	4.0

Course Objective: This subject aims to expose the students to geotechnical design of different types of shallow and deep foundations. Further they will be expose to understanding of earth pressure for stability of retaining structures along with various techniques for stability of slopes.

Soil Exploration: Introduction to soil exploration, scope, soil exploration for different structures, spacing, significant depth, boring and sampling techniques, bore hole plan, types of samples, penetration test (SCP and SPT), sample disturbances and Geophysical methods.
Earth Pressure: At rest condition, states of plastic equilibrium, Rankine and Coulomb's theories for active and passive conditions, Lateral Earth pressure in layered soils. Stability of cantilever Retaining wall.
Stability of Slopes: Infinite slope, types of failure, total and effective stress analysis, Taylor's stability numbers, concept of factors of safety, method of slices, modified method of slices, Swedish's circle method.
Bearing Capacity: Definitions, introduction to shallow and deep foundation, depth of foundation, Concept of net and gross bearing capacity. Terzaghi's general bearing capacity equation, IS code equation, factors affecting bearing capacity. Settlements for clays and sands, permissible settlements, bearing capacity by penetration tests, Influence of eccentric and inclined loads, plate load test.
Pile Foundations: Types, function, selection of piles, pile driving formulae, equipment, point, bearing and friction piles. Load carrying capacity of single pile, group action, spacing of piles, Negative skin friction, settlement of pile groups, under-reamed piles.
Caissons and Wells: Introduction, components, shapes, Construction and sinking of well, tilts and shifts.

Laboratory Work:
The students will be introduced to various laboratory & field experiments as per BIS specifications.

1. Determination of bearing capacity by Standard Penetration test.
2. Determination of bearing capacity by Plate load test.
3. Determination of bearing capacity by static and dynamic cone Penetration test.
4. Numerical modelling and simulation of earth retaining systems
5. Numerical modelling and simulation of slopes,
6. Numerical modelling and simulation of shallow foundation systems,
7. Numerical modelling and simulation of deep foundation systems

Course learning Outcome:
After completion of this course, the students will be able to:

1. Design and analyze problems related to shallow and machine foundations
2. Analyze lateral earth pressure for design of earth retaining structures
3. Assess stability of natural/man-made slopes under varying in-situ material properties
4. Design and analyze problems related to pile and well foundations

Text Books

1. *Gopal Ranjan& A.S.R. Rao, Basic and Applied Soil mechanics, New Age Publisher, New Delhi (2016)*
2. *Murthy V.N.S., Advanced Foundation Engineering, C.B.S. Publisher, New Delhi .(2017)*
3. *Parshotham Raj, Geotechnical Engg., Pearson , New Delhi .(2013)*

References Books

1. *Bowles J.E., Foundation Analysis and Design, McGraw Hill Book Company, New York .(2009)*
2. *Das B.M., Principles of Soil Mechanics, Thomson Publisher, USA. (2015)*
3. *Saran Swami, Soil Dynamics and Machine Foundations, Galgotia Publishers, New Delhi .(2016)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weights (%)
1.	MST	30
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UCC602: ENVIRONMENTAL ENGINEERING

L	T	P	Cr
3	1	2	4.5

Course Objective: To introduce the water supply and sanitation systems, designing the components and suitable treatment processes associated with the water supply and sanitation systems. This course will also provide the exposure of software to design the water supply distribution system

Water and water supply system: Source of water, impurities in water and their effect, domestic water quality standards; water demand and quantity estimation, Intakes, distribution of water, and design of distribution system.

Water treatment*:* Water treatment plants and components; Sequencing of unit operations and processes, coagulation-flocculation, slow sand and rapid gravity filtration, disinfection, softening, ion exchange and adsorption.

Wastewater system: Quantification of sewage; Characterization of sewage; Types of sewerage systems; Hydraulic design of sewers, sewer outfalls and sewer appurtenances

Waste water treatment: Components of domestic wastewater treatment, Screening, Grit removal, sedimentation, biological processes, microbial growth kinetics, aerobic and anaerobic process, nitrification and denitrification, trickling filter, Activated Sludge process, sludge digestion process, Waste stabilization pond systems, Anaerobic stabilization units, UASB reactors, Natural wastewater treatment systems.

Software application: Design of water supply distribution system using Water GEMS/EPANET.

Laboratory work:

pH, acidity, alkalinity and hardness testing; DO, BOD and COD; Solids (TSS, VSS and TDS); Nutrients(TKN, TN and TP); SVI and Settling tests; Chlorination, residual chlorine and MPN test; Oil and grease and pesticides; Iron, fluorides, sulfates, chlorides, sulfides and phenols

Course Learning Outcomes (CLO):

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

1. Characterize water and wastewater
2. Evaluate and design a suitable municipal water treatment unit
3. Evaluate and design a suitable sewerage treatment unit

Text books:

1. *Garg,S.K,EnvironmentalEngineering,Vol.I,.KhannaPublishers,New-Delhi.*
2. *CPHEEO ManualonWaterSupplyandTreatmentbyMinistryofUrbanDevelopment,NewDelhi.*
3. *CPHEEO Manualonsewerageandsewagetreatment,MinistryofUrbanDevelopment,NewDelhi.*

4. *P.N.* Modi*;SewageTreatmentanddisposal&WasteWaterEngineering,StandardBook House New-Delhi.*

Referencebooks:

1. *Metcalf Eddy, WastewaterEngineering,McGrawHill.*
2. *Peavy,RoweandTchobanglous,EnvironmentalEngineering,McGraw Hill.*
3. *Fair,Geyer&Okun, WaterandWasteWaterEngineering (Vol.1 & 2),JohnWiley,NewYork.*
4. *Sawyer,McCarty&Parkins,EnvironmentalChemistry,McGrawHill.*
5. *StandardMethodsfortheExaminationofWaterandWasteWater,AmericanPublicHealthAssociation.*

UCE513: CONSTRUCTION MANAGEMENT

L	T	P	Cr
3	0	2	4.0

Course Objective: This subject aims to develop an understanding of principles and techniques of estimating construction costs, with emphasis on quantity take-off and pricing elements of work. It also covers the basic principles, techniques, and practices used as management tools by contractors to plan, schedule, and control time and costs on building various infrastructure projects.

