SCHEME & SYLLABUS

OF

V & VI SEMESTERS

B.E. CIVIL ENGINEERING

2024-25

Vision of the Department of Civil Engineering

To become a premier Civil Engineering Department offering excellent engineering education in design methods and advanced technologies to the students, to pursue research in thrust areas and to offer professional services to the society.

Mission of the Department of Civil Engineering

The Department is committed to develop competent professionals by offering need based curriculum in Civil Engineering areas, promoting research and innovation to prepare the students for higher study, life-long learning and societal responsibility. The department is also committed to provide good learning environment to develop professional ethics and skills in our students and to provide engineering services to the society.

Programme Educational Objectives of Civil Engineering

PEO#1	Graduates of the program will practice Engineering profession as competent professionals applying fundamentals, state-of-the-art knowledge and technical skills. ***[Theme: Practice Engineering profession as competent professionals]***
PEO#2	Graduates of the program will excel in higher education with life-long learning. ***[Theme: Higher education and life-long learning]***
PEO#3	Graduates of the program will exhibit leadership qualities, communication skills and team spirit. ***[Theme: Communication and team work]***
PEO#4	Graduates of the program will contribute to societal needs with ethical attitude. ***[Theme: Initiated to Society and ethical practice]***

Programme Outcomes of Civil Engineering

The following list of program outcomes describes what graduates are expected to know and be able to do at the time of graduation. Graduates will have:

PSO#1	An ability to conduct standardized field testing on civil engineering materials, interpret experimental data and provide conclusions. Demonstrate the construction of masonry, reinforcement fabrication for beams columns, slabs, etc., electrical wiring, assembling of water supply and sanitary layouts, application of painting and welding of joints. *[Short title: CE Field experiments and demonstration].*
PSO#2	An ability to estimate material quantities, cost estimates, prepare specifications, produce engineering drawings by conducting appropriate survey works and 3D modeling of systems/components using modern tools for technical projects *[Short title: CE technical reports and 3D modeling].*
PSO#3	Able to perform analysis and design in at least three to four of the technical areas appropriate to Civil Engineering. *[Short title: CE Technical areas].*

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3. **Design/development of solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
4. **Conduct investigations of complex problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)
5. **Engineering tool usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
6. **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
7. **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
8. **Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9. **Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
10. **Project management and finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
11. **Life-long learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A' grade & ISO 9001:2015 Certified)

B.E. in Civil Engineering

SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (w.e.f. 2024-25)

V Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	HSMS	S5CV01	Construction Management and Entrepreneurship	Civil	42	0	**0**	48	3	50	50	100	3
2.	IPCC	S5CVI01	Analysis of indeterminate structures	Civil	42	**0**	**28**	50	3	50	50	100	4
3.	IPCC	S5CVI02	Geotechnical Engineering (Integrated)	Civil	42	0	28	50	3	50	50	100	4
4.	PCCL	S5CVL01	BIM Lab	Civil	0	0	28	2	3	50	50	100	1
5.	PEC	S5CVPE1x	Professional Elective Course-I	Civil	42	0	0	48	3	50	50	100	3
6.	PROJ	S5PRJ01	Mini Project / Extension Survey Project	Civil	0	0	60		3	100	-	100	2
7.	AEC	SHS04	Research Methodology and IPR **(Board: IEM)**	ME, IM, CH	28	28	0	34	3	50	50	100	3
8.	HSMS	SHS05	Environmental Studies **(Board: CV)**	Civil	28	0	0	32	3	50	50	100	2
9.	NCMC	ARAS	Aptitude Related Analytical Skill	T&P	0	0	28	0	0	100	-	100	1
10.	NCMC	SHS01	National Service Scheme (NSS)	NSS CO	0	0	28	0	0	100	-	100	0
		SHS02	Physical Education (PE) (Sports and Athletics)	PED									
		SHS03	Yoga	PED									
			Total							**550**	**350**	**900**	**23**
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: **HSMS:** Humanity and Social Science and management Course **IPCC**: Integrated Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course**; PROJ**: Project/Mini Project; **AEC**: Ability Enhancement Course; **NCMC**: Non-Credit Mandatory Course, **L**: Lecture, **T**: Tutorial, **P**: Practical **S=SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

Professional Elective Course (PEC)

S5CVPE11	Building Services-HVAC, Acoustics & Fire Safety	S5CVPE14	Numerical Methods and Applications
S5CVPE12	Advanced Concrete Technology	S5CVPE15	Construction Automation and robotics
S5CVPE13	Smart materials and structures	S5CVPE16	Industrial Waste Treatment

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B.E. in Civil Engineering

SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (w.e.f. 2024-25)

VI Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	IPCC	S6CVI01	Design of Reinforced Concrete structures	Civil	42	0	28	50	3	50	50	100	4
2.	PCC	S6CV01	Transportation Engineering	Civil	42	28	0	50	3	50	50	100	4
3.	PEC	S6CVPE1	Professional Elective Course-II	Civil	42	0	0	48	3	50	50	100	3
4.	OEC		Open Elective Course-I		42	0	0	48	3	50	50	100	3
5.	PROJ		Major Project Phase I	Civil	0	0	56	4	3	100	-	100	2
6.	PCCL	S6CVL01	Transportation Engineering Lab	Civil	0	0	28	2	3	50	50	100	1
7.	AEC	SHS06	Soft Skills		0	0	28	2	1½	50	50	100	0
8.	NCMC	SHS01	National Service Scheme (NSS)	NSS CO	0	0	28			100	-	100	0
		SHS02	Physical Education (PE)(Sports and Athletics)	PED									
		SHS03	Yoga	PED									
			Total							**500**	**300**	**800**	**17**
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: **IPCC**: Integrated Professional Core Course, **PCC**: Professional Core Course; **PEC**: Professional Elective Course**;**
OEC: Open Elective Course; **PROJ:** Project Phase –I; **PCCL**: Professional Core Course laboratory;
AEC: Ability Enhancement Course, **SEC**: Skill Enhancement Course; **NCMC**: Non Credit Mandatory Course;
L: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

Professional Elective Course (PEC)

S6CVPE21	Traffic Engineering	S6CVPE24	Ground improvement techniques
S6CVPE22	Structural Dynamics	S6CVPE25	Air pollution & Control
S6CVPE23	Advanced Geotechnical Engineering	S6CVPE26	AI & ML

Construction Management and Entrepreneurship

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S5CV01	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:	
This course will enable students to:	
1	Understand the concept of scheduling and cost management in construction project.
2	Understand the concept of procurement and contract management including dispute resolution and contract breach.
3	Understand quality, safety and risk management involved in construction projects.
4	Understand the entrepreneurship skills and market demands in civil engineering field.

UNIT I

9 Hours

Planning and Scheduling • Project Planning: Construction project formulation – construction management, define scope – scope management, types of project planning and its management, Statutory and regulatory requirements- layout and building plan approval, contract, fire and safety, quality, environmental, commencement certificate, legal and public policies. • Project Scheduling: WBS, Bar charts, sequencing and dependency, network diagram (AOA and AON), activity duration and relationships, Float, Lead, Lag, Critical Path Method (CPM), PERT, Case study. • Cost Management: Creating schedules, Assigning Resources, Cost, Evaluation,Optimization and Tracking. • Practice: Project scheduling including resource allocation and costing in MS Project •

UNIT II

9 Hours

Resource Management: Basic concepts of resource management, class of labour, Wages & statutory requirement, Labor Production rate or Productivity, Factors affecting labour output or productivity of excavator, dozer, compactors, graders, and dumpers. • Contract and Procurement Management • Procurement: Procurement Types, Planning, Stages, Procurement Execution, Sustainable Procurement Management • Construction contract: Formation, Types, Essential elements, Contract law, Tendering process, Contract award, Documentation, Contractor and Sub-contractor Management, Claims, Disputes Compensation, Breach of Contract, Project Completion and Project Closure. •

UNIT III

8 Hours

Quality, Safety and Risk Management • Quality Management: Occupational Health, Safety and Environment, Barriers, Quality Management System – Chart and tools. • Safety management: Safety Requirements, Safety and Health codes. • Risk management: Process, Terminology, Identification, Analysis and Response Strategy Completion certificate, occupancy certificate, Facilities Management •

UNIT IV

8 Hours

Civil Business Planning Process: Business planning process, marketing plan of Civil Works, financial plan civil works, project report and feasibility study civil Construction, guidelines for preparation of model project report for starting a new venture in Civil Engineering Field. Introduction to international entrepreneurship opportunities in Civil Field. •

UNIT V

8 Hours

Introduction to Civil Entrepreneurship Characteristics of a Successful Civil Entrepreneur, Understand the entrepreneurial journey of Civil Entrepreneur, different entrepreneurial styles, personality traits, strengths of Civil Entrepreneur, and weaknesses. • Case studies of successful entrepreneurs in Civil Engineering • (1)

Larsen & Toubro Limited-Founder of Henning Holck-Larsen and Soren Kristian Toubro (2) JSW Steel-Sajjan Jindal, Managing director of JSW Steel (3) Puravankara Limited-Abhishek Kapoor, Executive Director & Group CEO (4) Adithya Birla Group-Kumar Mangalam Birla, Chairman. •

TEXT BOOKS:

1	Chitkara, K.K,	“Construction Project Management: Planning Scheduling and Control”, Tata McGrawHill Publishing Company, New Delhi, 3rd Edition, 2014.
2	Jimmie W.Hinze	"Construction Planning and Scheduling", Pearson, 4th Edition, 2011.
3	U.K. Shrivastava	“Construction Planning and Management”, Galgotia Publications Pvt. Ltd. New Delhi,2000.
4	R. Panneerselvam	"Engineering Economics", PHI Learning Pvt. Ltd., 2nd Edition, 2020.
5	Poornima. M. Charantimath	"Entrepreneurship Development - Small Business Enterprises", Pearson Education, 3rdEdition, 2018.

REFERENCES:

1	T. R. Banga and S. C. Sharma	"Mechanical Estimating & Costing", Khanna Publishers, 17th Edition, 2001.
2	Raina V.K.	“Construction and Contract Management practice”, Shroff Publishers, 2nd Edition, 2010.
3	S. S. Khanka	"Entrepreneurial Development", S. Chand Publishing, S Chand & Company Limited, 2nd Edition, 2020.

COURSE OUTCOMES: Upon completion of this course the student will be able to:

CO1	Develop WBS & network and schedule the project considering the resources and costs involved.
CO2	Plan resource management for a construction project.
CO3	Describe the procurement management, construction contracts, tending process including breach of contract and dispute resolution methods.
CO4	Describe the quality, safety and risk management of a construction project.
CO5	Describe the concept of Business planning in Civil Engineering.
CO6	Describe entrepreneurship in Civil Engineering

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1					3					3				
CO2										3				
CO3										3				
CO4										3				
CO5								2			2			
CO6								2			2			

Analysis of Indeterminate Structures

Contact Hours/ week: (L-T-P-S)	3-0-2-3	**Credits:**	4
Total Lecture Hours:	120 = 42 (L)+0(T)+28(P)+50(S)	**CIE Marks:**	50
Sub. Code:	S5CVI01	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	Analyse indeterminate structures such as continuous beams, rigid frames and redundant trusses under different loading and boundary conditions and to graphically represent BM and SF values by using slope deflection method, strain energy method and matrix methods.
2	Analyse indeterminate structures under elastic-perfectly-plastic material behavior

UNIT I

7 Hours

SLOPE DEFLECTION METHOD: • Analysis of continuous beams without and with sinking of supports, analysis of frames without sway. •

UNIT II

8 Hours

MOMENT DISTRIBUTION METHOD: • Stiffness factor, Distribution factor, Carry-over factor. Analysis of continuous beams with and without sinking, restrained frames, Unrestrained symmetrical frames without sway. •

UNIT III

8 Hours

STRAIN ENERGY METHOD: • Introduction to strain energy method, Castigliano's II theorem, Unit load method. Analysis of continuous beams and frames up to redundancy 2, Analysis of indeterminate trusses, redundancy up to 2nd degree. •

