Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name	**: Diploma In Civil Engineering**		
Programme Code	**: CE**	**With Effect From Academic Year**	**: 2023-24**
Duration Of Programme	**: 6 Semester**	**Duration**	**: 16 WEEKS**
Semester	**: Sixth** **NCrF Entry Level : 4.0**	**Scheme**	**: K**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme											
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																							
1	MANAGEMENT	MAN	AEC	315301	1	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125
2	CONTRACTS AND BILLING	CAB	DSC	316307	1	4	-	2	2	8	4	3	30	70	100	40	25	10	-	-	25	10	150
3	DESIGN OF RCC AND STEEL STRUCTURES	DRS	DSC	316308	1	4	2	4	2	12	6	4	30	70	100	40	25	10	25#	10	25	10	175
4	MAINTENANCE AND REPAIRS OF STRUCTURES	MRS	DSC	316309	2	4	-	2	-	6	3	3	30	70	100	40	25	10	-	-	-	-	125
5	CAPSTONE PROJECT	CPE	INP	316004	-	-	-	2	2	4	2	-	-	-	-	-	50	20	50#	20	50	20	150
ELECTIVE COURSE- II (Any - One)																							
6	BUILDING SERVICES	BSE	DSE	316310	2	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175
	EARTHQUAKE RESISTANT BUILDING	ERB	DSE	316311	-	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175
	SOLID WASTE MANAGEMENT	SWM	DSE	316312	2	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175
Total					**7**	**18**	**2**	**12**	**8**		**20**		**150**	**350**	**500**		**150**		**100**		**150**		**900**

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends : @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , AbilityEnhancement Course (AEC) , Skill Enhancement Course (SEC) , GenericElective (GE)

Programme Name/s	**: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Computer Science/ Textile Technology/ Electronics & Computer Engg.**
Programme Code	**: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ SE/ TC/ TE**
Semester	**: Fifth / Sixth**
Course Title	**: MANAGEMENT**
Course Code	**: 315301**

I. RATIONALE

Effective management is the cornerstone of success for both organizations and individuals. It empowers diploma engineers/ professionals to accomplish their tasks with finesse and efficiency through strategic planning and thoughtful execution, projects can optimize finances, enhance safety measures, facilitate sound decision-making, foster team collaboration and cultivate a harmonious work environment. The diploma engineers require leadership and management skills with technical knowledge of the core field to carry out various tasks smoothly. This course aims to instill fundamental management techniques, empowering diploma engineers/ professionals to enhance their effectiveness in the workplace.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Apply the relevant managerial skills for achieving optimal results at workplace.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use relevant management skills to handle work situation
- CO2 - Apply appropriate techniques of product, operations and project management
- CO3 - Use comprehensive tools of recent management practices
- CO4 - Plan suitable marketing strategy for a product / service
- CO5 - Utilize supply chain and human resource management techniques for effective management

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

MANAGEMENT **Course Code : 315301**

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315301	MANAGEMENT	MAN	AEC	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125

Total IKS Hrs for Sem. : 1 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

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2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Justify the importance of management thoughts in Indian knowledge system. TLO 1.2 Describe the importance of management in day to day life. TLO 1.3 Explain Henry Fayol’s principles of management. TLO 1.4 Describe the role of each level of management in its management hierarchy. TLO 1.5 Practice the self management skills for a given situation TLO 1.6 Apply the required managerial skills for a given situation	**Unit - I Introduction to Management** 1.1 Evolution of management thoughts from ancient/medieval to modern times in India (IKS) 1.2 Management: meaning, importance, characteristics, functions & challenges. 1.3 Introduction to scientific management- Taylor's & Fayol's principles of management 1.4 Levels & functions of management at supervisory level. 1.5 Self management skills: Self awareness, self discipline, self motivation, goal setting, time management, decision making, stress management, work life balance and multitasking 1.6 Overview of Managerial Skills: negotiation skills, team management, conflict resolution, feedback, leadership	Presentations Case Study Interactive session Quiz competition Mixed Picture Puzzle

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Identify the appropriate creativity technique for new product development TLO 2.2 Describe the new product development process for a product / service TLO 2.3 Comprehend the importance of various strategic steps Product Management TLO 2.4 Elaborate Agile product management TLO 2.5 Explain the significance of the Project Management TLO 2.6 Describe the various tools of project management	**Unit - II Product, Operations and Project Management** 2.1 Creativity and innovation management: creativity techniques - brainstorming, checklist, reverse brainstorming, morphological analysis, six thinking hats. 2.2 New product development, change management 2.3 Product Management -meaning, strategic steps for sustainable design of a product 2.4 Agile product management- concept, benefits, principles and manifesto 2.5 Project Management: importance, areas within project management,4Ps and phases 2.6 Tools of Project Management: PERT and CPM, GANTT & Chart Overview of Estimate and Budget	Presentations Case Study Video Demonstrations Presentations Role Play
3	TLO 3.1 Understand the importance of quality management tools TLO 3.2 Explain the importance of various techniques for optimization and waste minimization TLO 3.3 State the importance of ISO quality standards TLO 3.4 Describe ERP TLO 3.5 State the importance of ISO TLO 3.6 Recognize the importance of customer satisfaction as a competitive advantage	**Unit - III Management Practices** 3.1 Quality circle, kaizen, Six Sigma, TQM 3.2 5S, Kanban card system, TPM, Lean Manufacturing: Meaning, Steps and Importance 3.3 Quality Standards and ISO: Meaning, ISO 9001:2016, ISO 14000, OSHA 2020 3.4 The overview of ERP along with example 3.5 Service quality and customer/client satisfaction, servicescape	Presentation Case study Interactive session Quiz Video Demonstration Lecture Using Chalk-Board
4	TLO 4.1 Explain the importance of marketing techniques TLO 4.2 Explain the importance of needs, wants and desires in marketing TLO 4.3 Interpret the traditional and digital marketing techniques TLO 4.4 Plan different aspects of an event management	**Unit - IV Marketing Management** 4.1 Marketing management: meaning, significance, Seven P's of Marketing 4.2 Needs, wants and demands in marketing. Customer relationship management 4.3 Types of marketing: traditional and digital marketing 4.4 Event management: types, different aspects of event management, crisis management	Case Study Interactive session based video Role Play Flipped Classroom Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 State the importance of supply chain and logistics management TLO 5.2 Explain the components of supply chain and logistics Management TLO 5.3 Describe the role of information technology in supply chain & logistics management TLO 5.4 State the significance of Human Resource Management TLO 5.5 Analyze the various methods of recruitment, selection and training for an organization TLO 5.6 List the qualities of a successful supervisor	**Unit - V Supply Chain & Human Resource Management** 5.1 The overview of Supply Chain and logistics Management 5.2 Components of Supply Chain and logistics Management 5.3 Role of information technology in supply chain & logistics management 5.4 Overview of Human Resource Management-Meaning,significance,scope and principles 5.5 Recruitment, selection and training of human resources. Chalk Circle 5.6 Qualities of a successful supervisor /team leader and types of leadership	Presentations Video Demonstrations Case Study Collaborative learning Video Demonstrations Chalk-Board

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment / Article

- Make a one page note based on a book of management you read.
- Write a short article on inventory management exploring online learning resources.
- Prepare a report on ISO standards applicable to your field. a. IATF 16949-2016 / SLA-TS 16949-2016, - Automotive Industry b. ISO 22000 — Food safety management c. ISO 50001 — Energy management d. ISO/IEC 27001 - Cyber Security e. ISO/DIS 4931-1 - Buildings and civil engineering works
- Prepare a 4 quadrant matrix of time management for managing the tasks.
- Prepare a report on any one software used for Supply Chain and Logistics Management.
- Prepare a GANTT Chart for project management related to your field.

Note Taking

- Watch a Tedx Talk Video on managerial skills and take notes in the form of keywords.

Case Study

- Prepare a case study and discuss the same on following topics a.Self Management Skills b.Six Thinking Hats c.Kaizen d.Quality Circle e.Safety Measures in different organizations related to your field
- Study the recruitment and selection process of any organization related to your field.
- Prepare a case study on management lessons based on life of Chhatrapati Shivaji Maharaj
- Conduct outbound training on managerial skills. Make a video and upload on social media.

Quizes

- Participate in online quizzes related to areas of management .