Quantity Surveying and Cost Estimation: Quantity survey measurements, Bill of quantities, analysis of rates for different items of work, Specifications and Units of different items of work, Detailed Estimate of various items of Building and Pavements using MS Excel, Common schedule of rates for different items of works, Bar Bending Schedule

Contracts: Typesofcontractsandtheircharacteristics,procedurefortendering/e-tendering and contracts, BOT, DBFOT, PPP & HAM financial models, evaluation and examination of tenders, award of work, Joint Ventures, Concession Agreements,

Network Techniques: Methods of Scheduling-Gantt Chart, Bar chart, Development of Bar charts and Gantt chart, Merits & limitations of Bar chart & Gantt chart. Concept of CPM & PERT: Introduction to Critical path method (CPM), Program evaluation & review techniques (PERT), Network Diagramming of Projects Activity-on arrow (AOA) Diagrams- Concept of Activity and Event, Time-Analysis of Networks- Forward Pass, Backward Pass, Probabilistic Durations- Optimistic Time, Pessimistic Time, Most Likely Time, Project Scheduling- ES and LS Schedules as Limits, Resource Scheduling, Time/Cost Trade-off Definitions, functions & characteristics of project planning and principles of project Planning and Management, Bar milestone charts, Planning and scheduling with PERT / CPM, Time cost optimization, Probability concepts Allocation of resources and resource levelling, Updating, Application of software for Project planning, scheduling.

Experimental Project/Assignment/Micro Project:

1. Complete cost estimation of the building or highway project using MS Excel
2. Development of a contract document for the infrastructure project.
3. Planning & Scheduling of infrastructure project using software.

Course learning Outcomes(CLO):

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

1. Perform the rate analysis for the various construction activities
2. Estimate the cost for the building and the road projects
3. Perform the project planning, scheduling, and time-cost optimization of the project.
4. Perform resource allocation and project controlling of the project

TextBooks:

1. *Kohli D. D.; A Text book on Estimating and Costing and Accounts, S. Chand &Company New Delhi(2013)*
2. *R.L.Peurifoy,W.B.LedbetterandC.J.Schexnayder,"Constructionplanningandmethods",Fiftheditions,Mc Graw Hill Internationaledition(2010)*

Reference Books:

1. *SeetharamanS.,ConstructionEngineeringandManagement,UmeshPublicationDelhi(2017)*
2. *PunimaB. C. and Khandelwal; Project Planning and Control with PERT andCPM,LaxmiPublication New Delhi(2016)*
3. *K.K.Chitkara,Constructionprojectmanagement:planning,schedulingandcontrolling,TataMcGraw-Hill.(2014)*
4. *L.S.Srinath,PERTandCPMprinciplesandApplication,Thirdedition,Affiliatedeast-westpressPvtLtd(2001)*
5. *J.Singh,HeavyConstruction-Planning,equipmentandmethod,Oxford&IBHPublishingCo.Pvt(2001)*
6. *DattaB.N.EstimatingandCostinginCivilEngineering,U.B.S.Publisher(2016)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessional(include Assignments/Projects/Tutorials/Quizzes)	35

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SEMESTER-VIII

UCC801: EARTHQUAKE ENGINEERING & SIMULATION

L	T/D	P	Cr
3	0	2	4

Course Objective: This course will be providing insight into analysis and design of structures to withstand earthquake forces and a hands-on training for earthquake analysis simulation using structural analysis program.

Earthquake Genesis and Vibration of Structures
Causes of earthquake and its propagation, Basic conceptsof structural vibrations in Single-Degree and Multi-Degree of Freedom systems.Characterization of ground shaking and strong ground motions, Seismic hazard assessment – Deterministic and Probabilistic.

Seismic Analysis and Simulation of Buildings-
Seismic design philosophy for RC buildingsas per Indian Standard (IS) 1893 (Part-1)-2016, Development of IS design response spectrum and site specific response spectrum using software, Seismic analysis of buildings–Static and Dynamic analysis procedures using IS 1893:2016.Computer simulation for earthquake response using structural analysis software. Seismic performance assessment using software.

Seismic Design and Simulation of Building Components:
Capacity based design, Introduction to Indian Standard, IS 13920-2016 for ductile detailing, Application of IS for detailing provisions of structural elements in RC buildings. Computer simulation for earthquake resistant design using structural design software.

Course learning Outcome (CLO):

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

1. Understand concepts and fundamentals related to seismology& seismic hazard assessment.
2. Evaluate lateral forces in buildings for seismic loads using IS provisions and computer simulation
3. Understand ductile detailing provisions in building components using IS provisions and computer simulation

Practical/Lab: Seismic analysis and design simulation for a 3-storeyed structure based on Indian Standards, and estimation of seismic performance.

TextBooks:

1. Pankaj Agarwal, andManish Shrikhande,EarthquakeResistantDesignof Structures, PHI(2022).
2. Mario Paz and William Leigh,StructuralDynamics(TheoryandComputation),Kluwer Academic Publishers, London (2004).
3. Srinivas Vasam and K. Jagannadha Rao, Structural Dynamics and Earthquake Engineering, Publisher: S.K. Kataria & Sons, (2018) ISBN 10: 9350146541 / ISBN 13: 9789350146545

ReferenceBooks:

1. *ChopraA.K.,Dynamicsofstructures – Theory and Applications to Earthquake Engineering,PearsonEducation(2016).*
2. *Roberto Villaverde, Fundamental Concepts of Earthquake Engineering, CRC Press, (2009), ISBN 9781420064957*

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weightage(%)
1.	MST	25
2.	EST	35
3.	Sessional (May include Assignments/Projects/Tutorials/Quizzes)	40

ELECTIVE-I

UCC611: BUILDING INFORMATION MODELLING IN CONSTRUCTION

L	T	P	Cr
1	1	4	3.5

Course Objectives:

The objective of this course is to provide students with a comprehensive understanding of Building Information Modeling (BIM) in civil and structural engineering. The course covers BIM standards, data integration, and modeling workflows to enhance collaboration across disciplines. Students will gain expertise in modeling concrete, steel, and precast structures, along with advanced scheduling and detailing techniques. The curriculum also introduces cloud-based worksharing, BIM model coordination, and clash detection to ensure efficient project execution. Additionally, the integration of 4D (time) and 5D (cost) BIM, along with infrastructure design using industry-relevant software.