UNIT IV

8 Hours

STIFFNESS MATRIX METHOD: • Generation of stiffness coefficients and stiffness matrix from definition, analysis of continuous beams, trusses and rigid jointed plane frames with kinematic indeterminacy up to 3 •

UNIT V

8 Hours

PLASTIC ANALYSIS OF STRUCTURES • Plastic behaviour of materials. Plastic behaviour of sections under bending. Assumptions in plastic analysis of beams. Shape factor and load factor. Conditions at ultimate loads. Theorems of plastic analysis. Methods of plastic analysis. Plastic analysis of beam and frames for collapse load using static and kinematic methods. •

LAB COMPONENT

28 Hours

Introduction to STAAD Pro- Analysis of Determinate structures • Analysis of different types of pin-jointed plane frames • Analysis of different types of indeterminate 2D beams for deflections, SFDs and BMDs • Analysis of rigid-jointed plane frames, their deflections, AFDs, SFDs and BMDs • Analysis of arches and their SFD, SFD and BMD • Analysis of cable structures • Analysis of simply supported and continuous beams under moving loads • Analysis of beams curved in plan • Analysis of 3D frames and trusses • Analysis of 3D multistoried frames under lateral loading • Analysis of 3D frame under torsional loading •

TEXT BOOKS:		
1	Hibbeler, R.C.	"Structural analysis", Pearson Prentice Hall, 9th ed., 2017
2	Wang, C. K.	"Intermediate structural analysis", Tata McGraw Hill Education, First Edition, 2017
3	Reddy, C. S.	"Basic structural analysis", Tata McGraw-Hill Education, 3rd Edition, 2017.
4	Dilip S.Solanki	Structural Analysis and Design Using STAAD.Pro, Tata McGraw-Hill Education, 2ndEdition, 2012
5	Singiresu S.Rao	STAAD.Pro V8i Tutorial, Prentice Hall, 1st Edition, 2010
6	Murthy, Y. R.S.	Civil Engineering Design Using STAAD.Pro, Pearson Education, 3rd Edition, 2018

REFERENCES:		
1	Pandit, G. S., Gupta, S. P.	"Structural analysis", Tata McGraw-Hill Education, 2nd ed., 2008.
2	Menon, D.	"Structural analysis", Narosa, First Edition, 2010

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Analyze continuous beams and single storey non-sway frames using slope deflection method.
CO2	Analyse continuous beams, rigid frames using Moment distribution method
CO3	Analyse statically indeterminate beams, rigid frames and redundant trusses up to degree two, by strain energy method and unit load method.
CO4	Analyse continuous beams, trusses and rigid jointed plane frame kinematic indeterminacy up to 3, using the stiffness matrix method.
CO5	Evaluate the collapse loads of indeterminate beams and frames made of Elastic-perfectly-plastic material
CO6	Analyse the given indeterminate structure using STAAD Pro software

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1												2
CO2	3	1												2
CO3	3	1												2
CO4	3	1												2
CO5	3	1												2
CO6	1	2			3									3

Geotechnical Engineering (Integrated)

Contact Hours/ week: (L-T-P-S)	3-0-2-3	**Credits:**	4
Total Lecture Hours:	120 = 42 (L)+0(T)+28(P)+50(S)	**CIE Marks:**	50
Sub. Code:	S5CVI02	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:	
This course will enable students to:	
1	Understand basic concepts of soil mechanics and an exposure to the mechanical behavior of soils.
2	Gain knowledge on index properties and soil structure.
3	Understand the hydraulic conductivity, compaction, strength and compressibility behavior of soil system.

UNIT I

9 Hours

Index properties of soils: Phase systems and inter-relationships, Index properties of soils and their laboratory determination, Grain size analysis - mechanical and sedimentation analysis, Consistency limits - Definitions, significance and their determination. Numerical Problems. • Classification of soils: As per Unified and IS soil classification systems. Numerical problems. •

UNIT II

9 Hours

Compaction: General principles, standard proctor test, factors affecting compaction, modified proctor test, structures of compacted cohesive soil, effect of compaction on cohesive soil properties, field compaction, specifications for field compaction, special compaction techniques. Numerical Problems. • Compressibility of soil: Fundamentals of consolidation (Spring–Mass analogy), Terzaghi 1D consolidation theory, 1D laboratory consolidation test, void ratio– pressure, determination of consolidation characteristics (compression index, coefficient of consolidation; determination of coefficient of consolidation by square root of time fitting method and logarithmic time fitting method). Normally consolidated and over consolidated soils, determination of pre-consolidation pressure. Numerical Problems. •

UNIT III

8 Hours

Flow of water in soil: Hydraulic gradient, Darcy's law, limitations, Assumptions and Seepage velocity, coefficient of permeability, factors affecting permeability, laboratory determination of coefficient of permeability, equivalent permeability in stratified soil, field permeability tests. Numerical Problems. • Effective Stress Analysis: Concept of effective stress, effective stress in partially saturated and saturated soil without seepage, capillary rise in soils, effective stress in capillary zone, quick sand condition. Numerical Problems. •

UNIT IV

8 Hours

Shear strength of soil: Concept of shear strength, factors affecting shear strength of soils, Mohr–Coulomb failure criteria, Modified Mohr–Coulomb Criterion, total and effective shear strength parameters, determination of shear strength parameters for soils in the laboratory by direct shear test, unconfined compression test, triaxial test (UU, CU and CD tests) and Vane shear test. Sensitivity & thixotropy. Numerical Problems. •

UNIT V

8 Hours

Bearing capacity of foundations: Introduction, terminology, bearing capacity failures, Terzaghi's bearing capacity equation, Hansen's bearing capacity equation, bearing capacity equation as per IS code, footings with eccentric loadings, Effect of water table, bearing capacity from SPT & CPT. Determination of stress-strain modulus by lab & in-situ tests. Numerical Problems. • Settlement: Types of settlements and importance, Computation of immediate and consolidation settlement, permissible differential and total settlements (IS 8009 Part 1). Numerical Problems. •

LAB COMPONENT
28 Hours
Tests for determination of specific gravity using (a) Density bottle method (b) Pycnometer method • Grain size analysis of soil sample (a) Dry sieve analysis (b) Wet sieve analysis (c) Hydrometer analysis • Determination of In-situ density by (a) Core cutter method (b) Sand replacement method • Determination of Consistency Limits (a) Liquid limit (b) Plastic limit (c) Shrinkage limit • Determination of optimum moisture content and maximum dry unit weight by standard Proctor test • Determination of Coefficient of Permeability by using (a) Constant head permeameter (b) Variable head permeameter • Determination of shear strength parameters by (a) Direct shear test on cohesive and cohesionless soils. (b) Triaxial Shear test (UU and CU tests) (c) Unconfined compression test • Demonstration • Determination of free swell index • Determination of relative density of cohesionless soils • Demonstration of different types of augers, Samplers, rapid moisture meter, Proctor's needle •

TEXT BOOKS:		
1	Gopal Ranjan & ASR Rao	"Basic and Applied Soil Mechanics", New Age International publishers, 5th Edition, 2023.
2	V N S Murthy	"Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering", CRC Press, 2016.
3	B C Punmia, Ashok Kumar Jain and Arun Kumar Jain	"Soil Mechanics and Foundations", Laxmi Publications Pvt. Ltd., New Delhi, 16th Edition, 2017.

REFERENCES:		
1	Muni Budhu	"Soil Mechanics and Foundations", Wiley India Pvt. Ltd., 3rd Edition,2011.
2	Donald P Coduto	"Geotechnical Engineering", Phi Learning Private Limited, New Delhi.2010
3	Shashi K. Gulathi & ManojDatta	"Geotechnical Engineering", McGraw Hill Education, 2017.

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Determine the index properties of soil using inter-relationships of soil phase system, soil composition by mechanical and sedimentation analysis and consistency limits and other indices.
CO2	Classify soils in accordance with different soil classification methods and identify the suitability for civil engineering applications using grain size and consistency limits data.
CO3	Evaluate the compaction characteristics of soils by standard laboratory methods. Specifications for quality control from field tests, identify the suitability of compaction equipment based on soil type for field compaction.
CO4	Apply Terzaghi's one dimensional consolidation theory for laboratory one dimensional test data to determine one dimensional consolidation characteristics and use the information for determining the primary consolidation settlement in saturated cohesive soil. In addition they would be able to analyze the consolidation data to determine the consolidation state of soils.
CO5	Determine the hydraulic conductivity of soils based on the principles of Darcy's law using laboratory permeability and field pumping tests and compute equivalent permeability of stratified soils.
CO6	Apply the Mohr-Coulomb failure concepts to determine the shear strength parameters from various laboratory shear tests under different drainage conditions.
CO7	Determine bearing capacity of soils for foundations using theoretical and empirical correlations.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3												
CO2		3												
CO3	2	3												
CO4	2	2												
CO5	2	2												
CO6	2	3												
CO7	2	3												

Building Information Modeling Laboratory

Contact Hours/ week: (L-T-P-S)	0-0-2-0	**Credits:**	1
Total Lecture Hours:	30 = 0 (L)+0(T)+28(P)+2(S)	**CIE Marks:**	50
Sub. Code:	S5CVL01	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:	
This course will enable students to:	
1	Elements (with hands on sessions) of building information modeling software including modeling and modification of building elements- plans, levels, walls, doors and windows.
2	Documentation, managing views, plan and elevation-3D, detailing and drafting views, site design, settings, topo surface, importing and exporting to and from CAD format.

UNIT I
4 Hours
Introduction to BIM and Revit Architecture: • Overview of the Interface; Starting Projects, Creating Levels & Grids (Datum); Glance on Project Unit Settings, Snaps, Project Information. •
UNIT II
4 Hours
Drawing and Modifying Walls : • Drawing Walls, Curtain Walls, Embedded Walls, Stacked Walls; Using Curtain System, Grids & Mullions in Curtain Walls; Wall Sweep & Wall Reveal; Modifying Walls, Creating Openings; Section and Presentation of Walls Using Edit Type; Helpful Editing Tools, Applying Materials • Modifying Tools: • Align (Al), Offset (Of), Mirror-Pick Axis (MM), Mirror-Create Axis (DM), Split Element (SL), Split with Gap, Move (MV), Copy (CO), Rotate (RO), Trim/Extend to Corner (TR), Trim/Extend Single Element, Trim/Extend Multiple Element, Scaling. •
UNIT III
4 Hours
Doors, Windows & Components: • Adding & Editing Doors, Windows & Components Using Library, Creating Model in Place; Creating Columns & Beams by Placing & by Using Grids •
UNIT IV
4 Hours
Creation of Floors and Roof: • Roof by Footprint; Flat Roof, Slope Roof, Pitched Roof; Roof by Extrusion; Roof by Soffit, Fascia, Gutter; Modifying Roof, Creating Openings; Creating Ceiling; Creating Floor & Slab Edge; Splitting the Floor and Creating Slope in Floor; Edit Floor & Applying material •
UNIT V
4 Hours
Stairs, Railing, Ramp (Circulation): • Stairs, By Component, By Sketch, Modifying the Stairs using Edit Type- Thread, Raiser, Stringers, Nosing Etc., Modifying Stairs Using Family, Applying Material Railings, Sketch Path, Place on Host, Creation of Baluster & Handrail by Using Family, Applying Material; Ramp •
UNIT VI
4 Hours
Mass Objects: • Create Model with Extrusions, Sweeps, Revolves, Blends; Working With X-ray (Form Elements); Transform Mass to Building Elements; Model Site- Topo Surface, Site Component, Parking Component, Modify Site •

UNIT VII
4 Hours
Rendering and walkthrough and Quantity Estimation of prepared model •

TEXT BOOKS:		
1	Chuck Eastman, Paul Teicholz, Rafael Sacks, Kathleen Liston	"BIM handbook: A guide building information modeling for owners, Managers,Designers, Engineers, and Contractors", John Wiley & Sons Inc; 2nd edition (2011), ISBN-10 : 9780470541371, ISBN-13 : 978-0470541371

REFERENCES:

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Prepare and modify drawing of building elements like plans, levels, walls, doors and windows
CO2	Equipped to 3D modeling of floors, roofs, library elements, and manage view
CO3	Create models with extrusion/sweeps/blends/revolve
CO4	Rendering, walkthrough of prepared building models
CO5	Prepare estimate of building systems using modern tools

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1					3			2					2	
CO2					3			2					2	
CO3					3			2					2	
CO4					3			2					2	
CO5					3			2					2	

Building Services-HVAC, Acoustics and Fire Safety

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S5CVPE11	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	Learn the basics of MEP systems. (Mechanical, Electrical and plumbing)
2	Expose the learners to building acoustics
3	Impart knowledge on HVAC and fire protection systems in building

UNIT I

9 Hours

Advanced Electrical System Design for Buildings • Basics of Electrical System, Electrical terminologies, Major Electrical equipment, Buildingpower distribution and its schemes, Fundamentals of Power& distribution transformers, HT,LT, DG Sets, Cables & Wires, UPS and its importance, Introduction of HT, LT switch gears systems, Importance of Lighting design and different Light fixtures used in buildings– Interior, external, street & offices,RMU, HT consumer, Substation Building in Master plan – Space planning for RMU, HT, DG set, HSD yard, Space provision for Electrical Equipment including Substation, Va rious equipment clearance requirements, HVAC, PHE, FPS service electrical load input for designing electrical power distribution, Pedestals & ceiling support requirement for all Electrical equipment •

UNIT II

9 Hours

Extra Low Voltage System for Infrastructure and Building Acoustics • Introduction & Brief of ELV Systems, Concept of Building Management System (BMS) &Fire Alarm System, Interface with Architecture/ Structure, Access control, CCTV & Publicaddresssystem-Brief and purpose, BMS Brief and purpose, BMS interfaces with Electrical, HVAC, Fire and Life Safety and PHE, BMS interfaces with airport systems. Basics of sound and Building acoustics – Acoustic defects and prevention of sound transmission •

UNIT III

8 Hours

Heating, Ventilation & Air-conditioning systems • Basics of HVAC - Psychrometry and its importance - Major Components of Air conditioning System-Fundamental concepts of Heat transfer, Air-conditioningsystem,Ventilation system, Pressurization Systems and their importance to Life safety, Chilled water system,Cooling towers and major HVAC equipment, Pumping system in HVAC, Importance of Thermal and Acoustic Insulation, Introduction and basics of Variable Refrigerant Flow (VRF) systems, Radiant cooling, Under floor distribution, Chilled beams–Space planning, Importance of Static weight /Operating weights of mechanical equipment – Importance of Floors lab and Terrace roof slab openings /cut-outs •

UNIT IV

8 Hours

Fire Protection and Life Safety System • Basics of Fire Protection System - Active Fire protection system - Passive Fire protectionsystem-Basics of Smoke Control and Fire Stop Systems, Codes and Standards and Statutory Compliance - Fire and its Classes - Hazard Classification based on building occupancy -Means of Egress and its components - Importance of Life Safety - Refuge Area, Fire Tower and Fire Lift- Occupant Load and Capacityfactors-Fire Stopping Materials, Compartmentation in a building- Smoke control and management in Fire Zoning– •

UNIT V	
	8 Hours
Plumbing for water supply and sanitary system • Scope of works in Public Health Engineering, Sanitary fixtures and types-Water supply and treatment - Rain water drainage system - Landscape irrigation features – Water demand calculation based on building occupancy– Piping for different plumbing systems in buildings– Pump selection–Plant room sizing Sewage, treatment process- External water supply, storm drainage and sewerage system - Solid waste management - Interfacing PHE system with Architect and Structural engineers •	

TEXT BOOKS:		
1	Bureau of Indian Standards	Code of Practice for fire safety of buildings (IS1641–IS1646)
2	GRIHA	The Sustainable Habitat Handbook (6 Volume Set), GRIHA Version 2019
3	IGBC	IGBC Green new building rating system - version 3.0 - Abridged reference guide
4	Majumdar, M. (Ed)	Energy efficient Buildings in India, Tata Energy Research Institute, Ministry of Non Conventional Energy Sources, 2002
5	Tyagi, A. K.(Ed)	Handbook on energy audits and management, Tata Energy Research

REFERENCES:		
1	Weblinks	E-learning content on L&T EduTech Platform.

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Explain Electrical System along with substation for a building infrastructure
CO2	Explain the basics of acoustics and ELV systems in building
CO3	Design and implementation of HVAC System
CO4	Implement Fire Alarm System (PAS) for building
CO5	Explain the importance of water supply and sanitary plumbing system for a building

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1					2								
CO2	1					2								
CO3	1					2								
CO4	1					2								
CO5	1					2								

Advanced Concrete Technology

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S5CVPE12	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES: This course will enable students to:	
1	Elucidate the hydration mechanism of cement, the role of mineral and chemical admixtures, the properties of fresh concrete, and the proportioning of concrete mixes.
2	To explain the properties and testing of hardened concrete, quality control measures, creep and shrinkage of concrete, utility of non-destructive testing and special concretes.

UNIT I

9 Hours

Hydration of Portland Cement: • Chemistry of Hydration, Properties of the Hydration products, microstructure of hydrated cement pastes, properties of hardened cement pastes. • Mineral Admixtures: • Mineral Admixtures and Blended Cements–Pozzolanic Materials, blast furnace slag, blended cements, proportioning with mineral admixtures, effects of properties of fresh and hardening concrete. • Chemical admixtures: • definitions and classifications, use of admixtures, air–entraining admixtures, water–reducing admixtures •

UNIT II

9 Hours

Fresh Concrete: • workability, measurement of workability, setting of concrete, tests of fresh concrete. • Proportioning concrete mixes: • Basic considerations, fundamentals of mix design, IS Methods- IS10262 • Curing: • curing at Ambient Temperatures, Curing at Elevated Temperatures, curing compounds •

UNIT III

8 Hours

Hardened Concrete: • Response of concrete to stress – interfacial transition zone (ITZ), modulus of Elasticity, tension and fracture, compression, cyclic loading, multiaxial states of stress, factors affecting strength. • Testing of hardened concrete: • Need for 'Standard' Tests, significance of tests, tests for compressive strength, other concrete tests, assessment of concrete quality •

UNIT IV

8 Hours

Non Destructive Testing of concrete: • destructive and Non-destructive testing • Durability: • permeability of concrete, chemical transport, chemical attack, physical attack, cracking in concrete, repair and maintenance of concrete • Time dependent deformation: • plastic shrinkage, drying shrinkage, strain rate effects, creep of concrete, prediction of shrinkage and creep •

UNIT V

8 Hours

Special Concretes: • Concretes for special applications–lightweight concrete, highdensity concretes, Ultra high performance concrete, architectural concrete- stamped concrete, concrete dyes, acids staining, water based staining, overlaying, PC overlays, stamped overlays, quoting, polishing, finishing, engraving, other types of concretes • Cement–polymer, composites–latex–modified concrete, polymer–impregnated concrete. Organoceramics. Fiber reinforced concrete–definitions, fiber–matrix bond, mechanics of fiber reinforcement, fabrication of FRC, properties of fiber reinforced concrete, applications of FRC. Self-compacting concrete & Mix design. •

TEXT BOOKS:		
1	Mehta, P. K. and Paulo Monteiro, J.M.	"Micro structure and properties of concrete", McGrawHill, 4rth Edition, 2014. ISBN:9780071797870
2	Sidney Mindess, Young and Darvin.	"Concrete", Prentice Hall, 2nd Ed. 2002, ISBN-10 : 0130646326, ISBN-13 : 978-0130646323

REFERENCES:		
1	Shetty,M.S.	"Concrete Technology", Chand and Co., 7th Edition, 2005. ISBN-10 : 9788121900034,ISBN-13 : 978-8121900034
2	A.M.Neville	"Properties of Concrete", ELBS, 5th Edition, 2012. ISBN-13: 978-0273755807, ISBN-10:0273755803

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Explain the effect hydration of cement, mineral and chemical admixtures on concrete.
CO2	Evaluate the fresh properties of concrete to prepare concrete as per IS code.
CO3	Evaluate concrete strengths using destructive and non-destructive tests.
CO4	Identify the different types of deterioration and damage, able to explain the reasons and recommend suitable remedial measures
CO5	Identify the various performance characteristics, behavior and mix design of special concretes such as HPC, SCC and HPFRC.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2											1		
CO2	2											1		
CO3	2											1		
CO4	2											1		
CO5	2		1											

Smart materials and structures

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S5CVPE13	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:	
This course will enable students to:	
1	Understand the need for smart infrastructure
2	Deliberate on applications of various smart materials used in building smart infrastructure
3	Understand the role of bio-inspired material, fibre optic sensors and self-healing materials.
4	Explain various sensory systems such as wind, pressure, seismic and level sensors and their utility.
5	Describe various non-destructive testing methods, self-healing materials, and self-repairing concrete

UNIT I

9 Hours

Smart materials • shape memory alloys, basic characteristics of shape memory alloys, constitutive modelling of shape memory effect, applications of shape memory alloys in smart civil engineering structures, piezoelectric materials, applications of piezoelectric materials in smart civil structures. magnetostrictive materials, basic characteristics, applications in smart civil structures. •

UNIT II

9 Hours

Smart materials • shape memory alloys, basic characteristics of shape memory alloys, constitutive modelling of shape memory effect, applications of shape memory alloys in smart civil engineering structures, piezoelectric materials, applications of piezoelectric materials in smart civil structures. magnetostrictive materials, basic characteristics, applications in smart civil structures. •

UNIT III

8 Hours

Electro-rheological and magneto-rheological materials • characteristics, their applications in smart civil structures, optical fibres, characteristics of optical fibres, fibre-optic sensors and their applications in smart civil structures. Bio inspired materials, bio inspired materials for sensing systems, self-healing materials, nano materials. •

UNIT IV

8 Hours

Sensors and sensory systems • wind sensors, pressure transducers, wind profile measurements, seismic sensors, load cells, weigh in motion, thermometers, strain gauges, displacement sensors, level sensors, tilt beams, Global navigation satellite system, accelerometers, fibre optic sensors, non-contact sensors, weather stations, chemical and corrosion sensors •

UNIT V

8 Hours

Structural damage detection • non-destructive testing methods, Ultrasonic pulse velocity method, Impact-echo/impulse-response methods, acoustic emission method, radiographic method, eddy current method, infrared thermographic method, concept of structural self-rehabilitation, self-healing materials, and self-repairing concrete. •

TEXT BOOKS:		
1	You lin Xu, Jia He	Smart Civil Structures, Taylor & Francis Publications, 2017.
2	Macro Casini	Smart Buildings Advanced Materials and Nanotechnology to Improve Energy-Efficiency and Environmental Performance, Wood Head Publishing, 2016.

REFERENCES:		
1	Caijun Shi, Y.N.Mo	High performance construction materials – science and applications, World scientific publishing, 2008.
2	Joseph N. Pelton , Indu B. Singh	Smart cities of today and tomorrow- Better technology and Infrastructure, Springer International Publishing, 2019.
3	Web link videos	https://www.youtube.com/watch?v=FOzBe0ePw68. https://www.youtube.com/watch?v=6Us25DGQk8c

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Elaborate on smart structures concepts and the necessity of smart structures and smart materials
CO2	Present the applications of shape memory alloys, piezoelectric materials, and magneto strictive materials in developing smart civil infrastructure
CO3	Use the knowledge gained to select appropriate smart materials from among host of available ones
CO4	Apply the knowledge about sensors to select appropriate sensor to address the situation or the need.
CO5	Deliberate on non-destructive methods and be able to recommend appropriate technique from among host of techniques specific to the nature of structure and nature of distress.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1		2			2							1		
CO2					2								2	
CO3					2									3
CO4					2									3
CO5					2									3

Numerical Methods & Applications

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S5CVPE14	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	Introduce to classical numerical methods available for engineering problem-solving
2	Expose to concepts such as precision, errors and tolerances and their effect on the quality of the solutions produced by scientific computing
3	Develop a sound understanding of the various numerical techniques, principles and their application to civil engineering problems.