Assignment

- Workshops to be conducted for students on following topics a. creativity techniques b. time management c. stress management d. negotiation and conflict e. goal setting f. meditation new product development

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED : NOT APPLICABLE

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Management	CO1	13	8	6	4	18
2	II	Product, Operations and Project Management	CO2	8	2	4	6	12
3	III	Management Practices	CO3	8	4	4	6	14
4	IV	Marketing Management	CO4	8	2	4	6	12
5	V	Supply Chain & Human Resource Management	CO5	8	4	4	6	14
Grand Total				**45**	**20**	**22**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- MCQ Based Class Test, Self Learning Activities / Assignment

Summative Assessment (Assessment of Learning)

- Summative Assessment (Assessment of Learning) MCQ based

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3

CO1	1	1	1	-	-	2	3			
CO2	1	3	3	-	1	3	3			
CO3	1	3	1	-	1	1	3			
CO4	1	2	2	-	1	2	3			
CO5	1	1	2	-	1	2	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	A. K. Gupta	Engineering Management	S. Chand, ISBN: 81-219-2812-5, 2007, 2nd Edition
2	O. P. Khanna	Industrial Engineering &management	Dhanpat Rai Publication, ISBN: 978-8189928353, 2018
3	Harold Koontz and Heinz Weinrich	Essentials of Management	Tata McGraw Hill Education ISBN: 9789353168148, 2020, 12th edition
4	E. H. McGrath	Basic Managerial Skills for All	PHI ISBN: 978-8120343146, 2011, 9th Edition
5	Andrew DuBrin	Management Concepts and Cases	Cengage Learning, ISBN: 978-8131510537, 2009, 9th edition
6	K. Dennis Chambers	How Toyota Changed the World	Jaico Books ISBN: 978-81-8495-052-6, 2009
7	Jason D. O'Grandy	How Apple changed the Wolrd	Jaico Publishing House ISBN: 978-81-8495-052-0, 2009
8	Subhash Sharma	Indian Management	New Age International Private Limited ; ISBN-978-9389802412, 2020, 1st edition
9	Chitale, Dubey	Organizational Behaviour Text and Cases	PHI LEARNING PVT. LTD., ISBN: 978-9389347067, 2019, 2nd Edition

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.debonogroup.com/services/core-programs/six-thinking-hats/	Six Thinking Hats
2	https://hbr.org/1981/09/managing-human-resources	HR Management
3	https://theproductmanager.com/topics/agile-product-management/	Agile Product Management
4	https://www.cdlogistics.ca/freight-news/the-5-components-of-supply-chain-management	Supply Chain Management
5	https://www.infosectrain.com/blog/understanding-the-concepts-of-gantt-chart-and-critical-path-methodology-cpm	PERT, CPM, GANTT Chart
6	https://www.simplilearn.com/best-management-tools-article	Management Tools
7	https://www.psychometrica.in/free-online-psychometric-tests.html	Psychometric Tests
8	https://www.investopedia.com/terms/e/erp.asp	ERP
9	https://asq.org/quality-resources/quality-management-system	QMS
10	https://testlify.com/test-library/creative-thinking/	Psychometric Tests
11	https://www.mindtools.com/	Management Skills
12	https://www.investopedia.com/terms/d/digital-marketing.asp	Digital Marketing

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MANAGEMENT **Course Code : 315301**

MSBTE Approval Dt. 24/02/2025 **Semester - 5 / 6, K Scheme**

CONTRACTS AND BILLING **Course Code : 316307**

Programme Name/s	**: Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/**
Programme Code	**: CE/ CR/ CS/ LE**
Semester	**: Sixth**
Course Title	**: CONTRACTS AND BILLING**
Course Code	**: 316307**

I. RATIONALE

For infrastructure development various construction projects are required to be undertaken. These projects are to be executed by entering into a legal contract. Therefore, a diploma student is expected to have adequate knowledge of different types of contract and relevant accounting procedures. This course is essential for ensuring that students are equipped with the skills of executing the contract through its provisions.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Evaluating Tender for construction projects

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Implement the Public Works Department procedure for initiating the works.
- CO2 - Draft the contract document for given civil engineering works.
- CO3 - Prepare the tender documents for the given civil engineering work.
- CO4 - Use the prescribed formats to pay the bill of the executed work
- CO5 - Prepare the detailed specification for various items of construction work.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316307	CONTRACTS AND BILLING	CAB	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	-	-	25	10	150

Total IKS Hrs for Sem. : 1 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

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4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
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7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

CONTRACTS AND BILLING **Course Code : 316307**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Daw the flowchart representing organization structure of PWD. TLO 1.2 1b. Explain the roles and responsibilities of engineering personnel in the PWD. TLO 1.3 1c. Explain the PWD procedure followed for the construction of the given work. TLO 1.4 1d. Justify the relevant method of contracting for the given type of work adopted in PWD.	**Unit - I Fundamentals of Execution of PWD works.** 1.1 Organization structure of Public Works Department (PWD). 1.2 Roles and responsibilities of engineering personnel, Financial powers if any. 1.3 PWD Procedure of initiating the work . 1.4 Methods used in PWD for carrying out works- contract method, departmental method -rate list method, piece work method, day's work method, employing labours on daily wages basis.	Lecture Using Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 Explain the requirements of valid contract in the given situation. TLO 2.2 Justify the necessity of provision/s made regarding breach of contract in given contract TLO 2.3 Classify the construction Contracts based on the given criteria. TLO 2.4 Explain the significance of FIDIC contract along with its provisions. TLO 2.5 Illustrate the Registration process of contractor in the given class in Public Works Department (PWD). TLO 2.6 Justify the importance of Built operate transfer (BOT) contract in the given situation.	**Unit - II Contracts: Types and Clauses** 2.1 Definition of contract, Objects of contract, requirements of valid contract, 2.2 Indian Contract Act 1872 – objectives of the act, Clauses related to contract formation, contract performance, breach of contract, importance of workman's compensation act on construction projects only 2.3 Types of engineering contract with advantages, disadvantages and their suitability- Lump sum contract, item rate contract, percentage rate contract, labour contract, demolition contract, target contract, negotiated contract, All in contract, Engineering Procurement Construction Contract (EPC),(IKS*-Informal Agreements and Oral Contracts) 2.4 FIDIC Contract – Introduction, different books used with colour code, Conditions and Provisions of red book for contractor and Employer 2.5 Classification of contractor on basis of financial limits, Requirement of documents for registration of contractor in Public Works Department (PWD). 2.6 Built Operate Transfer (BOT) Contract: Objectives, scope, advantages, Disadvantages, Provisions, conditions, etc with relevant examples.	Lecture Using Chalk-Board Presentations Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Justify the need of the tender document for the given situation. TLO 3.2 Explain the given relevant terms related to tendering procedure. TLO 3.3 Draft the Notice Inviting Tender (NIT) for the given type of work. TLO 3.4 Reproduce the prescribed relevant format/s used in tender document. TLO 3.5 Use the relevant condition of contract in the given situation. TLO 3.6 Explain the process of Two envelope system for submitting tender document. TLO 3.7 Justify the necessity of implementing E- Tendering system for the given type of work. TLO 3.8 Explain the significance of the arbitration clause/s used in the given contract in resolving the disputes raised during execution of work.	**Unit - III Tender and Arbitration** 3.1 Tender - Definition, necessity, Types -local, Global, open, Limited and negotiated tender 3.2 Terms used in tender documents: - Earnest Money Deposit (EMD), Security deposit (SD), Additional Performance Security Deposit, Validity period, right to reject one or all tenders, corrigendum to tender notice and its necessity. 3.3 Notice Inviting Tender (NIT) -Points to be included while drafting tender notice. 3.4 Tender documents – Index, tender notice, general instructions, special instructions, schedule A, Schedule B, schedule C. 3.5 Conditions of tender documents – contract conditions-time limit, time extension, penalty, defective material and workmanship, termination of contract, suspension of work, subletting of contract, extra items, price variation clause(escalation), defect liability Period, liquidated and un-liquidated Damages 3.6 Procedure of submitting filled tender Document (Two envelope system) by offline method, procedure of opening tender, comparative statement, scrutiny of tenders, award of contract, acceptance letter and work order 3.7 E -Tendering System – Online procedure of Submission of Tender in PWD, Online procedure of opening of Tender in PWD 3.8 Arbitration- Meaning, Qualification of an arbitrator, appointment, Causes and Settlement of disputes, Powers and duties of Arbitrator, Award of result. Important features of Arbitration and Conciliation Act - 1996	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom
4	TLO 4.1 Record the measurements of relevant work/s in the measurement book for payment. TLO 4.2 Explain the relevant terms associated with advances and payment of the given civil work. TLO 4.3 Billing procedure used for the given type of work with reference to issue of materials etc. from the department/ owner.	**Unit - IV Measurements and Accounts** 4.1 Various account forms and their uses – Measurement Books, E- Measurement book(E-MB), Completed Measurements, Nominal Muster Roll(NMR)- Issue and write of muster roll, Imprest Cash, Indent, Invoice, Bills, Vouchers, Hand receipt, Cash Book, Temporary Advance 4.2 Mode of Payment to the contractor and its necessity - Interim Payment, Advance Payment, Secured Advance, Petty advance,Mobilization advance, First And Final bill, Final bill, Running account bill, retention money, Reduce rate payment.(IKS*- Remuneration system : Builders and artisans were often paid in grain, land, royal patronage, or other goods rather than cash) 4.3 PWD Stores procedure	Lecture Using Chalk-Board Presentations Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Justify the importance of specification for construction work TLO 5.2 Classify the specifications based on the given criteria TLO 5.3 Explain the provisions made in specifications for given condition. TLO 5.4 Draft a detailed specification for a given items of engineering structure. TLO 5.5 Explain legal aspects related to specification of items of construction work	**Unit - V Specifications** 5.1 Specification- Definition Necessity and importance, points to be observed in framing specifications of an item. 5.2 Types of specification - Brief and Detailed, Standard and Manufacturers Specification 5.3 Provisions made in detailed specifications - Conditions relating to documents, general obligations of contractors, relating to Labor, execution of the work, measurements and payments, the default and non-completion of work, the settlement of disputes. 5.4 Preparing Detailed Specifications of items such as Excavation, PCC, Brick work, Internal and external plastering work, RCC work of Building construction, Canal lining, reinforcement, waterproofing of Irrigation Structures, WBM road, Bituminous road of transportation structures and Cast iron water pipes of Public health structures 5.5 Legal aspects of Specification.	Lecture Using Chalk-Board Presentations Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Organize of various activities required for initiating the works	1	*Develop the format for sequential activities involved in initiation of the given type of work	2	CO1
LLO 2.1 Evaluate the elements of given contract	2	*Prepare a detailed report on evaluation of elements of given contract of the project.	2	CO2
LLO 3.1 Identify the BOT projects to write a review on it.	3	Write a critical review on any one BOT project in your locality with your suggestions / recommendations.	2	CO2
LLO 4.1 Examine any five tender notices from the known source to offer your comments.	4	*Collect tender notice and write report.	2	CO3
LLO 5.1 Draft minimum two NIT for the given type of construction work.	5	*Prepare a NIT from the given data for the Construction of given structure.	2	CO3
LLO 6.1 Draft minimum two NIT for a work through E-tendering.	6	Prepare a NIT from the given data for the Construction of given structure through E tendering	2	CO3
LLO 7.1 Analyze of given tender documents.	7	*Interpret the given elements of tender document with justification.	2	CO3
LLO 8.1 Identify the documents required for E-tendering.	8	Prepare list of documents that are required to submit the tender through E tendering.	2	CO3
LLO 9.1 Identifying the documents required for preparing tender document for the given civil engineering structure in a group of five students on the basis of provided/collected detailed estimate with respect	9	*Prepare Tender document for the construction of a structure prepared in Estimating and Costing.	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Prepare Tender document for the given civil engineering structure in a group of five students on the basis of detailed estimate provided/collected by teacher/student. Generally prepared Brief tender n	10	*Prepare Tender document for the construction of a structure prepared in Estimating and Costing.	2	CO3
LLO 11.1 Prepare Tender document for the given civil engineering structure in a group of five students on the basis of detailed estimate provided/collected by teacher/student. Generally prepared Brief tender n	11	*Prepare Tender document for the construction of a structure prepared in Estimating and Costing.	2	CO3
LLO 12.1 Interpret contract litigation resolution through arbitration.	12	Interpret the given case study on, 'Contract litigation resolution through arbitration' and write your suggestions.	2	CO3
LLO 13.1 Record the measurements in the prescribed format of measurement book for minimum five items of works with abstract, completion certificate and prepare final bill for payment with relevant form of bill	13	*Prepare final bill of works.	2	CO4
LLO 14.1 Draft Detailed specification for following items related to building constrution – a) P.C.C. bed concrete for foundation b) U.C.R.masonry in foundation and plinth c) Burnt brick masonry in CM in sup	14	*Compose Specification for given items related to building construction.	2	CO5
LLO 15.1 Prepare minimum one case study on unbalanced tender and ring formation.	15	Draft case study of unbalanced tender and ring formation.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Prepare power point presentation on Procedure of "E-Tendering".
- Collect various account forms used in any one of following organization and write report on it. MHADA/PWD/CIDCO etc.
- Arrange Expert session on tendering processes commonly used by Private/Non Government contractors for the construction work.
- Give seminar on relevant topic.
- Preparing report on procedure of registration as a contractor in different organizations.
- Prepare power point presentation on given topic.
- Prepare detailed specification for any two item for following structure – Transportation Structure/Public Health structures/Irrigation structures.