BIM STANDARDS AND PROCESSES FOR CIVIL AND STRUCTURAL ENGINEERING

Base data for civil and structural BIM, Infrastructure Structure modelling workflows; Federation of structural models with models from other disciplines and the legal implications; Family creation / Intelligent parametric libraries; Data/information exchange with structural analysis software.

CONCRETE, STEEL AND PRECAST MEMBERS MODELING

Advanced modelling technique, scheduling of precast concrete elements, rebar detailing, and creation of schedule.

PHYSICAL & CLOUD WORKSHARING

Introduction of physical and cloud worksharing methodologies within a common data environment. Integrate and real-time collaborate with Architecture Engineering and Construction.

BIM MODEL COORDINATION AND CLASH DETECTION

Modelling of RCC Structures and Prefabricated components for clash detection. Identification and resolution of clashes or conflicts in a 3D digital model, ensuring seamless collaboration among various disciplined involved in Civil Engineering project

4D, 5D BIM

Integration of time (4D) and cost (5D) dimensions within the BIM process in the project.

DESIGN AND MODELING OF ROADS

Build models automatically from maps, road design and traffic simulation, Simulation of drainage systems, bridges, watersheds, and slopes. Conceptual and detailed design using BIM based software and InfraWorks together. Design intersections, road widenings, and diverse road cross-sections.Conceptually and precisely design roads and buildings.

Project: Hands-on experience in modelling, articulating, perform tasks and collaborate in a project.

Course learning Outcome (CLO):

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

1. Apply advanced modeling techniques for reinforced concrete, steel, and precast elements, including scheduling, rebar detailing, and element management.
2. Integrate physical and cloud-based work-sharing methodologies within a common data environment to enhance collaboration in AEC projects.
3. Utilize BIM tools for project time (4D) and cost (5D) in construction projects.
4. Apply BIM methodologies for road design, traffic simulation, drainage systems, and landform modeling using tools.

Reference Material

1. H. Savla, C. Chavan, P. Patil., "*Building Information Modeling: Global & Indian Perspective*". Notion Press Publisher, 2021
2. K. Bava& B. Sinha Building Information Modeling, Bio-Green Books, 2023

EvaluationScheme:

Sr. No.	**EvaluationElements**	**Weightage (%)**
1	MST	25
2	EST	35
3	Sessional(Tutorials & Project)	40

UCE831: BRIDGE ENGINEERING

L	T	P	Cr
3	1	0	3.5

Course Objectives: The course introduces various components of bridges and their various types ~~and~~. Standard loading standards developed by IRC which form a consistent basis for design are introduced. The course provides a lucid exposition of the theory and design of RC box culverts and T- Beam Bridges. The course covers the theory and design of superstructure and substructure (piers and abutments), bearing and foundations.

Introduction: Definition, components of a bridge, classifications, the importance of bridges.

Investigation of Bridges: Need for investigations, selection of bridge site, preliminary data to be collected, subsurface investigations for a bridge,design discharge and its determination, clearance above HFL, scour depth.

Standard Specifications: Road bridges, I.R.C. loadings, code provisions on width of carriageway, clearances

RC T-beam Bridges: Introduction, ***Design of Superstructure and Substructure***

Design of Superstructure: Design of *Two-way Deck Slab* using Pigeaud's Curves, Courbon's Theory, Design of *Longitudinal and Cross Girders*

Design of Substructure: Various types of expansion bearing and fixed bearings, Design of *Elastomeric Laminated bearings*, Design of *Abutment*

Pile Foundations: Overview, Design of Pile Cap

RC Box Culvert: *Components, Design loadings, Design of single cell box culvert*

Minor Project: Design of single cell box culvert for different classes of IRC loading using software

Course Learning Outcomes (CLO):

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

1. Specify various sub-surface investigations required for bridge construction and their application to bridge design
2. Implement standard loading specifications for bridge design followed by IRC codes.
3. Design various components of superstructure of T-beam bridges
4. Design various components of substructure and foundation of T-beam bridges
5. Design single cell box culvert on software

Text Books:

1. Victor, D.Johnson, Elements of Bridge Engineering, Oxford and IBH Publishers, New Delhi(2009)
2. Vazirani&Ratwani, Design of Concrete Bridges, Khanna Publishers, New Delhi(2010)

3. Raju,N.Krishna,Designof Bridges, 5th Edition, OxfordandIBH (2019)

Reference Books:

1. Raina, V.K., Analysis, Design and Construction of Bridges, Tata McGraw Hill (2010)
2. Jagadeesh T.R., Jayaram M.A., Design of Bridge Structures, 3rd Edition, PHI (2020)

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weights (%)
1.	Mid Semester Test	30
2.	End Semester Test	40
3.	Sessionals (Includes Assignments/Projects/Quiz Evaluations/Tutorials)	30

UCC612: Railway & Airport Engineering

L	T	P	Cr
3	1	0	3.5

Course Objectives: This subject aims to develop an understanding of the structural & geometrical design of various components of railway track & airport pavements as per the latest standards & software's.

Railway Engineering:

Permanent way specifications& design: Gauges in railway tracks, typical railway track cross-section, coning of wheels**,** Rails: Function of rails, requirement of rails, types of rail sections – comparison of rail types, length of rail, rail wear, rail failures, creep of rails, rail fixtures and fastenings, Sleepers: Functions and requirements of sleepers, classification of sleepers, comparison of different types of sleepers, spacing of sleepers and sleeper density**,** Ballast: Function and requirements of ballast, types, comparison of ballast materials, cross-section design of permanent way.

Geometric design: Alignment design, horizontal curves, super elevation, equilibrium, cant and cant deficiency, length & setting out of transition curve, gradients and grade compensation, use of OpenRail&HEADS Rail software.