UNIT I

9 Hours

Introduction to Numerical techniques: Errors, Matrices and Determinants • Solution of Linear Simultaneous Equation: a) Gaussian elimination method b) Gauss-Jordan matrix inversion method c) Gauss-Siedel method d) Cholesky method • Application of Solution of Linear System Of Equations To Civil Engineering Problems related to: Construction planning, slope deflection method applied to beams, frames and truss analysis. •

UNIT II

9 Hours

Solution of non-linear and Transcendental equations for Civil Engineering Problems: • a) Bisection method and b) Newton-Raphson method and its applications for solution of nonlinear algebraic and transcendental equations for problems in hydraulics, irrigation engineering, structural engineering and environmental engineering. •

UNIT III

8 Hours

Application of Numerical Integration for Solving Civil Engg. Problems: • a) Trapezoidal rule b) Simpson's one third rule. c) Newmark's method. •

UNIT IV

8 Hours

Solution of Ordinary Differential Equation to Civil Engineering Problems by: • a) Euler's method b) Runge Kutta 4th order method •

UNIT V

8 Hours

Application of Finite Difference Technique in Structural Mechanics: • Introduction, expression of derivatives by finite difference: backward differences, forward differences and central differences. Application of finite difference method for analysis of a) Statically determinate beams, b) Statically indeterminate beams c) Buckling of columns d) Beams on elastic foundation. •

TEXT BOOKS:

1	Steven C. Chapra & Raymond P. Canale	"Numerical Methods for Engineers", McGraw Hill; 8th edition (2021); ISBN-10 : 9354601367, ISBN-13 : 978-9354601361
2	N.Krishna Raju & K.U.Muthu.,	N.Krishna Raju & K.U.Muthu., "Numerical methods in Engineering Problem", Macmillan Childrens Books, (2000)

REFERENCES:		
1	Iqbal H. Khan & Q. Hassan.	"Numerical Methods for Engineers and Scientists," Galgotia, New Delhi, (1997)
2	Pallab Ghosh	"Numerical Methods in Computer Programs in C++," Prentice Hall of India Private Limited, New Delhi (2006).
3	Schilling	"Numerical methods for engineers using MATLAB and C", Thomson Publications, I-Edition (2000)

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Formulate and solve civil engineering problems involving linear simultaneous and non-linear algebraic equations by different numerical techniques.
CO2	Apply numerical integration for computing areas, volumes and determine the slope and deflections in simple beams by Numerical Integration methods.
CO3	Solve ordinary differential equations related to engineering problems using numerical techniques.
CO4	Apply finite difference techniques to solve structural mechanics problems

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3												
CO2	2	3												
CO3	2	3												
CO4	2	3												

Construction Automation and robotics

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S5CVPE15	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:	
This course will enable students to:	
1	Understand the automation and robotics in construction
2	Explore construction robotics technologies
3	Classify types of construction robots and their applications
4	Know the benefits and challenges of implementation of automation and robotics in construction
5	Develop analytical and problem-solving skills to address challenges in construction automation

UNIT I

9 Hours

Introduction to Construction Automation and Fundamentals of Robotics • Introduction to Construction Automation: • Overview of construction industry challenges and the role of automation. • Importance • Application • Historical development and recent trends in construction robotics. Fundamentals of Robotics: • Basics of robotics: components, actuators, sensors, and control systems. • Kinematics and dynamics of robot manipulators. • Robot programming: teach pendant programming, offline programming, and simulation. •

UNIT II

9 Hours

Types of Construction Robots • • Autonomous construction vehicles: drones, driverless bulldozers, and excavators. • Robotic arms for tasks like bricklaying, welding, and 3D printing. • Inspection robots, exoskeletons, and wearable robotics. • Automation in prefabrication and modular construction. • Autonomous construction equipment and vehicles. • Intelligent construction materials and structures. • Computer vision and machine learning for construction site sensing. •

UNIT III

8 Hours

Applications of Automation and Robotics in Construction • Applications of Automation and Robotics in Construction • Automation and robotics in steel component production • Automation of excavation operations, excavation force analysis, process analysis • Precast component storage and transportation automation • Building construction: robotic bricklaying, concrete placement, and assembly. • Infrastructure construction: drones for surveying, robotic bridge inspectors, and road construction vehicles. • Maintenance and inspection: robots for routine inspections and repairs. • Multi-robot systems and collaboration. • Hybrid robotic systems: combining aerial and ground robots. • Soft robotics and bio-inspired design for construction. •

UNIT IV

8 Hours

Integration with Building Information Modelling (BIM) • Integration with Building Information Modelling (BIM) • Virtual reality systems, sensory data acquisition and processing • Utilizing BIM data for planning and controlling robotic operations. • Simulation and virtual reality tools for optimizing robot deployment. • Collaborative robots (cobots) working alongside human workers. • Integration of BIM with robotic simulation and visualization. • Case studies of BIM-integrated robotic construction projects. Challenges and Considerations: • Safety considerations for working with construction robots. • Regulatory and legal challenges. • Cost-benefit analysis and return on investment considerations. •

UNIT V	
	8 Hours
Future Trends and Ethical Considerations • • Emerging technologies shaping the future of construction automation and robotics. • Robotics for sustainable construction practices. • Additive manufacturing (3D printing) in construction. • Nanotechnology and advanced materials for construction robotics. • Ethical considerations regarding the use of robots in construction. • Value addition to construction through simulation, Introduction, life cycle management, life design management, importance of design management, proactive design selection and project performance. Case Studies and Best Practices: • Real-world examples of successful implementation of construction automation and robotics. • Lessons learned, challenges faced, and best practices. • Group presentations on selected case studies. •	

TEXT BOOKS:		
1	B. Gambao-Araya and M. A. AbouRizk	Handbook of Robotics and Automation in Construction, Wiley, 2002
2	H. Asadi and A. C. Scott	Advanced Construction Robotics, Springer, 2020
3	Carlous Balguer, Mohammed Abderriahim	Robotics and Automation in Construction, Edited Volume, IntechOpen, 2008. ISBN 978-953-7619-13-8
4	Thomas Bock and Linner	Construction Robots, Cambridge Universities Press, 2016. ISBN 978-1-107-07599-3

REFERENCES:		
1	G. N. Walker and R. J. Schmitz	Automation in Construction, Wiley-Blackwell, 1992
2		C. T. Haas and J. C. Kunz Robotics and Automation in Construction, MIT Press, 1987
3	V. Kumar and R. Issa	Robotics in Construction, Springer, 2016
4	Thomas Bock, Thomas Linner, and Bruno Ninaber	Construction Robotics, Springer, 2008
5	Karl T. Ulrich and Clayton M. Christensen	Robotics in Construction
6	Noah W. D. Rapp and Anthony S. Perlinski	Autonomous Robots for Construction
7	Houtan Jebelli, Mahmoud Habibnezhad, Shayan Shayesteh, Somayeh Asadi, SangHyun Lee	Automation and Robotics in the Architecture, Engineering, and Construction Industry, Springer Nature,3 Jan 2022
8	Web link videos	https://www.youtube.com/watch?v=NUeJFscrnPc https://www.youtube.com/watch?v=aBHc2GsPU5E https://www.youtube.com/watch?v=O3al52UWoc0 https://www.youtube.com/watch?v=2fmRejSRkss https://www.youtube.com/watch?v=zBvvbOLq3t0 https://www.youtube.com/watch?v=vL2KoMNzGTo

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Understand the fundamentals of automation and robotics in construction.
CO2	Explore state-of-the-art construction robotics technologies and their applications.
CO3	Identify different types of construction robots and their applications.
CO4	Analyse the benefits and challenges of implementing automation and robotics in construction projects.
CO5	Evaluate real-world case studies of construction automation and robotics projects. Apply advanced analytical and problem-solving skills to address challenges in construction automation.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2				1									
CO2	1				1									
CO3	1				1									
CO4	1				1					2				
CO5	1				1					2				

Industrial Waste Treatment

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S5CVPE16	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES: This course will enable students to:	
1	This course introduces the students to the characterization of industrial wastewater and their effects on environment, type and characteristics of pollutants in streams and municipal wastes, treatment of wastes using physical, chemical, and biological methods, the standards and permissible limits for the discharge of treated waste, air pollutants and their quantification and treatment.
2	Understand Air pollutants and their quantification and treatment.

UNIT I

9 Hours

Introduction • Characteristics of industrial wastewater, pollutants in industrial wastewater and their effects, population equivalent. Difference between domestic and industrial wastewater, Effect of waste on streams and on municipal treatment plants. Stream quality, standards of stream quality for public water supply, industrial water supply and for aquatic life. Disposal by dilution and numerical examples using Streeter Phelps's equation, Industrial effluent standards for disposal into streams, on land and into sewers. Stream sampling. Economics of wastewater treatment. Legislation to control water pollution. •

UNIT II

9 Hours

Treatment Methods: • Volume, strength reduction, neutralization, equalization and proportioning. Removal of suspended solids by sedimentation, flotation and screening. Removal of colloidal solids by chemical coagulation and adsorption. Removal of organic solids by lagooning in oxidation ponds, activated sludge treatment, modified aeration, dispersed growth aeration, contact stabilization, high-rate aerobic treatment, trickling filtration, spray irrigation, wet combustion, anaerobic digestion, mechanical aeration system, well injection and foam separation. Numerical example on design of: sedimentation tanks, aeration tanks and trickling filters. •

UNIT III

8 Hours

Combined Treatment: • Treatment and disposal of sludge solids by anaerobic and aerobic digestion, vacuum filtration, drying beds, sludge lagooning, incineration, centrifuging and sanitary land filling. Feasibility of treatment of raw industrial wastes with domestic wastes and partially treated industrial wastes with domestic wastes. Discharge of completely treated waste to municipal sewer systems Discharge of partially treated industrial wastes directly to streams Discharge of completely treated wastes to streams or on land. Low cost waste water treatment methods- oxidation ponds, oxidation ditch and aerated lagoons. •

UNIT IV

8 Hours

Treatment of some industrial wastewater: • Characteristics, treatment and disposal of industrial wastewater form Dairy industry, Paper and pulp industry, Sugar industry, Tannery industry, cotton textile industry, woollen textile industry and Pharmaceutical industries •

UNIT V

8 Hours

Air pollution: • Introduction, Definition of air pollution composition of air. Ambient air sampling,

collection of gaseous pollutants. Grab samples, absorption in liquids, and adsorption on solids. Freezeout sampling, collection of particulate pollutants. Dust fall jar, high-volume filtration. Tape sampler, Impingement Electrostatic precipitation, Thermal precipitation. Treatment of gaseous pollutants by Cyclone separator, Filters-Fabric or cloth filters, Reverse jet filter, Envelope type fabric filter and multiple compartment type bag house, Electrostatic precipitators-principles. Pipe type and plate type precipitators. Dry and wet precipitators. Industrial applications of electrostatic precipitators, Scrubbers-spray towers, ventury, cyclone, packed and mechanical scrubbers. •

TEXT BOOKS:		
1	Patwardhan, A. D.	Industrial wastewater treatment, PHI Learning Pvt. Ltd. , First Editin, 2008.ISBN-13:978-8120333505
2	Rao, C. S.	Environmental pollution control engineering. New Age International, 3rd Edition, 2018.ISBN-13: 978-9386649898

REFERENCES:		
1	Nemerow, N. L. & Agardy F. J.	Strategies of industrial and hazardous waste management (1998), JohnWiley & Sons.
2	Nelson L. Nemerow,	Industrial waste water treatment, Wesley Publishing co. ISBN:9780123724939

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Compute pollution levels in streams before and after the disposal of the industrial waste and apply legislation standards
CO2	Decide the pre-treatment methods required for different type of industrial waste
CO3	Design various wastewater treatment units
CO4	Identify the characteristics of industrial wastes and recommend suitable sequence of treatment units
CO5	Identify air pollutants and their treatment

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2					2								
CO2	2					2								
CO3	2					2								
CO4	2					2								
CO5	2					2								

Mini Project / Extensive Survey Project

Contact Hours/ week: (L-T-P-S)	0-4-0-0	**Credits:**	2
Total Lecture Hours:	60 = 0 (L)+56(T)+0(P)+4(S)	**CIE Marks:**	100
Sub. Code:	S5PRJ01	**SEE Marks:**	0