Micro project

- Prepare a report on provisions made in arbitration conciliation act 1996.
- Visit to ongoing project and study various aspects related to accounting process (MB, RA bill, various advances).
- Visit to ongoing project and study various aspects related to contracts and tender document.
- Prepare a report on significance and applicability of GST in construction contracts.
- Write salient features of contract clauses included in Indian Contract Act 1872.

- Prepare a report on software used in tender related activities.
- Draft detailed specification for minimum one items for following structures – Transportation Structures, Irrigation Structures and Public Health Structures.
- Compare the tender documents of similar work of three different organizations.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	1.Computer system with Internet Connection	1,3,4,6,8,9,10,11

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals of Execution of PWD works.	CO1	8	4	4	0	8
2	II	Contracts: Types and Clauses	CO2	14	2	8	6	16
3	III	Tender and Arbitration	CO3	20	4	4	16	24
4	IV	Measurements and Accounts	CO4	8	2	4	4	10
5	V	Specifications	CO5	10	2	4	6	12
Grand Total				**60**	**14**	**24**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Term work of 25 marks based on progressive assessment
- SLA of 25 marks based on assignments of 10 marks and microproject of 15 marks

Summative Assessment (Assessment of Learning)

- NOT APPLICABLE

XI. SUGGESTED COS - POS MATRIX FORM

CONTRACTS AND BILLING **Course Code : 316307**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	-	-	2	1	2			
CO2	2	1	1	1	2	1	2			
CO3	2	1	2	2	2	2	2			
CO4	1	-	-	2	1	1	1			
CO5	2	-	2	1	2	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Datta, B.N.	Estimating and Costing in Civil engineering	UBS Publishers Pvt. Ltd. New Delhi. ISBN:9788174767295
2	Raina, V. K.	Construction Management and Contract Practices	Shroff Publishers & Distributers Pvt. Ltd. New Delhi ISBN: 9788184047875,
3	Rangawala, S.C.	Estimating and Costing	Charotar Publishing House PVT. LTD., Anand (Gujrat) Reprint -2011
4	Birdie,G.S.	Estimating and Costing	Dhanpat Rai. New Delhi 2016 ISBN : 978-93-84378-13-4
5	Patil, B.S.	Civil Engineering Contracts and Estimates	Orient Longman, Mumbai, Ed.2010 ISBN: 9788173715594, 8173715599
6	Chakraborti, M.	Estimating and costing, specification and valuation in civil engineering	Monojit Chakraborti, Kolkata ISBN: 818530436.

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	www.mahapwd.com	PWD official website.
2	https://mahatenders.gov.in	PWD official website realted to tender.
3	https://eprocure.gov.in/eprocure/app	e-tendering for construction and other government procurement processes.
4	https://nhai.gov.in/#/tenders	NHAI posts construction and maintenance tenders related to national highways and expressways
5	https://nhai.gov.in/nhai/sites/default/files/mix_file/BOT-Pr ojects-FY.pdf	This portal by the Indian government provides detailed information on BOT projects, across various sectors like roads, railways, airports, and urban infrastructure.
6	https://www.irc.nic.in/Tenderarchive.aspx	The Indian Roads Congress (IRC) publishes archive tenders with start and end date
7	https://cpwd.gov.in/cpwde_tender.aspx	Details about e-Tenders
8	https://www.youtube.com/watch?v=-wxYHWCe1Ok	E Tendering Training
9	https://www.youtube.com/watch?v=G3M1ffidoao	E-Tender filling process

CONTRACTS AND BILLING **Course Code : 316307**

Sr.No	Link / Portal	Description

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

DESIGN OF RCC AND STEEL STRUCTURES **Course Code : 316308**

Programme Name/s	**: Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/**
Programme Code	**: CE/ CR/ CS/ LE**
Semester	**: Sixth**
Course Title	**: DESIGN OF RCC AND STEEL STRUCTURES**
Course Code	**: 316308**

I. RATIONALE

Design of RCC & Steel Structure is an important course in civil engineering discipline having significant contribution in making the structure more durable and safe. However, Design of structural members with maximum efficiency & minimum cost is always a challenge to the Engineers. Therefore, Structural design analysis is required to ensure that the structure complies with the relevant design codes and safety requirements. It is also worthy to mention here that main purpose of structural steel design is to check the viability of steel for any kind of project. An in-depth analysis will enable the decision makers to take the appropriate decisions regarding the load and the wind speed that can be sustained by a structure and its overall capability in other environmental conditions. A civil engineer is expected to have the basic understanding of these design and analysis principles and methods to ensure the safety of structures. With this intention, this course is designed to develop basic competency among the diploma students.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified, Industry / Employer Expected Outcome through various teaching and learning experiences:
Design the given RCC/ steel structural component using the relevant method.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Explain the given criteria in relation to RCC and steel structures.
- CO2 - Design the reinforced concrete beams for given condition as per IS codes
- CO3 - Design the given type of slab for the given edge condition.
- CO4 - Design of axially loaded short columns and footings.
- CO5 - Design the connections for the given steel joints.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316308	DESIGN OF RCC AND STEEL STRUCTURES	DRS	DSC	4	2	4	2	12	6	4	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 1 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Select the material of required specification as laid in relevant IS for construction of RCC. TLO 1.2 Explain the given terms used in RCC design. TLO 1.3 Identify different types of loads, as per IS:875-1987. TLO 1.4 Identify the components of the given steel structure. TLO 1.5 Use the steel table to check the dimensions of identified sections.	**Unit - I Fundamentals of RCC and Steel Structures** 1.1 RCC; Definition, functions of reinforcement, materials required with their properties, use of IS:456-2000 1.2 Definition and types of limit states, partial safety factors for material strength, characteristic strength 1.3 Types of loads, use of IS:875-1987, characteristic load, design load 1.4 Steel structures: Steel as a structural material - Advantages, disadvantages. Functions and components of towers, roof trusses, water tanks, bridges, gantry and crane girders, columns, chimney, frames etc. 1.5 Types of sections used, Grades of steel and strength characteristics use of steel table IS 808-1989. (IKS*: Iron Beam used in the construction of Jagannath temple of Puri & Sun Temple of Konark in Orissa.)	Lecture Using Chalk-Board Video Demonstrations Presentations Hands-on Flipped Classroom