Points and crossings: Introduction, necessity of points and crossings, design of a turnout as per Indian railways specifications.

Signaling and interlocking: Objects of signaling, engineering principle of signaling, classification of signaling, methods of interlocking, Traction and tractive resistances, stresses in track, Hauling capacity of locomotive and modernization of railway track.

Airport Engineering:

Runway orientation using wind rose diagrams, runway length & width, corrections for elevation, temperature & gradient, airport classification.

Runway & Taxiway Design: Geometric design of runway as per standard guidelines, taxiway layout, geometric design standards for taxiway & aprons, Rapid Exit Taxiways,

Structural design of runway pavements: Design of flexible and rigid runways as per FAA procedure using FAARFIELD & PCA method, Design of joints for airport pavements, Specifications for the different layers of runway and taxiway pavements, Pavement Evaluation for runway & taxiway, ACN-PCN method, ACR-PCR rating systems.

Pavement Evaluation & maintenance: COMFAA & ELMOD software's, Airport Pavement management systems for runway pavements.

Airport Layouts: Terminal area, parking area, apron & hanger typical airport layouts, Lightings and markings design for airside area of an airport.

Computational Software's:

1. **FAARFIELD**
2. **COMFAA**
3. **ELMOD**
4. **ICAO-ACR**
5. **OpenRail**

Assignment/Project:

1. To design the flexible & rigid runway & apron pavements.

2. To design the turn out as per the Indian Railway specifications.

Course Learning Outcomes(CLO):

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

1. Determine the runway orientation and the runway length as per standard guidelines.
2. Design the airport pavements including air-side marking & lighting as per ICAO & FAA guidelines.
3. Evaluate pavements as per ICAO standards and learn the concept of pavement maintenance management system.
4. Employ Railway Track specifications and perform geometric design of the railway track.
5. Design of turnout and crossings as per the Indian Railways guidelines.

RecommendedBooks:

1. *Rangawala,S.C.,RailwayEngineering,CharotarPublishers,Anand,(2002).*
2. *Arora,S.P.andSaxena.,RailwayEngineering,DhanpatRaiPublishers, NewDelhi, (2001).*
3. *Khanna,AroraandJain.AirportPlanningandDesign,NemChandandBrothers,Roorkee, (2002).*
4. *RailwayEngineering,SatishChandraandM.M.Agrawal,OxfordUniversity Press, New Delhi (2013).*
5. *RobertHorenjeff;PlanningandDesignofAirports(5^{th}edition),McGrawHillBook Co. (2010)*

EvaluationScheme:

Sr. No.	EvaluationElements	Weightage(%)
1	MST	30
2	EST	40
3	Sessional(Mayincludeassignments/quizzes/tutorial evaluations)	30

UCE803: IRRIGATION ENGINEERING

L	T	P	Cr
3	1	0	3.5

Course Objectives:
To expose students to various methods of irrigation and design of hydraulic structures.

Introduction: Introduction, types and methods of irrigation, concept of smart irrigation systems

Water Requirement of Crops: Soil-moisture-irrigation relationship, depth and frequency of irrigation, irrigation efficiencies, consumptive use and its determination, duty and delta relationship, factors affecting duty, crop seasons.

Canal Irrigation: Canal irrigation system, canal alignment, canal losses, estimation of design discharge of a canal, design of stable channels by Lacey's and Kennedy's theory, Water logging, design of tile drains.

Canal Head works: Layout and component parts of a diversion headwork scheme, design of weir/barrage as per IS specifications

Design of Impermeable floor: Causes of failure of hydraulic structures founded on previous foundations, Bligh's creep theory and Khosla seepage theory, hydraulic jump and its applications in the design of hydraulic structures, design of a canal head regulator.

Canal Regulation Works: Canal falls, necessity, location, and types of falls, design of a vertical drop fall and a glacis fall, roughening measures for energy dissipation, cross regulators and distributary's head regulators, canal escape and canal outlets

Cross Drainage Works: Need, types, selection of suitable CD work, design of CD works

Course learning outcomes:
Upon completion of this course, the students will be able to:

1. Work out the water requirement of crops.
2. Solve problems related to different structures needed for diverting and regulating irrigation water
3. Describe and define different types of cross drainage works

Suggested reading

1. S.K. Garg, *Irrigation Engineering and Hydraulic Structures*, Khanna Publishers, *New Delhi (2015).*
2. P.N.Modi, *Irrigation Water Resources and Water Power Engineering,* Standard Book House, New Delhi *(2014)*
3. Bharat Singh, *Fundamentals of Irrigation Engineering,* Nem Chand, Roorkee *(1983).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage(%)
1	MST	30
2	EST	40
3	Sessional (May include assignments/quizzes/tutorial evaluations)	30

UCE616: ADVANCED CONCRETE DESIGN

L	T	P	Cr
3	1	0	3.5

Course Objective: The subject aims to develop an understanding of design and detailing ofdomes, beams curved in plan, various types of combined footings. Subject also covers the design concepts of water retaining and earth retaining structures.

Combined Footings: Different types, design of rectangular, trapezoidal, strap and raft footings, Pile Foundations

Retaining Walls: Types, behavior, stability requirements, design of cantilever type retaining walls. Introduction to counterfort type retaining wall.

Water Tanks: Introduction, general design requirements on no crack basis, Design of circular and rectangular tanks resting on ground, Design philosophy for design of overhead tanks, intze type tanks and their staging and foundation

Beams curved in plan: Reinforced Concrete Design Circular beam loaded uniformly and supported on symmetrically placed columns.

Flat Slabs: Introduction and Terminology, IS Code Provisions, Analysis and Design of Flat Slab, Reinforcement Detailing

Experimental Project/assignment/Micro Project:

Students will be required to design and prepare structural drawing for Intze type watertank.

Course learning Outcomes (CLO):

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

1. Design various types of combined footings
2. Design RCC water tanks
3. Design cantilever type retaining walls
4. Design beams curved in plan and flat slabs

Text Book:

Jain, A.K., Reinforced Concrete-Limit State Design, Nem Chand & Bros (1999).