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/ applications

UNIT I

0 Hours

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students. Departments shall allocate one full day for Mini-project in the Time Table. •

TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	To write a professional report with uniform styles, autonumbering and dynamic referencing
CO2	To give a professional presentation with innovative, impressive and clear communication of ideas
CO3	To communicate the underlying concepts, objectives, overall method adopted and conclusions
CO4	To systematically work towards the prescribed objectives in disciplined manner

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1														
CO2														
CO3														
CO4														

Research Methodology and IPR

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	SHS04	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

UNIT I

8 Hours

RESEARCH METHODOLOGY: • Objectives and motivation of research - Types of research - Research approaches - Significance of research - Research methods verses methodology - Research and scientific method - Importance of research methodology - Research process - Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations- Criteria of good research. Defining the research problem: Definition of research problem - Problem formulation - Necessity of defining the problem - Technique involved in defining a problem. •

UNIT II

8 Hours

LITERATURE SURVEY AND DATA COLLECTION: • Importance of literature survey - Sources of information - Assessment of quality of journals and articles - Information through internet. Effective literature studies approaches, analysis, plagiarism, and research ethics. Data - Preparing, Exploring, examining and displaying. Referencing methods •

UNIT III

9 Hours

RESEARCH DESIGN AND ANALYSIS: • Meaning of research design - Need of research design - Different research designs - Basic principles of experimental design - Developing a research plan - Design of experimental set-up - Use of standards and codes. Overview of Univariate/Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation. •

UNIT IV

8 Hours

INTELLECTUAL PROPERTY RIGHTS (IPR): • Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. Role of WIPO and WTO ni IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance. •

UNIT V

9 Hours

PATENT RIGHTS (PR): • Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs. Licenses, Licensing of related patents, patent agents, Registration of patent agents. •

TEXT BOOKS:		
1	Kothari C. R.	“Research methodology: Methods and techniques”, New Age International, 5th Edition,2023. ISBN-13: 978-9389802559
2	R. Ganesan	"Research Methodology for Engineers", MJP Publishers, Chennai, 2011.

REFERENCES:		
1	Cooper Donald R, Schindler Pamela S and Sharma JK	"Business Research Methods", Tata McGraw Hill Education, 11th Edition, 2012.
2	Catherine J. Holland	"Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3	David Hunt, Long Nguyen, Matthew Rodgers	"Patent searching: tools &techniques", Wiley, 2007.
4	The Institute of Company Secretaries of India, Statutory body under an Act of parliament	"Professional Programme Intellectual Property Rights, Law and practice", September 2013.
5	Peter S. Menel Mark A. Lemley, Robert P. Merges	"Intellectual Property in the New Technological-Vol. I Perspectives, 2021.
6	Laura R. Ford	"The Intellectual Property of Nations: Sociological and Historical Perspectives on a Modern Legal Institution Paperback -2021.

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Describe the research process & formulate research problem
CO2	Perform literature review, manage data & practice research ethics
CO3	Practice basic principles of experimental design, use standard codes and carry out research analysis
CO4	Distinguish between types of innovation, describe patenting procedure, maintenance and role of IPR establishments
CO5	Identify the significance of patent rights, licensing, technology transfer & manage patenting system

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1		3	2								2			
CO2		3	2								2			
CO3		3	3				2				2			
CO4		3	2								2			
CO5		3	2								2			

Environmental Studies

Contact Hours/ week: (L-T-P-S)	2-0-0-2	**Credits:**	2
Total Lecture Hours:	60 = 28 (L)+0(T)+0(P)+32(S)	**CIE Marks:**	50
Sub. Code:	SHS05	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	Describe the problems of depletion of natural resources due to deforestation, agricultural practices, and adverse environmental effects, pesticides, soil erosion, mining.
2	Explain the different types of energy- renewable, non-renewable and energy conservation, the impact of environmental pollution on water quality, air quality, soil pollution and noise pollution.
3	Describe solid waste management- disposal, treatment of different types of solid waste including MSW, e-waste, biomedical waste, the societal impact of environmental issues- ozone layer depletion, GHG effects, water conservation and harvesting and environmental protection & Acts

UNIT I

6 Hours

Introduction: • Components of Environment and their interactions • Natural Resources: • Forest Resources- Deforestation, Causes of deforestation, Environmental effects of deforestation and solutions • Water resources, World's water reserves, Hydrological cycle • Land resources, Land degradation. Soil erosion, Causes and prevention, Soil conservation and its types • Numerical problems on rainfall & runoff •

UNIT II

6 Hours

Energy and resources: • Types of Energy-Renewable, Non renewable & sustainable energy & their advantages and disadvantages • Renewable energy sources- Solar energy, Wind energy, Tidal energy, Ocean thermal energy. Geothermal energy, Hydroelectric power, Biomass energy, Hydrogen energy, Thermal power- environmental impacts • Conservation of energy • Numerical problems on Solar energy, Wind power •

UNIT III

6 Hours

Environmental pollution: • Sources of pollution- Natural and anthropogenic sources • Pollutants - Classification & their effects on environment • Air Pollution -Composition of clean air, Sources of air pollution, Effect of air pollution on human health and climate • Water quality – Potable water, Wholesome water, Sources of water pollution Polluted water & Contaminated water• Common impurities in water(physical, chemical and bacteriological), Effects of impurities on human health • Soil Pollution – Sources, effects, and its control • Noise pollution- Sources of noise, Effects on human health & its control • Numerical problems on pH, hardness of water, noise pollution •

UNIT IV

5 Hours

Solid Waste Management • Refuse, Garbage, Rubbish, Ash, types of solid waste • Necessity of safe disposal, Impacts on human health and environment • Classification of solid wastes- Quantity and composition of MSW, Collection of solid waste- methods • Disposal of solid waste-Sanitary land-fill • E-waste- Problems and solutions • Biomedical waste-Impacts on human health, storage, treatment methods and disposal • Numerical problems on moisture content, density & proportioning of land fill •

UNIT V	
	5 Hours
Sustainable development: • Issues on energy utilization, water conservation, concept of 3 R's, Rain water harvesting- methods • Global environmental issues: Population growth, Urbanization, Global warming, Acid rains, Ozone layer depletion & controlling measures. • Environmental acts, Regulations, Role of state & central governments, • Numerical problem on carbon foot print & rainwater harvesting. •	

TEXT BOOKS:		
1	Joseph, B	Environmental Studies (2009), India: Tata McGraw-Hill. ISBN: 9781283922524
2	Tripathi, A. K	Environmental Studies(2016), India: Energy and Resources Institute. ISBN:9788179935828

REFERENCES:		
1	Erach Bharucha	Environmental studies for Undergraduate Courses, 1st Edition, University Press, (2013)
2	Santhosh Kumar Garg	Environmental Science and Engineering Ecology and Environmental Studies, Khanna Publishers, (2015), ISBN-10 : 8174092188 ISBN-13 : 978-8174092182

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Explain the importance of forestation, effects of deforestation, land degradation, adverse effects of mining on environment, using the principles of natural sciences compute the runoff from rainfall & estimates the conservation of water for beneficial use of humans.
CO2	Choose appropriate renewable energy sources by formulating, reviewing the literature, calculating the power potential of solar & wind energy and using the principles of natural sciences.
CO3	Explain the effects of pollution of air, water, soil & noise on humans and the environment, identify and analyze the pollution problems related to air, water, soil & noise and quantify pollution levels & draw valid inferences using the principles of engineering sciences
CO4	Describe Impact of solid waste on human health and environment, its safe disposal. Use population data & compute percapita solid waste generation, land area requirement for sanitary landfill
CO5	Appreciate the importance of sustainable development, current global environmental issues, present state & central governments protection acts, compute carbon footprint using data(vehicles/industries) & asses its impact on the environment.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1						2								
CO2						2								
CO3						2								
CO4						2								
CO5						2								

Aptitude Related Analytical Skills

Contact Hours/ week: (L-T-P-S)	0-0-0-0	**Credits:**	0
Total Lecture Hours:	0 = 0 (L)+0(T)+0(P)+0(S)	**CIE Marks:**	0
Sub. Code:	ARAS6	**SEE Marks:**	0

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES: Upon completion of this course the student will be able to:

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1														
CO2														
CO3														
CO4														

Design of Reinforced Concrete Structures

Contact Hours/ week: (L-T-P-S)	3-0-2-3	**Credits:**	4
Total Lecture Hours:	120 = 42 (L)+0(T)+28(P)+50(S)	**CIE Marks:**	50
Sub. Code:	S6CVI01	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	The course introduces the students to the design of RC structural elements-Slabs, Beams, Columns, Footing and staircase as per relevant IS Codes, handbooks and equip the students to design the different elements of simple RC framed building.

UNIT I

9 Hours

Basic Design concepts • Introduction to Limit State Design and Serviceability: Introduction to working stress method, Difference between Working stress, Ultimate load method and Limit State Method of design as per IS 456-2000. • Philosophy and principle of limit state design with assumptions. Partial Safety factors, Characteristic load and strength. Stress block parameters, concept of balanced section, under reinforced and over reinforced section • Introduction to various type of loads and exposure to IS 875-2015 • Design of rectangular sections (singly and doubly reinforced) for flexure and shear. Calculation of Limiting deflection, short-term deflection •

UNIT II

9 Hours

Design of Beams • Ultimate flexural strength of T beams. Design of T beams for flexure and shear. calculation of short-term deflection in beams. • Calculation of Bond, Anchorage and development length •

UNIT III

8 Hours

Design of slabs: • Limit state design of slabs–One way and two-way slabs for various boundary conditions as per IS 456:2000. •

UNIT IV

8 Hours

Design of Columns and footings • Design of columns– Limit state design of axially loaded short R.C. column, design for uniaxial and biaxial compression bending, concept of interaction diagram and use of SP16. Design of footings– Different types of footings and their applications, design of isolated footing for axial load– square & rectangular footings •

UNIT V

8 Hours

Design of staircases: • Introduction to various types of staircases, design of stairs with waist slab spanning transversely and longitudinally •

LAB COMPONENT

28 Hours

Lab Component • 1. Selection of two-story architectural drawing & column placing/positioning in the architectural drawing. • 2. Preparation of Beam and column layout • 3. Applications of STAADPRO/ETABS software for analysis for two-story RC building • 4. Design of structural members such as beam, column, slab, footing for the selected RC building • 5. Preparation of footing/foundation layout •

TEXT BOOKS:		
1	Pillai S. U. and Menon, D.	"Reinforced Concrete Design", McGraw Hill Education India Private Limited, 3rd Edition, 2017.
2	N. Krishnaraju	"Reinforced concrete design", New age international publishers, First Edition,2018

REFERENCES:		
1	Jain, A.K.	"Reinforced Concrete (Limit state design)", Nemichand and Bros, 7th Edition, 2012
2	Varghese, P.C.	"Limit state design of reinforced concrete", PHI Learning Pvt. Ltd. 2nd Edition, 2008

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Design singly reinforced and doubly reinforced beams using Limit State Philosophy.
CO2	Design one way and two way slabs.
CO3	Design compression member for axial loading and moments.
CO4	Design isolated footing for axial load and bending.
CO5	Design staircase.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1			3											2
CO2			3											2
CO3			3											2
CO4			3											2
CO5			3											2

Transportation Engineering

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S6CV01	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	This course introduces the student to deal with road geometrics, materials, design, and construction methods. Also to follow the guidelines prevalent for Indian geographical conditions.