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Discuss the various code provisions for limit state of flexure. TLO 2.2 Draw the stress-strain diagram for singly reinforced sections TLO 2.3 Differentiate between under-reinforced, over-reinforced, and balanced sections in RCC design. TLO 2.4 Design of singly reinforced rectangular beam using limit state method TLO 2.5 Draw the stress-strain diagram for doubly reinforced sections. TLO 2.6 Calculate the shear reinforcement for the given structural section. TLO 2.7 Determine the development length in tension and compression as per IS code provision.	**Unit - II Analysis and Design of Beam** 2.1 Limit State of collapse (flexure) : assumptions, IS specifications regarding spacing, cover, minimum reinforcement, effective span in beams 2.2 Stress-strain diagram for singly reinforced section, design parameters and constants, ultimate moment of resistance 2.3 Under- reinforced, over-reinforced and balanced sections 2.4 Analysis and design of singly reinforced section,: determination of design constants, ultimate moment of resistance, ultimate load carrying capacity, design of rectangular sections. 2.5 Introduction of Doubly reinforced section, conditions for providing doubly reinforced beams. Stress-strain diagram for Doubly reinforced section (No Numerical will be asked on doubly reinforced section) 2.6 Shear: Meaning of shear in beams and slabs. IS code specifications. Various forms of shear reinforcement .Use of bent up bars. Zones of minimum shear reinforcement. Numerical problems on design of shear reinforcement in beam. 2.7 Bond: Meaning of bond as per IS code provisions. Meaning and calculation of development length in tension and compression.	Lecture Using Chalk-Board Video Demonstrations Presentations Demonstration Hands-on
3	TLO 3.1 Suggest the relevant type of slab for the given support condition. TLO 3.2 Check the serviceability of slabs for deflection criteria. TLO 3.3 Design one-way and cantilever slabs, including development length check. TLO 3.4 Design two-way slabs with four edges discontinuous, including torsion reinforcement at corners and deflection check as per IS 456:2000	**Unit - III Design of Slabs** 3.1 Slabs, support conditions, I.S. specifications regarding main steel, distribution steel, spacing and cover for reinforcement, effective span, minimum reinforcement 3.2 Limit state of serviceability of slabs for deflection criteria only 3.3 Design of one-way and cantilever slab including development length check only 3.4 Design of two-way slab with four edges discontinuous and provision of torsion reinforcement at corners (As per IS 456:2000, table no 26 case no 9 only). Check for deflection only.	Lecture Using Chalk-Board Video Demonstrations Presentations Demonstration Hands-on

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Explain the salient features of limit state of collapse in compression. TLO 4.2 Describe IS specifications for reinforcement in columns TLO 4.3 Perform load analysis for axially loaded columns in given situation. TLO 4.4 Design axially loaded short column of square and rectangular cross section. TLO 4.5 Suggest the relevant type of footing for the given situation TLO 4.6 Describe IS specifications for reinforcement in footings TLO 4.7 Design isolated square sloped footings with flexural design checks for given type of shear.	**Unit - IV Design of axially loaded short Columns and footing** 4.1 Limit state of collapse in compression, assumptions, effective length, slenderness ratio, short and long columns, and minimum eccentricity. 4.2 IS specifications for reinforcement in column 4.3 Load analysis for a column : load on an axially loaded column from beams at a different floor levels in a building 4.4 Design of axially loaded short column of square and rectangular section (IKS*:Construction of pillar in meenakshi amman temple and Sri Kalahasti Temple etc.) 4.5 Various RC footings : Isolated and Sloped footings, combined footings, piles 4.6 IS specifications for reinforcement in footing 4.7 Design of isolated square sloped footing: Flexural design with checks for bending moment, one-way shear, two-way shear and bond. (Problems on design of footing restricted to one check only in theory examination)	Lecture Using Chalk-Board Video Demonstrations Presentations Demonstration Hands-on
5	TLO 5.1 Discuss the various steel connection with their modes of failure. TLO 5.2 Describe IS specifications for bolt holes in bolted connections. TLO 5.3 Determine the strength of bolts in shear, and tension. TLO 5.4 Design the bolted joints for axially loaded condition TLO 5.5 Design welded connections for the given conditions. TLO 5.6 Design the fillet welded joints for the given situation TLO 5.7 Explain the significance of the terms tension and compression in steel members.	**Unit - V Design of Steel Structures Connections** 5.1 Steel Connection types, uses of bolts and joints: Black bolts and High strength bolts, modes of failure, 5.2 Specifications of bolt holes for bolted connections. 5.3 Strength of bolt in shear, tension, bearing and efficiency of joint. 5.4 Analysis and design of bolted joints for axially loaded plate, single and double angle members 5.5 Welded connections: Butt and Fillet welds, size of weld, throat thickness 5.6 Analysis and design of fillet welded joint for plate, single and double angle members subjected to axial load 5.7 Definition of Tension members and Compression members (No numerical will be asked in theory examination.)	Lecture Using Chalk-Board Video Demonstrations Presentations Demonstration Hands-on Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify the relevant IS clauses related to partial safety factors from IS 456:2000.	1	Write IS clauses related to partial safety factors for loads and materials from IS 456:2000.	2	CO1
LLO 2.1 Identify the relevant IS clauses related to shear reinforcement in beams and slabs from IS 456:2000.	2	Write five IS clauses related to shear reinforcement in beams and slabs from IS 456:2000.	2	CO2
LLO 3.1 Identify the relevant IS clauses for slabs and columns from IS 456:2000.	3	Write five IS clauses related to each for slab and column from IS 456:2000.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Write the stepwise procedure for design of Doubly reinforced beam section.	4	*Write the stepwise procedure for design of Doubly reinforced beam section.	2	CO2
LLO 5.1 Reading of working drawing of a structural element.	5	*Interpret the given working drawing and write reinforcement details along with sizes provided for minimum two structural members.	2	CO1 CO2 CO3 CO4
LLO 6.1 Use the given data to Design the given cantilever slab and draw reinforcement details.	6	*Design a cantilever slab for the given data and draw reinforcement details.	2	CO3
LLO 7.1 Use the given data to Design the given one way simply supported slab and draw reinforcement details.	7	*Design a one-way simply supported slab for the given data and draw reinforcement details.	2	CO3
LLO 8.1 Use the given data to Design the given two way simply supported slab and draw reinforcement details.	8	*Design a two-way simply supported slab for the given data and draw reinforcement details.	2	CO3
LLO 9.1 Use the given data to Design the beam and draw reinforcement details.	9	*Design the beam for the given data and draw reinforcement details.	2	CO2
LLO 10.1 Use the given data to Design one axially loaded Square column and draw reinforcement details.	10	*Design an axially loaded Square column for the given data and draw reinforcement details.	2	CO4
LLO 11.1 Use the given data to Design one axially loaded Rectangular column and draw reinforcement details.	11	*Design an axially loaded Rectangular column for the given data and draw reinforcement details.	2	CO4
LLO 12.1 Use the given data to Design footing for axially loaded Square column designed in Sr. no.10 and draw reinforcement details.	12	*Design the footing for the axially loaded Square column designed in Sr. no. 10 and draw reinforcement details.	2	CO4
LLO 13.1 Use the given data to Design footing for axially loaded rectangular column designed in Sr. no.11 and draw reinforcement details.	13	Design the footing for the axially loaded rectangular column designed in Sr. no. 11 and draw reinforcement details.	2	CO4
LLO 14.1 Draw the reinforcement details for the given type of slab under specific loading conditions.	14	*Draw the reinforcement details for cantilever slab, one way simply supported slab and two way simply supported slab designed in Sr. no. 06 to 08 using Auto-CAD software.(A2 Size Sheet)	4	CO3
LLO 15.1 Draw the reinforcement details for the given type of beam, column and footing under specific loading conditions.	15	*Draw the reinforcement details for the beam, column and footing designed in Sr. no. 09 to 13 using Auto-CAD software.(A2 Size Sheet)	4	CO2 CO4
LLO 16.1 Inspecting the reinforcement of RCC slab and beam to write a detailed report on it with neat sketches	16	*Prepare a report of site visit to a RCC work under construction for slab and beam reinforcement with neat sketches.	4	CO2 CO3
LLO 17.1 Inspecting the reinforcement of RCC column and footing to write a detailed report on it with neat sketches.	17	Prepare a report of site visit to a RCC work under construction for column and footing reinforcement with neat sketches.	4	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 18.1 Identify the relevant IS clauses related to loads from IS 875:1987.	18	Write five IS clauses related to load from IS 875:1987.	2	CO1 CO2 CO3 CO4
LLO 19.1 Identify the relevant IS clauses related to joints in steel structures from IS 800:2007.	19	Write five IS clauses related to joints in steel structure from IS 800:2007.	2	CO5
LLO 20.1 Use the given data to Design a bolted connection.	20	*Design a bolted connection for the given data.	2	CO5
LLO 21.1 Use the given data to Design of a welded connection.	21	*Design a welded connection for the given data.	2	CO5
LLO 22.1 Identify the relevant IS clauses related to tension member and compression member steel structures from IS 800:2007.	22	Write three IS clauses related to tension member and compression member in steel structure from IS 800:2007.	2	CO5
LLO 23.1 Write the stepwise procedure for Design of tension member.	23	*Write the stepwise procedure for Design of tension member.	2	CO5
LLO 24.1 Write the stepwise procedure for Design of compression member.	24	*Write the stepwise procedure for Design of compression member.	2	CO5
LLO 25.1 Inspecting the joints in Steel structures and write a detailed report on it.	25	*Prepare a report on a site visit for joints in steel structures.	4	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Student should maintain a separate A3 size Sketch book to solve the assignment given by course teacher. Course teacher can assign following type of assignments to students. Assignments should be solved by individual students compulsorily and corrective actions should be given by course teacher.