Reference Books:

Varghese, P. C., Limit State Design of Reinforced Concrete, PHI Publishers (2002).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	30

ELECTIVE-II

UCE837: SUSTAINABLE & SMART MATERIALS

L	T	P	Cr
3	1	0	3.5

Course objective: To expose the students to the latest trends in the development of sustainable and smart materials in the field of construction industry based on the efficient uses of resources.

Sustainable Materials

Introduction to sustainability concepts and life cycle analysis

Role of Materials: Carbon from Cement, alternative cements and cementitious material, Alternative fuel for cements for reduction in carbon emission, Sustainability issues for concrete

Use of sustainable construction materials- Strength, durability and environmental impact, Material Characterization,

Concrete made with industrial by-products as replacement to cement, coarse or fine aggregates, Concrete with natural sustainable materials

Overview of Life cycle analysis – Life Cycle Assessment of Cement and Concrete, Life Cycle Stages of Buildings, LCA Software tools, Embodied carbon calculation of concrete mix and building

Smart Materials

Definition of smart materials and structures

Different smart materials, properties and applications

Energy Harvesting Materials, energy conservation in built environment using smart materials,

Zero energy buildings

Learning from nature: Bio-inspired materials

Exercises/Assignments:
Case studies related to the application of traditional and advanced technology for smart and sustainable construction.

Course Learning Outcomes (CLO):
Upon completion of this course, the students will be able to:

1. Introduction to concepts of Sustainability and role of construction materials.
2. Develop concrete using various industrial by-products and natural materials in achieving sustainable construction.
3. Use LCA approach for designing a sustainable concrete mix.
4. Use smart materials and smart systems in construction

Text Books

• Brian Culshaw, Smart Structures and Materials, Artech House, 2000
• Suresh Bhalla, 'Piezoelectric materials: Applications in SHM, energy harvesting and biomechanics', Ane Books Pvt Ltd., 2016
• Siddique R, Cachim P. Waste and Supplementary Cementitious Materials in Concrete: Characterisation, Properties and Applications. Woodhead Publishing

Reference Books:

- Baoguo Han, Xun Yu, JinpingOu, Self-sensing Concrete in Smart Structure, Butterworth-

Heinemann and Elsevier, 2014
- Michael Thomas, Supplementary Cementing Material in Concrete, CRC Press, 2013
- Satish Chandra, Waste materials used in concrete, Noyes Publications, 1997

Evaluation Scheme:

Sr.No.	EvaluationElements	Weightage(%)
1.	MST	30
2.	EST	45
3.	Sessional (May includeAssignments/Projects/Tutorials/Quizzes)	25

UCE838: PRESTRESSED CONCRETE STRUCTURES

L T P Cr
3 1 0 3.5

Course Objectives-To make students familiar with the analysis and design of typical pre-stressed concrete structural elements.as per IS codal provisions.

Introduction-Theory and Basic Concepts: Prestressing concrete terminology, advantages and applications of prestressed concrete, types of prestressing, materials for prestressed concrete and permissible stresses, prestressing systems and devices, losses in prestress.

Limit State Design: Review of limit state design concepts- safety and serviceability requirements.

Analysis and Design for Axial Tension and Flexure: Analysis of members under axial load and flexure, resultant stresses at a section, analysis at service loads-load balancing concept, cracking moment, analysis for ultimate strength, calculation of moment demand, design of type 1 and type 2 members, detailing requirements, analysis of partially prestressed sections.

Analysis and Design for Shear and Torsion: Stress in an uncracked beam**,** limit state of collapse for shear and torsion, design steps and detailing requirements.

Calculations of Deflection and Crack Width: Total deflection due to gravity load and prestressing force, limits of deflection, limits of span-to-effective depth ratio, prediction of long-term deflections, calculation of crack width, limits of crack width.

Transmission of Prestress in pre-tensioned and post-tensioned members: Introduction, transmission length and end zone reinforcement.

Course learning Outcome (CLO):

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

1. Characterize the materials required and various methods of prestressing and evaluate losses in various pre-stressed members.
2. Analysis of prestressed concrete members under flexure and tension.
3. Evaluate the deflections and crack widths in prestressed concrete members.
4. Design various prestressed concrete structural elements for bending, axial tension, shear and torsion.
5. Analysis and Design of end zone in pre-tensioned and post-tensioned members.

Textbooks:

1. Krishna Raju N., “Prestressed concrete”, 5th Edition, Tata McGraw Hill Company, New Delhi,2012.
2. Pandit G. S. and Gupta S. P., “Prestressed Concrete”, CBS Publishers and Distributers Pvt. Ltd,2012.
3. Singh S. B., “Analysis and Design of Prestressed Concrete Structures” Willey, 2023.

Reference Material

1. Structural design manual, Precast concrete connection details, Society for the studies in the useof precast concrete, Netherland BetorVerlag, 2009
2. Glower, F., “Structural Pre-cast Concrete”, Oxford Publishers (2008)
3. Rajagopalan.N, “Prestressed Concrete”, Narosa Publishing House, 2002.

4. Dayaratnam.P., “Prestressed Concrete Structures”, Oxford and IBH, 2013.
5. Lin T.Y. and Ned.H.Burns, “Design of prestressed Concrete Structures”, Third Edition, WileyIndia Pvt. Ltd., New Delhi, 2013.
6. IS1343:2012 Code of Practice for Prestressed Concrete, Bureau of Indian Standards, New Delhi,2012.

EvaluationScheme:

Sr. No.	**EvaluationElements**	**Weightage, (%)**
1	MST	30
2	EST	45
3	Sessional(weeklyassessedtutorials)	25

UCE852: INTERNET OF THINGS (IoT) & SMART CITIES

L	T	P	Cr
3	1	0	3.5

Course Objective: This subject aims to develop an understanding of the application of Internet of things (IoT) to tame the pressure of urbanization, create new experience for city residents, make day-to-day living more comfortable and secure and to present an optimal approach to the implementation of smart city solutions. Introduction: The evolution of cities up to the present day: social, political and spatial planning models, Urbanization and its impacts on cities, Urban evolution in India, Changing patterns of urban growth, Quality of life in the city, Efficiencies and inefficiencies in cities; challenges and opportunities, Eco challenges in the contemporary cities, Principles of green and smart cities, International initiatives including UN and EU level, Corporate social and environmental strategies in cities.