UNIT I

8 Hours

Introduction to Transportation Engineering • Importance of transportation; types of transportation. • Road transportation; classification of roads; Importance of roads in India; Current road developments in India (with numerical problems if any). • Stages of road engineering surveys. •

UNIT II

10 Hours

Road Geometrics Characteristics • Design Criteria: cross section elements of roads, typical cross section of roads; roadway capacity; design speed; Design vehicle; terrain conditions. • Geometric design of rural highways IRC 73-1980: stopping sight distance; passing sight distance; horizontal alignment-superelevation, extra widening (Numerical problems). • Vertical alignment IRC-SP 23: Gradient; design speed; summit curves; valley curves -both SSD and OSD (Numerical problems). •

UNIT III

8 Hours

Introduction to Pavement Design • Design Process: AASHTO design philosophy (in a single flow chart); Design factors-Loading only (Wheel configuration, wheel load, contact pressure); fixed traffic; fixed vehicle; ESWL (Boyd and Foster method only); EALF and EAL. • Introduction to flexible pavements: bituminous pavement components, types; chronology of IRC 37 guidelines (No full length design problems). • Introduction to rigid pavement: Cement concrete pavement components, types; joints in concrete pavements; chronology of IRC 58 guidelines (No full length design problems). •

UNIT IV

8 Hours

Pavement Materials • Subgrade (No embankment): Desiable properties; HRB classification; California bearing ratio; Modulus of subgrade reaction; Numerical problems • Aggregates: Aggregate production (Crusher plant); Desirable properties; Consensus properties only; Gradation (0.45 power chart, Rothfutch's method, Trial and error method only) • Bitumen and Bituminous mix: Desirable properties; Type of bitumen (IS 73-2008 only); Types of bituminous mix (Dense, gap, and Open); Volumetric properties (Phase diagram only) • Cement concrete (Whitetoppng): Cement; admixtures; air entraining; Requirements of concrete mix design- IRC:SP76-2008 only •

UNIT V

8 Hours

Pavement Construction • Subgrade layer excluding embankment: Construction of subgrade; Choice of equipment • Subbase and base layer: Construction of granular subbase (GSB) layer only; Construction of wet-mix macadam (WMM) only; Choice of equipment • Surface layer: Construction of bituminous concrete (BC) layer only; Choice of equipment • Pavement drainage: Drainage measures (IRC:37-2001 only); Internal drainage (IRC:37-2018) •

TEXT BOOKS:		
1	S.K. Khanna, C.E.G. Justo, and A. Veeraraghavan	"Highway Engineering", 10th edition, NemChand Brothers, ISBN: 185240434, (2014)
2	P.S. Kandhal	"Bituminous Road Construction in India", 1st edition, PHI Learning Private Limited, (2016)
3	American Association of State Highway and Transportation Officials	"AASHTO guide for design of pavement structures", AASHTO (1993), American Association of State Highway and Transportation Officials, Washington, DC.

REFERENCES:		
1	Indian Roads Congress	"Guidelines for the design of flexible pavements", IRC 37(2018), Indian RoadsCongress, New Delhi.
2	Indian Roads Congress	"Guidelines for the design of plain jointed rigid pavements for highways", IRC 58 (2015), Indian Roads Congress, New Delhi.
3	Ministry of Road Transport and Highways	"Specifications for Road & Bridge works", MoRTH (2013), Fifth Revision, Indian Roads Congress, New Delhi.

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Identify different types of transportation modes, different types of roads, state and central road agencies and research centers, and current development of road networks in India
CO2	Analyze the road geometric features such as SSD, OSD, horizontal and vertical curves.
CO3	Design roads as per Indian specifications related to flexible and rigid pavements
CO4	Select the pavement materials for construction of roads.
CO5	Practice the construction of various pavement layers and provision of drainage system

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2		1											1
CO2	2		2											2
CO3	2	2	2											2
CO4	2	2	2											1
CO5	2	2	2											1

Traffic Engineering

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S6CVPE21	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	understand the importance of traffic engineering, its performance on road network, knowledge of basic laws relating to regulation, planning, designing and operating to achieve safe and efficient movements of person and goods.

UNIT I

9 Hours

Vehicle and Human Characteristics • Road user – Visual characteristics of the drivers, fields of vision, perception – reaction time, pedestrian characteristics, impact of drugs and alcohol, impact of aging, psychological, personality and related factors. • Vehicle Characteristics – Concept of vehicle, types, concept of design vehicle, turning characteristics of the vehicle, breaking characteristics, acceleration characteristics, stopping distance and application, roadway characteristics. • Traffic Studies: • Traffic volume measurement, data analysis, concept of ADT, AADT, critical hourly volume and its significance, prediction of the traffic growth, importance of peak hour effect. •

UNIT II

9 Hours

Speed Studies: • Spot speed, speed measurements, interpretation of the data – frequency distribution, cumulative frequency distribution curve, relevant applications. • Speed and Delay Studies: • Measurement along the length of the road, assessing the causes of delay, estimation of travel time, computing journey speed, running speed. • Parking Studies: • Inventory, characteristics, on and off-street parking, numerical problems • O & D Studies: • Objectives, methods, presentation of the data and relevant applications. •

UNIT III

8 Hours

Toll Operation Studies: • Fuel, emission and consumption models, air quality models. • Accident Studies: • Factors influencing accidents, data collection, analysis and remedial measures. • Road safety Audit: • Key elements of a road safety audit, stages of audit, work zone, vulnerable zone, school zone, methods for identifying other hazardous road locations, case studies. •

UNIT IV

8 Hours

Traffic Regulation: • Regulation on vehicles, driver, parking, traffic signs (regulatory, warning, informatory), design of traffic signals – cycle length, green phase, red phase, different types of signals – fixed signals, traffic actuator signals, designing the cycle length by Webster method. • Traffic Management: • Restrictions on turning movements, one-way streets, tidal flows, exclusive bus lanes, closing side street, rotary intersection. •

UNIT V

8 Hours

Statistics in Traffic Engineering: • Elements of probability, probability distribution – binomial distribution, normal distribution, Poisson's distribution, sampling, standard deviation, mean, sampling, significance testing, regression analysis, numerical problems. •

TEXT BOOKS:		
1	SK.Khanna, C.E.G Justo, A.Veeraragavan	Highway Engineering, Nem Chand & Bro. ISBN 978-81-85240-72-5, Revised 10th Edition.
2	Dr. L.R.Kadiyali	Traffic Engineering and Transportation Engineering, Khanna publishers, ISBN 81-7409-220-x, 7th edition.

REFERENCES:		
1	C.Jotin Khisty, B.Kent Lall	Transportation Engineering, PHI, ISBN978-81-203-2212-7, 3rd Edition
2		Relevant IRC codes

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Analyze the road user and vehicle factors in overall scope of traffic Engineering.
CO2	Collect the traffic data, analyse and interpret the results.
CO3	Explain the causes of accidents and propose the remedial measures.
CO4	Explain the traffic regulations measures and suggest suitable traffic control devices.
CO5	Apply statistical tools to conceptualize and identify real word events as function of discrete/ continuous distributions.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2											2
CO2	3	2												1
CO3	3	2												1
CO4	3	2												1
CO5	3	2	2											2

Structural Dynamics

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S6CVPE22	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:	
This course will enable students to:	
1	Introduce the students to the basic formulations governing the dynamic response of structural systems
2	Solving the governing equations (analytically or numerically) to obtain the dynamic response to given excitations
3	Analyse the response of SDOF and MDOF systems under dynamic loading
4	Seismic analysis of MDOF using simplified method

UNIT I

9 Hours

Free vibrations of SDOF systems: • Concept of degrees of freedom, Vector representation of simple harmonic motion, equations of motion for SDOF, mathematical model of SDOF system, free vibration response of undamped system, viscous damping, free vibration of damped systems (overdamped, underdamped and critically damped systems), logarithmic decrement •

UNIT II

9 Hours

Response of SDOF to harmonic loading: • Response to harmonic loading of undamped and damped systems, half power method for determination of damping, energy dissipation, response to support motion, vibration transmissibility and isolation, principle of vibration measuring instruments – seismometer and accelerometer •

UNIT III

8 Hours

Response of SDOF to general loading: • Response to periodic forces, Duhamel's integral and direct integration methods, response of SDOF for various loading cases (constant force, rectangular pulse, triangular, linearly varying load), numerical methods applied to dynamic analysis of SDOF. Concept of response spectrum for ground excitations •

UNIT IV

8 Hours

Free vibration response of MDOF systems: • Stiffness of MDOF systems, Lumped and consistent masses for MDOF, natural frequencies and normal modes of MDOF, orthogonality of normal modes, modal superposition-method, Free vibration of MDOFs with special reference to shear buildings. •

UNIT V

8 Hours

Forced vibration analysis of MDOF systems: • Modal transformation method, Seismic analysis of MDOF using response spectrum method •

TEXT BOOKS:

1	Mario Paz and WilliamLeigh	Structural dynamics–Theory and Computation, Elsevier Publications, 5th Ed., 2004.
2	Humar, J. L.	Dynamics of Structures, CRC press, 3rd Edition. 2012.
3	Agarwal P. and Shrikande,M.	Earthquake Resistant Design of Structures, Prentice Hall Ltd, New Delhi,2006

REFERENCES:		
1	Chopra, A.	Dynamics of Structures, 1976
2	Duggal, S. K.	Earthquake resistant design of structures, Oxford University Press, 2013
3	BIS	IS-1893 (Part I): 2016 and IS-13920: 2016

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Formulate and solve the dynamic equilibrium equation for free vibration response of SDOF systems
CO2	Solve the dynamic equilibrium equation for response of SDOF systems to harmonic excitations
CO3	Solve the dynamic equilibrium equation for response of SDOF systems to arbitrary excitations by analytical and numerical methods
CO4	Determine and use natural frequencies and mode shapes of MDOF system
CO5	Analyze MDOFs subjected to dynamic and seismic loads

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2													2
CO2	3	2												2
CO3	3	2												2
CO4	3	2												2
CO5	2	3												2

Advanced Geotechnical Engineering

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S6CVPE23	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:	
This course will enable students to:	
1	Understand the concepts of site exploration and sampling techniques.
2	Understand the stresses in soils due to different types of loading.
3	Understand the lateral earth pressure behind retaining walls and seepage analysis through earth dams.
4	Understand the determination of stability of earth slopes and design of foundations.

UNIT I

9 Hours

Soil Exploration and Sampling Techniques: Introduction, methods of exploration (disturbed & undisturbed samples), planning exploration program, Soil boring (primary boreholes and secondary boreholes), soil sampling (cohesionless soil sampling, disturbed sampling, undisturbed cohesive soil sampling, underwater sampling). Extraction of samples of rock. Standard Penetration Test (SPT), corrections to SPT, SPT correlations. Cone Penetration Test (CPT), CPT correlations for cohesive soil, CPT correlations for cohesionless soils. Geophysical tests (Seismic refraction & electrical resistivity). Ground water table location, number and depth of borings, bore log, soil report. Numerical Problems. • Stresses in soils: Boussinesq's method of stress distribution for point loads, strip loading, loading on circular area. Pressure distribution Diagrams, Isobars, vertical stress distribution on a horizontal plane, vertical stress distribution on a vertical line. Westergaard's method of stress distribution for point loads and loading on circular area. Numerical Problems. •

UNIT II

9 Hours

Lateral earth pressure: Lateral earth pressure at rest, Rankine's active earth pressure, Rankine's passive pressure, Coulomb's active earth pressure, Coulomb's passive earth pressure. Graphical solutions for active and passive earth pressure for cohesionless soils. Numerical Problems. Types of retaining structures, Stability of gravity and RCC concrete cantilever retaining walls, Drainage requirements, Numerical Problems. •

UNIT III

8 Hours

Seepage Analysis: Laplace's equation for flow through soils, characteristics of flow nets, Construction of flow nets for earth dams, sheet pile walls, Phreatic line in earth dams (graphical method), Estimation of quantity of seepage & exit gradient. Numerical Problems. •

UNIT IV

8 Hours

Stability of earth slopes: Types of slopes, types of failure and their causes, Stability of infinite slopes, Stability of finite slopes – Swedish circle method (total stress analysis for cohesive and c-Φ soils), Stability of slopes of earth dams, Taylor's stability number. Numerical Problems. •

UNIT V	
	8 Hours
General Principles of Foundation Design Introduction, Classification of foundations systems. General requirement of foundations, Selection of foundations, Computations of Loads, Design concepts. Combined footings (rectangular & trapezoidal), strap footings & wall footings. • Deep Foundations • Load Transfer in Deep Foundations, Types of Deep Foundations, Ultimate bearing capacity of different types of piles in different soil conditions, Laterally loaded piles, tension piles & batter piles, Pile groups: Bearing capacity, settlement, uplift capacity, load distribution between piles, Proportioning and design concepts of piles. •	