1. Draw five standard rolled steel sections showing all details.
2. Draw five commonly used built up sections showing all details.
3. Draw cross section, strain –stress diagram for singly reinforced section.
4. Draw stress block diagram for Under- reinforced, over-reinforced and balanced sections showing all details.
5. Draw cross section, strain diagram and stress diagram for doubly reinforced section.
6. Draw diagrams showing transfer of loads from one way simply supported slab and two way simply supported slab to the supporting beam as per I. S. 456:2000.
7. Draw reinforcement detailing of dog legged stair.
8. Draw the table showing details of deflected shape along with effective length of column as per IS 456:2000.
9. Draw modes of failure for bolted connections.
10. Draw types of welds and types of welded joints.

Micro project

- Student should prepare 08-10 pages microproject on any topic in a group of 4 students only. Course teacher can allot following topics to microproject group. Microproject report should be prepared with new information other than

classroom teaching. The necessary guidance for the microproject work should be provided by course teacher.
1. Enlist various software used for the design of RCC structures and give details of any one software.
2. Enlist various software used for the design of steel structures and give details of any one software.
3. Collect the details of various types of the formwork used for RCC structures at site.
4. Collect the details of safety norms followed during RCC construction at site and write a report.
5. Collect the details of safety norms followed during Steel construction at site and write a report.
6. Collect the information of various types of connections used in actual practice.
7. Visit the site and study the labor management for any one activity related to RCC component and write a report.
8. Visit the site and study the material management for any one activity related to RCC component and write a report.
9. Visit the site and check the level for slab, plumb of column and depth of column as per blue print and write detailed procedure of any one.
10. Identify the various human errors occurred while placing reinforcement and suggest remedial measures.
11. Enlist all the instruments used on site along with photograph and parallel terminology used by local mason/labour/worker.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computer system with Internet Connection	14,15
2	Auto-CAD Software	14,15

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals of RCC and Steel Structures	CO1	6	4	4	0	8
2	II	Analysis and Design of Beam	CO2	18	4	8	10	22
3	III	Design of Slabs	CO3	12	2	0	12	14
4	IV	Design of axially loaded short Columns and footing	CO4	12	0	4	10	14
5	V	Design of Steel Structures Connections	CO5	12	4	4	4	12
Grand Total				**60**	**14**	**20**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Term work (Lab Manual), Self-Learning (Assignment) Question and Answers in class room, quiz and group discussion. Note: Each practical will be assessed considering 60% weightage to process related and 40 % weightage to product related.

Summative Assessment (Assessment of Learning)

- Practical Examination, Oral Examination, Pen and Paper Test.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	2	1	1	-	2			
CO2	3	3	3	2	1	1	2			
CO3	3	3	3	2	1	1	2			
CO4	3	3	3	2	1	1	2			
CO5	3	3	3	2	1	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dayarathnam, P.	Design of Steel Structures	S. Chand and Company, Delhi. ISBN-13: 978-8121923200
2	S K. Duggal	Design Of Steel Structures (Edition3)	McGraw Hill Education (India) Private Limited 978-93-5532-503-7
3	Shah,V. L. Karve, S. R.	Limit State Theory and Design of Reinforced Concrete Structures	Structures Publications, Pune. ISBN-13: 9788190371711
4	Sinha, N.C. Roy, S.K.	Fundamentals of Reinforced Concrete	S. Chand & Co., New Delhi. ISBN-13: 978-8121901277
5	Varghese, P. C.	Limit State Design of Reinforced Concrete	PHI Learning Private Limited, Delhi.ISBN-13: 978-8120320390
6	BIS New Delhi	IS:800-2007 Indian Standard code of practice for use of structural steel in general building construction	BIS New Delhi
7	BIS New Delhi	IS:875-1987 Part-1 to 5: Indian Standard Code for Loading Standards	BIS New Delhi
8	BIS New Delhi	IS hand book No. 1 Properties of structural steel rolled section.	BIS New Delhi
9	BIS New Delhi	IS 456:2000 - Plain and Reinforced concrete code of Practice	BIS New Delhi
10	BIS New Delhi	SP16- Design Aids for reinforced concrete to IS 456	BIS New Delhi
11	BIS New Delhi	SP 24 - Explanatory Handbook on IS 456	BIS New Delhi
12	BIS New Delhi	SP34: 1987 - Handbook on concrete reinforcement and Detailing	BIS New Delhi

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=0fTvE8aSsiE	Design of Doubly Reinforced Beam Flexure - I

DESIGN OF RCC AND STEEL STRUCTURES **Course Code : 316308**

Sr.No	Link / Portal	Description
2	https://www.youtube.com/watch?v=DjT5G6Klf1M	Limit State of Collapse Flexure - II
3	https://www.youtube.com/watch?v=pIdaC_I6H_M	Introduction – I (RCC)
4	https://www.youtube.com/watch?v=zVKf6hZfrhA	Limit State of Collapse Flexure
5	https://www.youtube.com/watch?v=iT2pjfYbyZg	Limit State of Collapse Shear
6	https://www.youtube.com/watch?v=PDJPcQq3PZE	Design of Slabs Part - 1
7	https://www.youtube.com/watch?v=wJWt0dcgafs	Design of Columns Part - I
8	https://www.youtube.com/watch?v=8ATp13mOhvg	Design of Footings Part - I
9	https://youtu.be/ruuKvu5QtkI	Steel as a structural material
10	https://youtu.be/KwDrEN5EPeY	Introduction to Connections
11	https://youtu.be/u9j04q6h4ww	Introduction to Bolt Connections
12	https://youtu.be/U1fOSARv6u4	Weld connection
13	https://youtu.be/bIITXe3MJzs	Design of Fillet Welds
14	https://youtu.be/EX2d8dri9EE	Tension Members and Net Area
15	https://youtu.be/pb-OyON6j_0	Design Strength of Tension Member
16	https://youtu.be/-0MogwoWgf4	Strength Calculation of Tension Members
17	https://youtu.be/79xaH_uTeMo	Strength of Tension Members with Weld Connection
18	https://youtu.be/r5ocul8iEKk	Compression Members
19	https://youtu.be/em-_8Ga0mzw	Compressive Strength
20	https://youtu.be/L0KnOJr7BIU	Design of Compression Members

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MAINTENANCE AND REPAIRS OF STRUCTURES **Course Code : 316309**

Programme Name/s	**: Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/**
Programme Code	**: CE/ CR/ CS/ LE**
Semester	**: Sixth**
Course Title	**: MAINTENANCE AND REPAIRS OF STRUCTURES**
Course Code	**: 316309**

I. RATIONALE

A newly constructed structure, if not maintained properly leads to manifold losses such as reduced life of building, increased cost of repairs etc. Therefore, building maintenance work is assumed to be the backbone of ensuring the safety, longevity, functionality, enhanced property value and aesthetic appeal of structures and prevent costly repairs. It encompasses a spectrum of tasks and services aimed at preventing deterioration, addressing wear and tear, and promoting a safe and comfortable environment for the residents. It also subsumes regular inspections, repairs, and upkeep tasks designed to identify and address any structural issues, such as wear and tear, corrosion, or damage. A civil engineer is expected to have the knowledge of these areas and should be then capable of conducting the structural audit of building for enhancing the life of the building in the light of the prevailing legal framework. Therefore, this course emphasizes to develop the basic competency among the diploma students to apply the relevant methods and principles required for repairing and maintenance of building.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified outcome through various teaching learning experiences: Maintain the given structure through relevant method of repairs.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Justify the need of repairs and maintenance for the given structure.
- CO2 - Undertake the Non-Destructive Testing (NDT) to carry structural audit of structures.
- CO3 - Propose the relevant materials for undertaking the repair of given structures.
- CO4 - Apply the relevant method of repair for the masonry work.
- CO5 - Suggest the relevant method of repair to regain the strength of the given RCC component.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316309	MAINTENANCE AND REPAIRS OF STRUCTURES	MRS	DSC	4	-	2	-	6	3	3	30	70	100	40	25	10	-	-	-	-	125