Smart Cities: Definition, drivers, barriers and benefits of smart cities, Characteristics and factors of Smart cities, Examples of smart cities, Study of the existing cities, Finding problems and how far they are solvable, Designing for Smart cities, Design, development and exhibition of a feasible innovation project which will enrich citizens and the city through all its phases: determining the scope, defining the idea, establishing objectives, identifying partners, selecting and acquiring tools and knowledge, planning and presentation, beginning to put the project into practice.

Internet of Things: IoT concepts: Technologies that led to evolution of IoT, IoT and SCADA, IoT and M2M, IoT and Big Data; IoT Standards: Requirement of international standard (case study), IoT standards in practice, Operating platforms /systems; Components of IoT System: Design of IoT systems; Development of prototypes**.**

IoT implementation in Smart Cities: IoT Applications: Lighting as a service (case study), Intelligent Traffic systems (case study), Smart Parking (case study), Smart water management (case study) ; IoT for smart cities (Case study Smart city Barcelona); IoT in Indian Scenario: IoT and Aadhaar, IoT for health services, IoT for financial inclusion ; IoT for rural empowerment.

IoT applications for Value Creations: IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications; Four Aspects in your Business to Master; Value Creation from Big Data and Serialization; IoT for Retailing Industry; IoT For Oil and Gas Industry; Opinions on IoT Application and Value for Industry, Home Management, e-Health.

Course Learning Outcomes (CLO): After the completion of this course the students would be able to:

1. Use the principles of green and smart cities, International initiatives including UN and EU level.
2. Determining the scope, defining the idea and establishing objectives for smart cities.
3. Develop the concept of Internet of Things and its implementation to smart cities.
4. Application of IoT for value creation in Industry.

Text Books:

1. The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World
2. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014
2.
3. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013

Reference Books:

1. How Green is Cities? By Dimitri Devuyst, Colombia University Press.
2. New York Sustainability Science and Engineering Vol 1, By Martin A. Abraham (editor) Elsevier Publication,

Evaluation Scheme:

Sr.No.	EvaluationElements	Weightage(%)
1.	MST	30
2.	EST	45
3.	Sessional (May includeAssignments/Projects/Tutorials/Quizzes)	25

UCE857: INTEGRATED WATERSHED MANAGEMENT

L	T	P	Cr
3	1	0	3.5

Course objectives: To impart students with a comprehensive understanding of watershed systems and need for a holistic approach to managing a watershed, considering all aspects of the ecosystem

Introduction: Definition, principles, classification and geomorphology of watersheds, physical and hydrological characteristics of watershed, factors affecting watershed management

Fundamentals of watershed hydrology: Understanding the natural processes within a watershed, water flow dynamics, rainfall-runoff modelling and water yield assessments from watershed

Soil, land use and water quality assessment and management: Principles of soil erosion, estimation of soil erosion using soil erosion models, land cover mapping, point and non-point pollution parameters, streamflow measurements. Strategies to mitigate soil erosion including contour farming, terracing, check dams, and vegetation restoration, best management practices.

Integrated planning and decision making: Approaches to develop comprehensive watershed management plans considering social, economic, and environmental factors, stakeholder engagement and collaborative decision-making, introduction to multi criteria decision making and modelling tools in a watershed.

Course learning outcomes:

After competition of the course, students will be able to:

1. Define a watershed as a system and identify major environmental problems within a watershed.
2. Perform soil, land use and water quality assessments within a watershed
3. Incorporate stakeholder engagement and community participation in decision-making processes.

Suggested Reading:

1. Debarry Paul A. *Watershed: Processes, Assessment and Management*, John Wiley & Sons, New Jersey, 2004
2. Dhruva N.V.V., Sastry G. and Patnaik U.S. 1990. *Watershed Management*, Indian Council of Agricultural Research, New Delhi, 1990
3. Murthy, J.V.S., *Watershed Management*, New Age International Publishers, 2017
4. Iyer K. G. and Roy U.N., (ed.). *Watershed Management and Sustainable Development*, Kanishka Publishers, New Delhi, 2005

Reference Readings:

1. Isobel W. Heathcote., (2009) *Integrated Watershed Management: Principles and Practice*. Wiley & Sons, Incorporated, John, USA, second edition, 2009
2. Tideman E.M. *Watershed Management–Guidelines for Indian Conditions*, Omega Scientific Publishers, New Delhi, 1999
3. Paul A. DeBarry. (2004). *Watersheds: Processes, Assessment and Management*. Wiley & Sons, Incorporated, John, USA, second edition, 2004
4. Randhir O. Timothy, 2007. *Watershed Management-Issues and Approaches*, IWA Publishing, 2007

Evaluation Scheme:

Sr.No.	EvaluationElements	Weightage(%)
1.	MST	30
2.	EST	45
3.	Sessional (May includeAssignments/Projects/Tutorials/Quizzes)	25

ELECTIVE-III

UCE854: ADVANCED STEEL STRUCTURE DESIGN

L	T	P	Cr
3	1	0	3.5

Course Objective: The objective of this course is to expose students to design of various industrial structures and steel bridges.

Column Bases: Introduction, slab base, gusseted base, design of column base subjected to axial load and moment

Plate Girders: Introduction, weight and economic depth, design of flanges, design of web, curtailment of flange plates, intermediate and bearing stiffeners, design of a riveted and welded plate girders, web and flange splice.