TEXT BOOKS:

1	Gopal Ranjan & ASRRao	"Basic and Applied Soil Mechanics", New Age International publishers, 5thEdition, 2023.

REFERENCES:

1	VNS Murthy	"Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering", CRC Press, 2016.
2	B C Punmia, Ashok Kumar Jainand Arun Kumar Jain	"Soil Mechanics and Foundations", Laxmi Publications Pvt. Ltd., New Delhi, 16th Edition, 2017.
3	Muni Budhu	"Soil Mechanics and Foundations", Wiley India Pvt. Ltd., 3rd Edition,2011

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Evaluate general suitability of the site for the proposed civil project using soil exploration techniques.
CO2	Determine the stresses in soils due to various types of loadings using Boussinesq's and Westergaard's solution.
CO3	Determine the lateral earth pressures on earth retaining structures applying using static equilibrium based on Rankine's and Coulomb's theory.
CO4	Determine the seepage loss and stability in various hydraulic structures.
CO5	Analyze the stability of slopes of simple geometry, including the effect of pore water pressure.
CO6	Identify the type of foundation and design them by using the loads acting over the foundation.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2												
CO2	2	3												
CO3	2	3												
CO4	2	3												
CO5	2	3												
CO6	3	3												

Ground Improvement Techniques

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S6CVPE24	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:	
This course will enable students to:	
1	have knowledge on the problems posed by the problematic soils and the remedies to build the various structures in problematic soils
2	introduce the various types of improvement methods of engineering properties of soils
3	introduce the application of engineering methods to ground improvement projects

UNIT I

9 Hours

Formation and Development of Ground: • Introduction, Formation of Rock, soil and soil profile, Soil distribution in India, Alterations of ground after formation, Reclaimed soils, Natural offshore deposits; Ground Improvement Potential – Hazardous ground conditions, poor ground conditions, favorable ground conditions, Alternative Approaches, Geotechnical processes. • Compaction: • Introduction, compaction mechanics, Field procedure, surface compaction, Dynamic Compaction, selection of field compaction procedures, compaction quality control. •

UNIT II

9 Hours

Drainage Methods: • Introduction, Seepage, filter requirements, groundwater and seepage control, methods of dewatering systems, Design of dewatering system including pipeline effects of dewatering. Drains, different types of drains. • Pre-compression and Vertical Drains: • Importance, Vertical drains, Sand drains, Drainage of slopes, Electro kinetic dewatering, Preloading. •

UNIT III

8 Hours

Chemical Modification-I: • Definition, cement stabilization, sandwich technique, admixtures. Hydration – effect of cement stabilization on permeability, Swelling and shrinkage and strength and deformation characteristics. Criteria for cement stabilization. Stabilization using Fly ash. • Chemical Modification-II: • Lime stabilization – suitability, process, criteria for lime stabilization. Other chemicals like chlorides, hydroxides, lignin and hydrofluoric acid. Properties of chemical components, reactions and effects. Bitumen, tar or asphalt in stabilization. •

UNIT IV

8 Hours

Vibration Methods: • Introduction, Vibro compaction – blasting, vibratory probe, Vibro displacement compaction – displacement piles, vibro flotation, sand compaction piles, stone columns, heavy tamping • Grouting and Injection: • Introduction, Effect of grouting. Chemicals and materials used. Types of grouting. Grouting procedure, Applications of grouting. •

UNIT V

8 Hours

Geosynthetics: • Introduction, Geosynthetic types, properties of Geosynthetics – materials and fibre properties, Geometrical aspects, mechanical properties, Hydraulic properties, Durability ; Applications of Geosynthetics - Separation, Filtration and Fluid Transmission, Reinforcement. • Miscellaneous Methods (Only Concepts & Uses): • Soil reinforcement, Thermal methods, Ground improvement by confinement – Crib walls, Gabions and Mattresses, Anchors, Rock bolts and soil nailing. Stone Column, Micro piles. •

TEXT BOOKS:		
1	Purushothama Raj, P	"Ground Improvement Techniques," Laxmi Publications; First Edition (1999), ISBN-10 : 8131808572, ISBN-13 : 978-8131808573

REFERENCES:		
1	Koerner R.M	"Construction and Geotechnical Methods in Foundation Engineering," McGraw Hill Pub. Co. (1984), ISBN-10 : 0070352453, ISBN-13 : 978-0070352452
2	Bell, F.G.	"Methods of treatment of unstable ground," Butterworth and Company PublishersLimited (1975)
3	Manfred Hausmann	"Engineering principles of ground modification", McGraw-Hill Inc., US, (1989), ISBN-10 : 0070272794, ISBN-13 : 978-0070272798
4	Ingles C.G. and MetcalfJ.B	"Soil Stabilization: Principles and Practice", Butterworth-Heinemann Ltd (1973), ISBN-10 : 0409482153 ISBN-13 : 978-0409482157

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Give solutions to solve various problems associated with soil formations having less strength.
CO2	Use effectively the various methods of ground improvement techniques depending upon the requirements.
CO3	Utilize properly the locally available materials and techniques for ground improvement so that economy in the design of foundations of various civil engineering structures
CO4	Choose different application of geosynthetics and miscellaneous techniques in Ground improvement

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2													
CO2	2													
CO3	2													
CO4	2													

Air Pollution & Control

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S6CVPE25	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	Learn History of air pollution; definition of air pollution and various types of sources and classification ofair pollutants
2	Effects of gaseous and particulate air pollutants on humans, plants and materials; principles of air pollution control and various control equipment at source.
3	Techniques and instrumentation of ambient air sampling, stack monitoring and experimental analysis ofair gaseous and particulate air pollutants.
4	Meteorological components, stability of atmosphere and corresponding plume shapes.
5	Recent problems concerning with global warming, ozone holes, acid rains and smog formation.
6	Standards and legislation, Environmental impact assessment in industrial plant locations and planning.

UNIT I

9 Hours

Introduction • composition of air, Definition of air pollution, Classification of pollutants-natural contaminants, aerosols (particulate matter), dust, smoke mist fog and fumes. Gases and vapours • Primary and secondary pollutants. Smog-photo chemical and coal induced smog. Behavior and fate of air pollutants. wet removal, dry removal and chemical reactions in the atmosphere • Effect of air pollution on human health. Mechanism of action of air pollutants. • Effect of air pollution on animals due to fluorine, arsenic and lead. • Effect of air pollution on plants. Effect of air pollution on properties. •

UNIT II

9 Hours

Meteorological factors affecting air pollution- atmospheric stability and temperature inversions. Wind rose diagram. • Ambient air sampling, collection of gaseous pollutants. Grab samples, absorption in liquids, adsorption on solids. • Freezeout sampling, collection of particulate pollutants. Dustfall jar, high-volume filtration. • Tape sampler, Impringement Electrostatic precipitation •

UNIT III

8 Hours

Control of gaseous contaminants-combustion, absorption and adsorption. • Control of air pollution by equipment-objectives of using control equipment, use of collector in series. Types of collecting equipment-settling chambers-advantages and applications • Inertial separators-principles, types-Baffle type, Louver type and dust traps. • Cyclone separator-advantages, disadvantages and applications Filters-Fabric or cloth filters- Reverse jet filter- Envelope type fabric filter and multiple compartment type bag house. • Electrostatic precipitators. Scrubbers or wet collectors-spray towers, venture, cyclone, packed and mechanical scrubbers •

UNIT IV

8 Hours

Air pollution due to automobiles-Introduction, Exhaust emission, crank case emission and evaporative emission. • Control of exhaust emission-modification in engines, treatment of exhaust gas. Catalytic converters. • Control of evaporative emission and crank case emission. Alternate methods. • Acid rain, Acid rain formation, Effects of acid rain on soil, surface waters, human health, materials, plants and animals • Green house effect- Effects of global warming on Climate, sea level, Water resources, Vegetation, Human health, Human settlement and society, Energy, Clouds and water vapour. Reduction of green house gases •

UNIT V	
	8 Hours
Major air pollution episodes-Bhopal gas episode (1984), London smog (1952), Meuse valley (Belgium 1930), Donora(USA 1948),Poza Rica(Mexico 1950), Tokyo(1967) • Standards and legislation-The air (prevention and control of pollution) act 1981. Constitution of the board, functions of central and state board. Ambient air quality standards, emission standards, penal provision act Air pollution indices-Determination of index. Diaplay Dissemination technique • Legislation to control air pollution and industrial plant location - City planning-factors to be considered. •	

TEXT BOOKS:		
1	Rao M.N. & Rao H.V.N.	Air Pollution, Tata Mc Graw Hill Publishing Company Ltd., 2007, ISBN-13: 9780074518717

REFERENCES:		
1	Anjaneyalu Y	Air Pollution and control Technologies, Allied Publishers (P) Ltd., 2012., ISBN9789387593435
2	Noel DeNevers	Air Pollution Control Engineering, Waveland Press, Inc., 2017.

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Explain the effect of air pollution on humans, animals, plants and Property.
CO2	Explain the methods of collecting air samples
CO3	Explain the methods of controlling gaseous contaminants
CO4	Describe the method of controlling air pollution due to automobiles, effect of acid rains and global warming.
CO5	Describe the major air pollution episodes, legislation to control air pollution and industrial plant location.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1						3						1		
CO2						3						1		
CO3						3						1		
CO4						3						1		
CO5						3						1		

AI & ML

Contact Hours/ week: (L-T-P-S)	3-0-0-3	**Credits:**	3
Total Lecture Hours:	90 = 42 (L)+0(T)+0(P)+48(S)	**CIE Marks:**	50
Sub. Code:	S6CVPE26	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	Understand the concepts of computational intelligence algorithms and programming.
2	Acquiring advanced technologies like ANN, ML, Deep learning

UNIT I

8 Hours

Introduction: What is AI? Acting humanly: The Turing Test approach, Thinking humanly: The cognitive modelling approach, Thinking rationally: The "laws of thought" approach, Acting rationally: The rational agent approach, • Intelligent Agents: Agents and Environments, Rationality, Omniscience, learning, and autonomy, the nature of Environments: Specifying the task environment, Properties of task environments, The Structure of Agents; Agent programs, Simple reflex agents, Modelbased reflex agents, Goal-based agents, Utility-based agents, Learning agents •

UNIT II

8 Hours

Solving Problems By Searching: Problem-solving agents; Well defined problems and solutions, Formulating problems, Example problems; Toy problems, Real-world problems, Searching for solution; Infrastructure for search algorithms, Measuring problem solving performance, Uninformed search strategies, Uniform-cost search, Depth-limited search, Iterative deepening depth-first search, Bidirectional search • Adversial Search: Games, Optimal Decisions in Games; The minimax algorithm, Optimal decisions in multiplayer games, AlphaBeta Pruning •

UNIT III

9 Hours

Machine Learning Introduction: If Data had Mass, The Earth Would Be A Black Hole, Learning; Machine Learning, Types of Machine Learning, Supervised Learning; Regression, Classification, The Machine Learning Process, A Note on Programming • Preliminaries: Some Terminology; Weight Space, The Curse of Dimensionality, Knowing What You Know; Overfitting, Training, Testing, and Validation Sets, The Confusion Matrix, Accuracy Metrics, The Receiver Operator Characteristic (ROC) Curve, Unbalanced Datasets, Measurement Precision,: Testing Machine Learning Algorithms, Turning Data into Probabilities; Minimising Risk, Some Basic Statistics, The Bias-Variance Trade-off. •

UNIT IV

9 Hours

Dimensionality Reduction: Linear Discriminant Analysis (LDA), Principal Components Analysis (PCA), Relation with the Multi-layer Perceptron, Kernel PCA, Methods Comparisons, Problems on LDA and PCA • Learning With Trees: Using Decision Trees, Constructing Decision Trees, Classification and Regression Trees (CART); Gini Impurity, Regression in Trees, Classification Examples and Problems •