Total IKS Hrs for Sem. : 2 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the necessity of maintenance and repairs of the civil structure. TLO 1.2 Classify the maintenance based on given criteria. TLO 1.3 Discuss the factors influencing maintenance of given structure with justification. TLO 1.4 Implement the instructions provided in maintenance manual for the given structure.	**Unit - I Basics of Maintenance and Repairs** 1.1 Maintenance and Repairs-Definition, Necessity, Objectives, Importance. 1.2 Types of maintenance based on interval- Routine, Periodic, Annual maintenance, Types of maintenance based on season- Pre-monsoon and Post monsoon maintenance, Types of repairing technique, Retrofitting, Re-strengthening, Rehabilitation, Restoration. 1.3 Factors influencing, advantages and limitations of maintenance and repairs of structures. 1.4 Approach of effective team management for maintenance and repairs. Details of maintenance manual of building. (IKS*: Restoration of Sun Temple in Konark Ajanta and Ellora caves, Taj Mahal.)	Lecture Using Chalk-Board Video Demonstrations Presentations Demonstration
2	TLO 2.1 Identify the cause of damage occurred in the given structure. TLO 2.2 Detect the damages in structure using visual observation method. TLO 2.3 Undertake the non-destructive test (NDT) for measuring the given type of damage. TLO 2.4 Carry out the structural audit for given structure using the prescribed formats.	**Unit - II Causes, Detection & Estimation of Damages** 2.1 Causes of damages in structures- distress, earthquake, wind, flood, dampness, corrosion, fire, dilapidation, termites. 2.2 Systematic approach of damage detection, various aspects of visual observations for detection of damages. 2.3 Tests on damaged structures: rebound hammer, ultrasonic pulse velocity, rebar locator, cover gauge, crack detection microscope, Endoscope, chloride test, sulphate attack, pH measurement, half-cell potential meter. 2.4 Structural Audit- Objectives, Budget estimation, Steps involved Applicable Formats, Competent authorities, Rules and regulations.	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit Case Study

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Select the relevant materials to repair the given type of damages with justification. TLO 3.2 Justify the suitability of given type of anti-corrosive/mortar repairing material. TLO 3.3 Suggest the type of grout for given type of repairing work. TLO 3.4 Explain the use of adhesives/ joint sealants for the repairing of given structure. TLO 3.5 Choose the relevant waterproofing materials for given type of leakage with justification.	**Unit - III Materials for Maintenance and Repairs** 3.1 Factors influencing the material selection for maintenance and repairs. 3.2 Anti-corrosion coating materials- cement slurry mortar, polymer modified cement slurry and epoxy zinc. Surface coating materials- bituminous cutbacks, chlorinated rubber coating, Vinyl coatings, epoxy coating and coal tar epoxy. 3.3 Mortar repair materials- cementitious mortar, polymer modified cementitious mortar and resin mortar. Grout materials- cement grout, cement sand grout, cement sand grout with additives, polymer modified cement grout and normal epoxies. 3.4 Adhesives materials- solvent free adhesives, epoxy adhesive, polyester adhesive, acrylic adhesive and water borne adhesives: polyvinyl acetate and vinyl acetate co-polymer Joint sealants materials- oleo resinous mastics, bitumen/rubber-based sealants and acrylic resin sealant. 3.5 Waterproofing roof materials- polyisobutylene (PIP) sheet, glass fiber reinforced plastics, bitumen and bituminous emulsion and latex cement coating. (IKS*: Use of natural material for repairs like mud, clay, lime, jaggery, cow dung, neem oil.)	Lecture Using Chalk-Board Video Demonstrations Presentations Model Demonstration
4	TLO 4.1 Identify the location of the masonry cracks mentioning its cause to suggest the remedial measures for the same. TLO 4.2 Organize the sequential steps involved in repairing of masonry work of given structure. TLO 4.3 Explain the repairing methods for the different crack types for the given structure. TLO 4.4 Carry out the repairs of minor/medium cracks using the relevant method with appropriate material. TLO 4.5 Carry out the repairs of major cracks using the relevant method with appropriate material.	**Unit - IV Maintenance and Repair of Masonry Work** 4.1 Causes of wall cracks- Bulging, shrinkage, bonding, shear and tension, differential settlement of foundation, thermal movement and vegetation. Locations of crack in masonry- junction of main & cross wall, junction of RCC column & wall, junction of slab & wall, cracks in masonry joints. 4.2 Stages of repairing: material removal and surface preparation, fixing suitable formwork, bonding/passivating coat and repair applications. 4.3 Repair techniques: grouting, patch spalling replacement or delaminating and epoxy bonded mortar. 4.4 Repairing methods for minor & medium cracks include epoxy injection, grooving & sealing, shotcrete, stitching, grouting and guniting. 4.5 Repairing methods for major cracks (width more than 5mm) include fixing mesh across cracks, dowel bars, RCC band and installing ferro-cement plates at corners and propping.	Lecture Using Chalk-Board Video Demonstrations Presentations Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain location and causes of failure of RCC building elements. TLO 5.2 Explain the repairing method of dampness in roof slab. TLO 5.3 Illustrate the repair methods for the cracked RCC elements. TLO 5.4 Explain the relevant repair methods for corroded RCC elements. TLO 5.5 Suggest the relevant repair technique of honeycomb and large voids in the given RCC component.	**Unit - V Maintenance and Repair of Concrete Work** 5.1 Cracks in RCC elements-Locations, causes of RCC building elements. 5.2 Causes of dampness in roof slab, repair techniques of dampness- mud phuska with brick tile topping, lime concrete terracing, ferro-cement topping and brick coba. 5.3 Repair methods for cracks in RCC structures such as epoxy injection, grooving & sealing, stitching, rebaring, grouting, spalling replacement, jacketing, shotcrete and gunitting. 5.4 Repair of corroded RCC element: exposing and undercutting rebar, cleaning reinforcing steel, compensating reinforcement and protective coating. 5.5 Repair methods of honeycomb and larger voids in RCC components.	Lecture Using Chalk-Board Video Demonstrations Presentations Site/Industry Visit