Industrial Buildings (Steel Structures)*:* Design of roof trusses and supporting system, Industrial building frames, bracing, crane girders and columns, design of crane girders,

Steel Bridges: Introduction to suspension bridges, cantilever bridges, cable-stayed bridges. Standard specifications for railway bridges, Railway bridge code. General arrangement of single-track broad-gauge railway bridge with open floor, design of stringers, cross girders, main trusses, top and bottom lateral bracing, complete design of through type truss bridge

Introduction to Pre-Engineered Buildings (PEB): Comparison with Conventional Steel Buildings, Components of PEB

Course learning Outcomes (CLO):

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

1. Design Column base
2. Analyze and design plate girders
3. Analyze and design different components of truss bridges
4. Analyze and design different components of industrial buildings

Experimental Project/assignment/Micro Project

Students will have to submit reports on the design of various structural elements of a steel building.

Text Books:

1. *Subramanian, N., Design of Steel Structures, Oxford University Press (2008).*
2. *Ajmani, J. L. and Arya, A. S., Design of Steel Structures, Nem Chand and Brothers (2000).*

Reference Books:

1. *Dunham, C.W., Planning of Industrial Structures, John Wiley and Sons (2001).*
2. *Gary, W., Steel Designer's Manual, Prentice Hall (2008).*
3. *S. M. A. Kazimi and R. S. Jindal, "Design of Steel Structures", Prentice Hall of IndiaPvt Ltd (1988).*
4. *M. Edwin, J. Gaylord and J. E. Stallmeyer, "Design of Steel Structures", Mc Graw Hill(2006).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UCE855: DESIGN OF REINFORCED EARTH STRUCTURES

L	T	P	Cr
3	1	0	3.5

Course Objective- To learn (i) basic concepts and applications of various types of soil reinforcement, and (ii) design of reinforced earth structures.

Detailed Syllabus

1. Introduction to Reinforced Earth Structures

Historical Background and Evolution, Basic Principles and Concepts of Reinforced Earth, Mechanism of Reinforcement and Load Transfer, Advantages and Applications of Reinforced Earth, Comparison with Conventional Retaining Structures

2. Materials Used in Reinforced Earth Structures

Types of Reinforcements: Geosynthetics, Metallic Strips, Geogrids, Geocells, Geomembranes, Properties and Selection Criteria for Reinforcement Materials, Soil-Reinforcement Interaction, Testing and Quality Control of Reinforcement Materials, Durability and Long-Term Performance of Reinforcements

3. Design and Analysis of Mechanically Stabilized Earth (MSE) Walls

Types of Reinforced Earth Retaining Walls, Failure Mechanisms: Internal, External, and Compound Failures, Design Methods: Limit Equilibrium and Limit State Approaches, Seismic Considerations in Reinforced Earth Walls, Drainage and Facing Considerations, Case Studies of Reinforced Retaining Walls, Lessons from Failures in Reinforced Earth Structures

4. Design of Reinforced Slopes and Landslide Mitigation

Types of slopes and their stability, Reinforcement Methods for Slope Stabilization, Design of Reinforced Slopes using Geosynthetics and Soil Nailing, Retaining systems involving breast walls, gabion walls, Landslide Control Measures and Case Studies,

5. Codal provisions

Review of related codes like SP102, IS14458, IS14680, Applicability for different situations.

Project

Numerical modelling and simulation of Reinforced Earth Walls and Slopes using RS3, Slide3

Pre-requisites: Soil Mechanics and Foundation Engineering

Course Learning Outcomes (CLO)-

The students will be able to:

CLO1 Learn the concept of reinforced earth and factors affecting same

CLO2 Design reinforced earth retaining wall

CLO3 Application of reinforcement to stabilize slope and evaluate stability

CLO4 Prepare and analyse computer aided numerical model of retaining wall and slope

Text Books- (At least 3)

1. *Bowels J.E., Foundation Analysis and Design, McGraw Hill Book Company (1997),*
2. *Shukla, S.K., Yin, Jian-Hua, Fundamentals of Geosynthetic Engineering, Taylor & Francis (2006).*
3. *Koerner, R., Designing with Geosynthetics, 6th Ed. Prentice Hall (2005),*
4. *Saran, S., Reinforced Soil and Its Engineering Applications, I.K. international (2005).*

Evaluation Scheme:

Sr.No	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UCC821: ADVANCED TRANSPORTATION ENGINEERING

L	T	P	Cr
3	1	0	3.5

Course Objectives: To expose students to various road specifications and various aspects of transportation planning and traffic engineering

Road Specifications: Specifications for bitumen roads, bitumen surface treatments, penetration macadam, bitumen bound macadam and bitumen concrete, mastic asphalt, specification for cement concrete roads, construction of bituminous and cement concrete roads.

Traffic control: Traffic signs, Road markings, traffic signals, types i.e. simultaneous system, alternate system, simple progressive system and flexible progressive system, general principles of signal design.

Traffic control aids: Road way delineations, object markers, guardrails, Barriers, Fundamental principles of Traffic Flow, Traffic flow Elements, Flow Density Relationships, Gap and gap acceptance, Introduction of Queing Theory.

Traffic regulations: Traffic laws, Basic principles of regulation, regulation of speed, regulations of vehicles, regulation concerning driver, regulation concerning traffic rules for pedestrian traffic, general rules concerning traffic, enforcement of regulations.

Highway capacity: PCU, Level of service concepts, factors affecting capacity, capacity of urban highways, capacity of rotary intersection.

Intersections: Design of intersection, grade separated intersection, Need for rotary intersection, principles of design, design of rotary intersection.

Transport Planning & Analysis: Basic elements of Transport Planning, Urban Transport System Planning, Level of Urban transport Planning

Evaluating Transportation alternatives: Evaluation Process, Evaluation Criterion, Economic analysis of cost and benefits, Highway Cost, Road User costs, Methods of Economic Analysis

Public Transport System: Purpose & Methods of Public Transport System

Computational Softwares:

Introduction to highway engineering softwares:

1. **HEADS**
2. **MX Road**
3. **HDM4**

Experimental Project/assignment/Micro Project:

ZZ

1. To design traffic signals for various locations in the city/for a given scenario.
2. To design and propose rotary for any particular location.
3. To perform cost benefit analysis of any highway project.

Course Learning Outcomes (CLO):

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

1. Understand the road specifications laid by Indian road authorities
2. Apply the concepts of traffic engineering including traffic control, highway capacity.
3. Design various intersections.
4. To evaluate the different transportation alternative for a given scenario.