UNIT V

8 Hours

Probabilistic Learning: Nearest Neighbour Methods Unsupervised Learning; Clustering: Introduction, Hierarchical Clustering, Agglomerative Clustering, The single Linkage Algorithm, The complete linkage

Algorithm, The Average Linkage Algorithm, Partitional Clustering, Forgy's Algorithm, The k-means Algorithm, Vector Quantization, The K-Means Algorithm, Isodata Algorithm, Problems. •

TEXT BOOKS:		
1	Stuart Russell and Peter Norvig	Artificial Intelligence a Modern Approach, Pearson Education, Third edition, 2010
2	Kothari Dwarkadas Pralhaddas, Samui Pijush	Artificial Intelligence in Civil Engineering, Lambert Academic Publishing, First Edition, 2012
3	Stephen Marsland	Machine Learning, An Algorithmic Perspective, CRC Press, 2nd Edition, 2014, ISBN-13: 978-1466583283
4	Earl Gose, Richard Johnson Baugh, Steve Jost	Pattern Recognition with Image Analysis, Pearson Education, 1996, ISBN-13: 978-0132364157

REFERENCES:		
1	David. L.Poole, Alan K. Mackworth	Artificial Intelligence – Foundations of Computational Agents, Cambridge University Press, 2nd Edition, 2010
2	Nikos D. Lagaros and Vagelis Plevris	Artificial Intelligence Applied in Civil Engineering, MDPI, 2022
3	Elaine Rich, Kevin Knight	Artificial Intelligence, Tata McGraw Hill, 3rd Edition, 2017, ISBN-13: 978-0070087705.
4	Christopher Bishop	Pattern Recognition and Machine Learning, Springer, Softcover reprint of the original 1st Edition, 2016, ISBN-13: 978-1493938438
5	Tom M Mitchell	Machine Learning, Tata McGraw-Hill, 1st Edition, 2017, ISBN-13: 978-1259096952

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Understand and Explore knowledge representation techniques and problem-solving strategies to common Artificial Intelligence (AI) applications
CO2	Discuss the structure of the agents and different types of agents commonly used in AI.
CO3	Differentiate between machine learning algorithms based on learning criteria and parameter employed
CO4	Apply and illustrate the significances of dimensionality reduction techniques for supervised and unsupervised problem solving.
CO5	Design applications to solve real world problems by applying machine learning algorithms such as classification, regression, and clustering

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3													1
CO2	3	2												1
CO3	3	2												1
CO4	3	2												1
CO5	3	3	2											1

Major Project Phase-I

Contact Hours/ week: (L-T-P-S)	0-0-0-0	**Credits:**	0
Total Lecture Hours:	0 = 0 (L)+0(T)+0(P)+0(S)	**CIE Marks:**	0
Sub. Code:	S6CVP1	**SEE Marks:**	0

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

NOTES:

TEXT BOOKS:

REFERENCES:

COURSE OUTCOMES: Upon completion of this course the student will be able to:

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1														
CO2														
CO3														
CO4														

Transportation Engineering Lab

Contact Hours/ week: (L-T-P-S)	0-0-2-0	**Credits:**	1
Total Lecture Hours:	30 = 0 (L)+0(T)+28(P)+2(S)	**CIE Marks:**	50
Sub. Code:	S6CVL01	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	The objective of this course is to expose the students to testing and evaluation of pavement materials namely soil, aggregates and bitumen. Also, to perform bituminous mix design and evaluate the performance of the designed mix.

UNIT I

6 Hours

Tests on Subgrade • Densification (Heavy Compaction) • In-situ Densification (Sand Replacement Method) • Empirical Strength (California Bearing Ratio) •

UNIT II

8 Hours

Aggregates Characterization • Aggregates distribution (Gradation through sieve analysis) • Specific gravity and water absorption • Hardness (Losangeles Abrasion Test) • Toughness (Impact test) • Strength (Crushing test) • Particle shape (Combined Index) •

UNIT III

6 Hours

Bitumen Consistency • Relative density (Specific gravity) • Hardness / Softness (Penetration test) • Flowability (Softening point test) • Elasticity (Ductility test) •

UNIT IV

8 Hours

Marshall Method of Mix Design (Demonstration) • Blending of aggregates (Trial and error method) • Preparation of Marshall test specimens • Marshall Stabilometer • Interpretation of data to arrive at optimum binder content (OBC) •

TEXT BOOKS:

1	S.K. Khanna, C.E.G Justo, and A. Veeraragavan	"Highway Materials and Pavement Testing". Nem Chnad & Bros, Roorkee, India 2013
2	G. Venkatappa Rao, K. Ramachandra Rao, Kaushik Pahari, D.V. Bhavanna Rao	"Highway Material Testing and Quality Control", I.K. International Publishing House Pvt. Ltd. 1st Edition, 2015.

REFERENCES:

1	The Bureau of Indian standards	IS:2720 (Part16)-1987,"Laboratory Determination of CBR", 2nd edition; IS:2720 (Part8)- 1974, "Determination of Water content Dry density Relation: Using Heavy Compaction", 1st edition; IS:2720 (Part28)-1974, "Determination of Dry density OF Soils In-Place, by the SandReplacement Method", 1st edition
2	The Bureau of Indian Standards	"Indian Standard Methods of Test for Aggregate for Concrete, Mechanical Properties, IS:2386(Part3-4)-1963, 2nd edition; Indian Standard Method of Test for Determining Aggregate Impact Value of Soft Coarse aggregates, IS:5460-1970, 2nd edition.

3	The Bureau of Indian Standards	"Indian Standard Methods for Testing Tar and Bituminous Materials: Determination of Specific Gravity", IS:1202-1978; "Indian Standard Methods for Testing Tar and Bituminous Materials: Determination of Penetration", IS:1203-1978; "Indian Standard Methods for Testing Tar and Bituminous Materials: Determination of Softening Point", IS:1205-1978; "Indian Standard Methods for Testing Tar and Bituminous Materials: Determination of Ductility", IS:1208-1978; All 2nd edition

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Conduct laboratory tests on soil, analyze and interpret the data by comparing with relevant standards.
CO2	Conduct laboratory tests on aggregates, analyze and interpret the data by comparing with relevant standards.
CO3	Conduct laboratory tests on bitumen, analyze and interpret the data by comparing with relevant standards.
CO4	Design bituminous mix, conduct laboratory tests on the designed mix, analyze and interpret the data by comparing with relevant standards.
CO5	Function as a team member.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2						2						
CO2	3	2						2						
CO3	3	2						2						
CO4	3	2	2					2						
CO5								2						

Soft Skills

Contact Hours/ week: (L-T-P-S)	0-0-2--2	**Credits:**	0
Total Lecture Hours:	0 = 0 (L)+0(T)+28(P)+-28(S)	**CIE Marks:**	50
Sub. Code:	SHS06	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES: This course will enable students to:	
1	• To make the students aware of the importance of soft skills in the present-day business world and workenvironment
2	• To learn the science behind picking up any skill quickly
3	• To help students realize as well as develop key soft skills interviewers look for – such as changemanagement, professionalism, inter- and intra-personal skills, adaptability etc.
4	• To develop effective resumes (paper-based as well as video)
5	• To understand the importance of and create an effective digital footprint
6	• To provide simulated Group Discussion and Personal Interview experience based on the modelsadopted by reputed companies. • To understand professional etiquette to be displayed in workplaces. • To learn to introspect over one's strengths and weaknesses, and apply them effectively for careergrowth.

ASSESSMENTS PROVIDED	The following assessments are integrated into the training programme to best judge a student's proficiency on soft skills. 1. Team building tasks (Inside training hours) 2. Participation in group activities (Inside training hours) 3. Psychometric test 4. Creating a resume 5. Creating an effective LinkedIn profile 6. Mock Group Discussion (Inside training hours)

UNIT I

6 Hours

How to pick up skills faster?- i) Knowledge v/s. skill ii) Skill introspection iii) Skill acquisition iv) "The 10,000 hours rule" and the converse • Interpersonal and Intrapersonal skill building- Social Interaction i) Interpersonal Communication ii) Peer Communication iii) Bonding iv) Types of social interaction Emotional Management Responsibility i) Types of responsibilities ii) Moral and personal responsibilities • Professional etiquette- Workplace etiquette - meeting room, pantry, cubicle Dining etiquette; Telephone etiquette; Email and Business correspondence etiquette •

UNIT II

6 Hours

Change Management- i) Who moved my Cheese? ii) Tolerance of change and uncertainty iii) Joining the bandwagon iv) Adapting change for growth – overcoming inhibition v) Adapt to changes (tolerance of change and uncertainty) vi) Adaptability Curve vii) Survivor syndrome • Creating a digital footprint- i) How what you post online / information online can affect people's and recruiter's perception about you ii) Usage of LinkedIn to further one's career prospects iii) Managing content that one posts on platforms like Twitter, Facebook, Instagram etc. to create positive footprint about oneself iv) Why is it important to leave a digital footprint? • Time Management- i) Prioritization - Time Busters ii) Procrastination iii) Scheduling iv) Multitasking v) Monitoring vi) Working under pressure and adhering to deadlines •

UNIT III

6 Hours

roup Discussion - Basics- i) Importance of GD round ii) Skills assessed in a GD iii) How to ace a GD iv) Do's and Don'ts in a GD v) Idea generation techniques vi) One mock GD involving 12 volunteers, facilitated by the trainer • Personal Interview - Basics- i) Self-introduction practice. ii) Body language – especially grooming - for personal interview. iii) Personal interview – FAQs discussion. • Building a

resume from scratch- i) How to write a good and impressive Resume. ii) Important aspects of an impressive resume. iii) Sample template and formatting ideas.

UNIT IV

6 Hours

Group Discussion - Advanced- i) GD sample Video with analysis and discussion. ii) GD Do's and Don'ts – Worksheet practice. iii) Role plays for Do's and Don'ts. iv) Idea generation – worksheet practice. • Personal Interview - Advanced- i) Extensive discussion on PI FAQs. ii) Interview questions from based on resume – discussion iii) PI Videos - discussion and analysis. iv) Highlighting successful answers for PI- questions. v) Body language during a personal interview. vi) Unconventional types of interviews (Stress panel, MR, Guesstimation)

UNIT V

6 Hours

Resume Writing - Workshop (Drafting a paper-based as well as a video resume)- i) Resume writing – Worksheet practice. ii) 3 stage Resume drafting iii) Rough draft-1. iv) Rough draft -2. v) Fair draft. vi) Discussion on specific aspects of an impressive Resume. vii) Creating a video resume • Setting and achieving targets- i) Ambition, goal, passion and career objective –difference ii) SMART goals and Action plans iii) Obstacles -Failure management (case studies) • Introspection- i) Identify your USP - Unique Selling Proposition ii) Recognize your strengths and weakness (SWOT) iii) Nurture strengths iv) Fixing weakness v) Overcoming your complex vi) Confidence building

UNIT VI

6 Hours

Group Discussion - Mock- i) Mock Group Discussions featuring groups of 10 people, with each GD lasting for 15 minutes. ii) Detailed feedback for each participant iii) Introspection by the audience to add value to the GD • Personal Interview - Mock- i) Mock personal interview for a sample set of candidates ii) Simulate the real personal interview experience. iii) Individual feedback and areas of improvements are shared.

TEXT BOOKS:

1	Spencer Johnson	'Who moved my Cheese?'
2	Malcolm Gladwell	'Outliers'
3	Daniel Goleman	'Emotional Intelligence'
4	Scott Peck M	'Road Less Travelled'
5	Dale Carnegie	'How to win friends and influence people'

REFERENCES:

COURSE OUTCOMES: Upon completion of this course the student will be able to:

CO1	• Display key soft skills expected by recruiters
CO2	• Be able to apply scientific methods to learn any skill quickly
CO3	• Participate in Group Discussions and Personal Interviews effectively
CO4	• Create effective resumes that impress interviewers (paper-based as well as video)
CO5	• Apply professional etiquette to be displayed in various workplace scenarios
CO6	• Set and achieve targets – work-place based as well as personal

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1														
CO2														
CO3														
CO4														