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Draft the maintenance strategies for given building.	1	Prepare the site visit report on pre-monsoon and post-monsoon maintenance strategies for given building.	2	CO1
LLO 2.1 Identify the damages and relevant remedial strategies of an existing building.	2	*Prepare the detailed photographic report on damages observed during the visit to suggest the remedial measures.	2	CO2
LLO 3.1 Identify the damages and relevant remedial strategies of non-residential structure.	3	*Prepare a photographic report on damage assessment and remedial measures of any one dam/bridge/industrial building.	2	CO2
LLO 4.1 Determine the strength and homogeneity of given structural elements using NDT.	4	*Determine the compressive strength of beam, column or slab of damaged or undamaged structure using Rebound Hammer at minimum 6 locations.	2	CO2
LLO 5.1 Determine the strength and homogeneity of given structural elements using NDT.	5	Determine the compressive strength of beam, column or slab using Ultrasonic Pulse Velocity test at minimum 3 locations.	2	CO2
LLO 6.1 Identify the location of reinforcing bar of the given RCC element using Rebar Locator.	6	Determine the dimensions and location of reinforcing bars of beam, column or slab using Rebar locator.	2	CO2
LLO 7.1 Determine the chloride extent in the given RCC element using Rapid Chloride Test.	7	Determine maximum chloride content in beam, column or slab in percent by weight of cement using Rapid Chloride Test. (Use cube if coring is not possible.)	2	CO2
LLO 8.1 Determine the deterioration of the given RCC element using phenolphthalein indicator.	8	Determine the depth of carbonation of beam, column or slab using phenolphthalein indicator.	2	CO2
LLO 9.1 Predict the susceptibility of the RCC member against the dampness.	9	Determine the moisture content of beam, column or slab using Digital Moisture Meter.	2	CO2
LLO 10.1 Determine the corrosion extent in the given RCC member using Half-cell Potentiometer.	10	Determine the corrosion extent of reinforcing bar of beam, column or slab using Half-cell Potentiometer.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Identify the nature of efflorescence in given type of structure.	11	Determine the extent of efflorescence at minimum 3 locations in given damaged or undamaged masonry or concrete structure.	2	CO2
LLO 12.1 Predict the stability of existing building structure under consideration.	12	*Prepare the structural audit report mentioning budget estimation, task force, equipment's and methodology for the given damaged structure.	2	CO2
LLO 13.1 Compare the repairing materials in terms of various criterion.	13	*Prepare the check list of required materials with current market rates required for repair of the given damaged load bearing or framed structure.	2	CO3
LLO 14.1 Undertake the repairing of plaster the given masonry.	14	*Prepare the visit report on materials and techniques required for repairing of spalling/delamination of plaster by visit/demo video.	2	CO4
LLO 15.1 Undertake the repairing of leakage in the given sanitary unit.	15	*Prepare the visit report on repairing of roof slab/ sanitary unit using any one technique to remove leakage.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Collect ten photographs of different types of damages in Masonry / RCC works in the area where student resides. Do the diagnosis of the ailments, suggest the remedial measures.
- Prepare the report on suggestion of the repair material and methods for the RCC beam as per type of crack developed.
- Prepare the budget with respect to material, task force, equipment's and methodology for the historical structure in your vicinity.
- Collect the details of advanced techniques used for repairing of masonry and RCC work.
- Collect the details of various types of the agencies working for repairs and maintenance of structures in actual practice.
- Collect the information of companies/firms of maintenance and repair work available nearby area.
- Prepare the report on study of environmental factors on maintenance and repair work of civil structure.
- Market survey for at least five materials used for repairs with respect specification, supplier, packaging and costing.
- Prepare the photographic report showing various types of cracks in damaged structures.
- Prepare the report on flexural strength of three RCC beams and three plain concrete beams and find the various types of cracks by applying one-point load, two-point loads etc. Collect the information of maintenance work made for any one famous building such as Taj Hotel, Taj Mahal etc.
- Collect the information of advanced methods of repairs of water leakages of RCC water tank, plumbing works, sanitary works, flooring repairs, door and window frames/panels repairs.
- Identify various types of failures in steel structures and write a detailed case study on any one type of failure in steel structures.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Half-cell potentiometer; voltage 220, electric power source, frequency 50 Hz, corrosion monitoring technique standardized by ASTM	10
2	Crack detection microscope: magnification = x 35, measuring Range = 4 mm, divisions = 0.02mm, weight including battery and box = 560gm, box dimensions = 150 x 100 50mm deep	2,3,15
3	Rebound Hammer: Manual Test Hammer of W-M-250, BS-1881-202, weight: 2.7 kg, size: 127 x 76 x 355 mm, shipping weight: 2.7 kg and minimum verifiable strength is 10 MPa to 62 MPa.	4
4	Ultrasonic Pulse Velocity test apparatus: range 0.1-7930 µs, resolution: 0.1 µs to 1 µs, display 7”, color 800 x 480, pulse voltage100 – 450 Vpp, bandwidth 20 – 500 kHz	5
5	Rebar locator: Model: GMS 120 professional, weight: 0.27 KG, detection depth for steel max : 120 mm and for copper max 80 mm	6
6	Cover gauge: concrete thickness gauge model of CTG-2 (Concrete Thickness Gauges), battery powered, ASTM Standard, frequency resolution 10Hz, thickness range 81 mm to 50.8 cm in standard mode.	6,10
7	Rapid chloride test apparatus: RCPT Apparatus is as per ASTM C 1202-05. 4 Port (230~250V AC power supply), plexi-glass chambers - 4 pairs,500mm vacuum desiccator, consumables - good for 1 doz	7
8	Digital concrete moisture meter- Confirming to ASTM F2170 measuring range of 0-6.9% moisture content, a resolution of 0.1%, and an accuracy of ±0.3%.	9,14,15

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Maintenance and Repairs	CO1	10	2	4	4	10
2	II	Causes, Detection & Estimation of Damages	CO2	14	2	4	10	16
3	III	Materials for Maintenance and Repairs	CO3	10	2	4	6	12
4	IV	Maintenance and Repair of Masonry Work	CO4	12	2	4	10	16
5	V	Maintenance and Repair of Concrete Work	CO5	14	6	4	6	16
Grand Total				**60**	**14**	**20**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Term work (Lab Manual), Self-Learning (Assignment) Question and Answers in class room, quiz and group discussion. Note: Each practical will be assessed considering 60% weightage to process related and 40 % weightage to product related.

Summative Assessment (Assessment of Learning)

- N.A.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	1	1	1	1	-	1			
CO2	2	2	3	3	2	-	2			
CO3	2	2	1	2	1	-	2			
CO4	2	2	2	2	2	-	2			
CO5	2	2	2	2	2	-	2			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Gahlot, P. S. Sharma, Sanjay	Building Repair and maintenance management	CBS Publishers & Distributors Pvt. Ltd. New Delhi, ISBN: 81-239-1243-9
2	Nayak B. S.	Maintenance Engineering for civil Engineers	Khanna Publication, New Delhi ISBN: 978-81-7409-051-7
3	Guha,P. K.	Maintenance and Repairs of Buildings	New Central book Agencies, New Delhi, ISBN 10: 8173810737 ISBN: 9788173810732
4	Hutchin Son, BD	Maintenance and Repairs of Buildings	Newnes-Butterworth, London (UK) ISBN : 0408001917
5	PWD, Maharashtra.	Maintenance Manual by PWD	PWD, Maharashtra.
6	BIS, New Delhi.	IS:15183-Part-I-2002- Guidelines for maintenance management of building.	BIS, New Delhi.

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=PojJX4VSnbc	Structural audit of buildings
2	https://nptel.ac.in/courses/105106202	NPTEL course on Maintenance & Repairs of Structures
3	https://www.youtube.com/watch?v=ANORiqAJ7kc	Repair of crack in plaster
4	https://www.youtube.com/watch?v=Zp4f_ReeSO0	Crack repair by epoxy injection method

MAINTENANCE AND REPAIRS OF STRUCTURES **Course Code : 316309**

Sr.No	Link / Portal	Description
5	https://www.youtube.com/watch?v=y1rOtvvxRzY	Concrete slab crack repair instructional video
6	https://www.youtube.com/watch?v=q_JeGja1Yb4	Repair a Crack in a Concrete Slab Floor
7	https://www.youtube.com/watch?v=eEXAWukRfD4	Repair Concrete with Epoxy Injection Techniques
8	https://www.youtube.com/watch?v=uvOBcjD4BVM	Cracks Repair Techniques
9	https://www.youtube.com/watch?v=mUnQfEYwZao	How to repair rusted iron bar | Interior design | Anti rust
10	https://www.youtube.com/watch?v=WEJPpCidJmg	Budget Estimation of Repairs

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Programme Name/s	**: Automobile Engineering./ Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Production Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ PG/ SE/ TE**
Semester	**: Sixth**
Course Title	**: CAPSTONE PROJECT**
Course Code	**: 316004**

I. RATIONALE

Capstone projects in engineering study are considered important as it allow students to integrate and apply the knowledge and skills acquired throughout their academic program and effectively demonstrating their learning of programme by tackling a real-world problem, ultimately keeping them well prepared for the job market. The capstone project is usually the final assignment and plays a vital role in preparing students for the world of work to its practical applications and ability to help hone students' professional knowledge and skills. Normally, capstone projects are developed in collaboration with industries or businesses, providing students with valuable insights. Capstone projects has been considered as an integral part of diploma curriculum. It helps learners to perform and demonstrate skills gained due to early courses of Diploma study independent. Therefore, this is considered as a course of final year/semester study.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Apply professional skills for solving , executing and demonstrating solutions to real-world problems

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Elaborate the identified field problem from the perspective of project work at institute.
- CO2 - Conduct feasibility & viability analysis (using data collection, experiments, Simulation , Coding) to validate required resources, cost, support of the project work.
- CO3 - Apply the acquired knowledge and skills in providing solutions to the real field/industrial problems.
- CO4 - Present Project and its output/ findings / achievements alongwith its exhibits.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316004	CAPSTONE PROJECT	CPE	INP	-	-	2	2	4	2	-	-	-	-	-	50	20	50#	20	50	20	150

V. General guidelines for PROJECT WORK

- The Project- problems must be related to the programme or may be interdisciplinary, based on the industry expected outcomes.
- The individual students have different aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work they would like to execute.
- Project titles are to be finalized in co-ordination/consultation with the Faculty mentor. However, faculty may form a team of students as per specific roles- Literature survey/data collection, data Analysts, model/prototype developers, testers, Project managers using IoTs ITES and software /application development. Study type project is NOT advisable.
- Project must be assigned to a group of 3-4 students under the guidance of identified faculty mentor.
- Students are required to prepare a prototype/working model/software of the Project and simultaneously prepare a report.
- Students shall Submit One Hard copy and one Soft copy each of Project Report and soft-copy of the project code or the working model.
- Students must maintain a project execution diary having the progress steps and details. The concerned faculty should check the diary on a weekly basis and accordingly interact with students based on the progress shown and keep proper record with feedback if any.
- Project shall address National Thrust area such as Environment, Digitization, Automation, sustainability and similar domains.
- Student shall try to use the national and international standards wherever possible (processes / materials / equipments etc ..)

VI. Project facilitation guidelines:

Once the Project statement has been finalized and allotted to the students, the Faculty Mentor role is very important as guide, motivator, catalyser to promote learning and sustain the interest of the students. At the same time the Faculty Mentor is not expected to guide the students on each step, otherwise it will curb the creativity of the students-group. The Faculty Mentor has to work as a mentor. Following should be kept in mind while facilitating the project at the institute:

1.Project orientation cum -briefing: the project should be relevant to the curriculum of the programme. The project shall be cost effective taking safety aspects, ethical issues, environmental issues and confidentiality as per expectation of industry(if any) into consideration, The work may be industry Sponsored.