Text Books

1. *KhannaS.K.andC.E.G.Justo,"HighwayEngineering", NemchandBros(2002).*
2. *KadyaliL. R.;HighwayEngineering,NemChand&Brothers, Roorkee(2002).*
3.

Reference Books

1. *Sharma&Sharma; Principle and Practice of Highway Engineering, Asia Publishing House, NewDelhi (1980).*
2. *RoadDevelopmentplanforIndia(1981-2001), IRC,NewDelhi(1984).*
3. *RaoG.V.;TransportationEngineering, TataMcGrawHillPublisher,NewDelhi(1965).*
4. *HighwayMaterials,H.M.S.O.(London(2014).*
5. *YoderE.J.;PrinciplesofPavementDesign,JohnWiley&Son(1975).*

EvaluationScheme:

Sr. No.	EvaluationElements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals(MayincludeAssignments/Projects/Tutorials/Quizzes/LabEvaluations)	25

UCE825: LIFE CYCLE ASSESSMENT

L	T	P	Cr
3	1	0	3.5

Course Objective: To introduce the concepts of circular economy and Life Cycle decision making for minimal environmental impact in manufacturing, commerce and service industries. Life Cycle analysis and Life Cycle Assessment will be applied to resource selection, process choices and waste management.

Introduction to life cycle analysis (LCA): Boundaries, functional unit, life cycleassessment (LCA assessment)

Concepts of LCA: Policy and organisational drivers, and application in practice life cycle assessment methodology including (e.g. stages of LCA, Setting the goal, scope, functional unit and boundaries of LCA, comparing products, identifying environmental indicators, interpretation of the LCA assessment (characterised vs normalised)

Assessment Methods: International standards on LCA (e.g. ISO 14044, PAS 2050),
Tools used for LCA (e.g.Excel and GaBi6), Principles and practice of design for sustainability.

LCA in Construction: Environmental purchasing based on LCA, Reuse, recycle, recover, waste management, Symbiosis – one company's waste becoming another company's feedstock.
Supply chain issues: Just in Time and optimisation along the supply chain.

Case Study: Undertake an LCA analysis for an activity/product/service, identify information inputs, environmental impacts and LCA analysis outputs, develop an assessment methodology to enable you to evaluate the relative impacts of the most significant aspects of all the potential solutions, and hence reach a conclusion of the preferred solution (the Life Cycle Assessment)

Course Learning Objectives (CLO)
The students will be able to:

1. Evaluate the economic, environmental, social and technical aspects that influence a manufacturing organisation
2. Appraise the product lifecycle and the related impact on a business
3. Analyse the information required to undertake an LCA
4. Undertake an LCA and assess its limitations.

Text Books

1. Arvanitoyannis, I.S., 2008. ISO 14040: life cycle assessment (LCA)–principles and guidelines. *Waste management for the food industries*, pp.97-132.
2. Life Cycle Analysis in Construction industry, George Xanthakis, 2014
3. Life Cycle Assessment in the Built Environment, Robert Crawford, 2011
   B002

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45

3.	Sessionals(MayincludeAssignments/Projects/Tutorials/Quizzes/LabEvaluations)	25

UCC822: REMOTE SENSING AND GIS APPLICATIONS IN WATER AND ENVIRONMENTAL PROJECTS

L	T	P	Cr
3	1	0	3.5

Course Objective: The purpose of this course is to expose students to the principles of remote sensing, sources of errors in raw data before its application, including data handling in GIS and to be able to learn the application of remote sensing in Civil and Environmental Engineering.

Fundamentals of Remote Sensing: Sources of Energy – Active and Passive radiation – Electromagnetic Radiation Reflectance, Transmission and Absorption, Thermal Emission – Plank's formula, Stefan – Boltzman Law, Wein's Displacement Law; Emissivity – Kirchoff's Law, Characteristics of Solar Radiant Energy.

Sensors and Platforms: Types of sensors, Multispectral, hyperspectral, thermal, orbital characteristics, working principles and instrumentation. Storage and Retrieval of data. IRS and ERS
satellite systems – Introduction, Stages of development, Sensory Characteristics, Orbit and Coverage's, various types of data product and its uses. Data Processing: Initial data statistics. Pre-processing – Atmospheric, Radiometric and Geometric corrections.

Data analysis: Image Interpretation Elements, Keys and Aids. Basic Instrumentation. Visual analysis of data in application of remote sensing to various engineering fields.

Digital Elevation Model: Principles of data collections; Application to various fields: Contours, profiles, watersheds, stream networks etc.

Geographical Information Systems (GIS): Geographic information and spatial data types, Hardware and software; GIS; Steps of spatial data handling, database management systems, Spatial referencing. Data: Quality, measures of location errors on maps, Satellite-based positioning, Spatial data input, data preparation, Point data transformation. Analytical GIS capabilities: classification; overlay analysis Map Projections: System of map projections.

Lab Assignments:
1. Prepare land use and land cover map.
2. Generate contours and sectional profile from a DEM data
3. Delineate watersheds and stream networks from DEM data
4. Projections of Maps
5. Geometric corrections of satellite data
6. Spatial data processing through GIS.

Course learning Outcomes (CLO): Upon completion of this course, the students will be able to:
1. Process the raw satellite imagery
2. Classify the satellite imagery prepare the land use and land cover maps.
3. prepare contours and topographical maps,delineate the watershed and prepare the stream network of an area.
4. Vector to raster data model generation

Text books:

1. Lillesand, T.M. and R.W. Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons, New York(1994).
2. Campbell, J.B, Introduction to Remote Sensing, Taylor & Francis, London (1996).
3. Joseph, G., Fundamentals of Remote Sensing, Universities Press, New Delhi (2003).

Reference Books:

1. Colwell, R.N. (Editor-in-Chief), Manual of Remote Sensing, Vols I & II, American Society of Photogrammetry, Falls Church, Virginia(1983).
2. Jensen, J. R., Remote Sensing of the Environment an Earth Resource Perspective, Pearson Education. Delhi(2007).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	25