2.Information search and data collection: the information and data should be realistic and relevant to the problem /project. Hypothetical data is not to be taken into consideration.

3.Implementation and Monitoring: The project must have important steps /milestones to achieve as per the time frame/action plan prepared by students and faculty. The monitoring mechanism such as daily/weekly dairy (**Format given below)** must be clearly explained and delineated for the students.

VII.Criteria of Assessment /Evaluation of Project work

A. Formative Assessment (FA) criteria

The **Formative Assessment** (FA) of the students for 50 marks is to be done based on following criteria.

Appropriate RUBRICS may be used for assessment

Rubrics for Assessment of the team

Sr.No.	Criteria	Marks
1	Project Selection & Problem definition	05
2	Literature survey and data collection/ Gathering	05
3	Design / concept of project/ Working - Execution of Project	10
4	Stage wise progress as per Action plan/milestone	05
5	Quality Report Writing	05

Rubrics for Individual Assessment

Sr.No.	Criteria	Marks
1	Contribution as a team member	05
2	Depth of Knowledge	10
3	Presentation	05

B. Summative Assessment Criteria

- The summative assessment for 50 marks is to be done and based on following criteria. This assessment shall be done by the faculty mentor and External examiner.

Sr.No.	Criteria	Marks
1	Capstone Project Completion as per plan	10
2	Project related Requirement Analysis & Designing	10
3	Developing a Solution with proper justifications, Teamwork	10
4	Project Report Writing	10
5	Project Presentation	10

(**NOTE :** Team based and Individual performance based summative assessment may include Innovativeness , Technology used , user friendliness , cost effectiveness , society benefits etc..)

SUGGESTED RUBRIC FOR SUMMATIVE ASSESSMENT OF CAPSTONE PROJECT

PROJECT ASSESSMENT				
Project Title:				
Project Assessment Rubric				
Performance	**Excellent**	**Good**	**Fair**	**Poor**
Criteria	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
Capstone Project Completion	Excellent **The project is completed as per tasks described in synopsis.**	Good **The project is completed but require minor modifications.**	Fair **The project is completed but require several modifications.**	Poor **The project is not completed as per tasks described in synopsis.**

Project related Requirement Analysis & Designing	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Effectively contributed in requirement analysis and designing.	**Partially Contributed in requirement analysis and designing.**	**Attempted to contribute in requirement analysis and designing**	**No contribution in requirement analysis and designing.**
Developing a Solution with proper justifications , Teamwork	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Developed the critical solution modules with Innovation, optimized design and worked very well with the team.	**Developed some solutions with higher complexity and worked well with the team.**	**Attempted to develop few solutions and worked with the team.**	**No contribution in developing a solution and in the team.**
Project Report Writing	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Worked very well to submit an excellent project report .	**Worked well to submit the project report with covering all the aspects of a standard report.**	**Tried to submit the project report but standard of report was not satisfactory.**	**No contribution in project report writing.**
Project Presentation	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Presented the project work flawlessly.	**Presented the project work very nice.**	**Presented the project work not so well.**	**Presentation skill is not up to the mark.**
Project Group Members				
ROLL NUMBER/Enrollment Number				
NAME				
Comments (if any)				

NOTE : " These are suggestive rubrics Faculty mentor and external examiner may frame different rubrics as per Programme need and assigned Project work "

C. Self Learning Assessment

Self Learning Assessment **Max Marks -50**

Sr.No.	Criteria	Max Marks	Marks Obtained
1	Project Selection & Problem definition	10	
2	Literature survey and data collection/ Gathering	05	
3	Design / concept of project/ Working - Execution of Project	15	
4	Stage wise progress as per Action plan/milestone/ psychomotor motor skills acquired	10	
5	Quality Report Writing	10	

VIII. CO-PO Mapping

CO-PO mapping will vary project wise and shall be prepared by concerned faculty for the given project

IX. Typographical instructions/guidelines for Project report writing

Following is the suggestive format for preparing the Project report. Actual report may differ slightly depending upon the nature of industry. The training report may contain the following.

a. The PROJECT report shall be computer typed (English- British) and printed on A4 size paper.
b. Text Font -Times New Roman (TNR), Size-12 point
c. Subsection heading TNR- 12 point bold normal
d. Section heading TNR- 12 capital bold
e. Chapter Name/ Topic Name – TNR- 14 Capital
f. All text should be justified. (Settings in the Paragraph)
g. The report must be typed on one side only with double space with a margin 3.5 cm on the left, 2.5 cm on the top, and 1.25 cm on the right and at bottom.
h. The training report must be hardbound/ Spiralbound with cover page in black colour. The name of the candidate, diploma (department), year of submission, name of the institute shall be printed on the cover [Refer sample sheet (outer cover)]
i. The training report, the title page [Refer sample sheet (inner cover)] should be given first then the Certificate followed by the acknowledgment and then contents with page numbers.

X. Project Report

On completion of the project work, every student will submit a project report which should contain the following:
1. Cover Page (as per annexure 1)
2. Title page (as per annexure 2)
3. Certificate by the Guide (as per annexure 3)
4. Acknowledgment (The candidate may thank all those who helped in the execution of the project.)
5. Abstract (It should be in one page and include the purpose of the study; the methodology used.)
6. Table of Contents (as per general guidelines): Detailed description of the project (This should be split in various chapters/sections with each chapter/section describing a project activity in totality).

Chapter–1 Introduction (background of the Industry or User based Problem/Task)
Chapter–2 Literature Survey (to finalize and define the Problem Statement)
Chapter–3 Scope of the project
Chapter–4 Methodology/Approach, if any
Chapter-5 Details of designs, working and processes
Chapter-6 Results and Applications

7. Conclusion
8. References (The listing of references should be typed 2 spaces below the heading “REFERENCES” in alphabetical order in single spacing left – justified. It should be numbered consecutively (in square [ ] brackets, throughout the text and should be collected together in the reference list at the end of the report. The references should be numbered in the order they are used in the text. The name of the author/authors should be immediately followed by the year and other details). Typical examples of the references are given below:

NOTE:
1. Project report must contain only a relevant and short mention – technology or platform or tools used. It must be more focussed on project work and its implementation
2. Students can add/remove/edit chapter names as per the discussion with their guide

Formats

Project Report

"Project Title----------"

as a partial fulfilment of requirement of the

THIRD YEAR DIPLOMA IN

Submitted by

1)Name Of Student	**Enrollment Number**
2)Name Of Student	**Enrollment Number**
3)Name Of Student	**Enrollment Number**
4)Name Of Student	**Enrollment Number**

Are the bonafide on

FOR THE ACADEMIC YEAR

20-----20---

(H.O.D)

(Principal)

(Internal Guide) **(External Examiner)**

Department Name

(If NBA Accredited mention that)
Institute Name

(An Affiliated Institute of Maharashtra State Board of Technical Education)

Table of Contents

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Note:

***Students can add/remove/edit chapter names as per the discussion with their guide**

Annexure

PROJECT DIARY (Weekly/Daily)

Name of the Student : _____

Name of Guide (Faculty) : _____

Enrollment Number : _____ Semester: _____Project batch Number : _____

WEEK : _____

Date	Activity carried out (Details)	Achievement of mile stone/step as per plan	Remark of Faculty
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Dated Signature of Faculty **Dated Signature of HOD**

MSBTE LOGO INST LOGO

Certificate

This is to certify that

Mr./Ms. *bearing examination seat No.* *has*

Satisfactorily completed his/her ***PROJECT*** *entitled*

Along with his/her batchmates in partial fulfillm ent for the

Diploma Course in

< PROGRAMME NAME>

Of the ***Maharashtra State Board of Technical Education*** *at our Polytechnic during the Academic Year20 -20 .*

The Project is completed by a group consisting of Persons under the guidance of the Faculty Guide

Faculty Name and Signature (Internal)	**Faculty Name and Signature (External if applicable)**	**HOD Name and Signature with Department Stamp**
Date and Time		

BUILDING SERVICES **Course Code : 316310**

Programme Name/s	**: Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/**
Programme Code	**: CE/ CR/ CS/ LE**
Semester	**: Sixth**
Course Title	**: BUILDING SERVICES**
Course Code	**: 316310**

I. RATIONALE

Buildings serve several societal needs – primarily as protection from adverse weather conditions, space for various activities like bathing & sanitation, food, rest, study, quite sleep, privacy and security to comfortably live and work. Building services are the systems installed in buildings to make them comfortable, functional, efficient and safe. They can include Plumbing, lighting, fire safety, IOT (Internet of Things), and so on. Building Services Engineers are the people who make this happen. The knowledge of building services is necessary to maintain the functional requirements of the building by a civil technologists. As buildings are becoming more complex and more modern, it is essential to include the same in the Civil Engineering curriculum. This course is designed to enhance the skills of diploma students in the domain of building services.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified expected outcomes through various teaching learning experiences: Execute the building services for creating human comfort in the buildings.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Draw the layout of domestic water Supply and gas supply line for the given area.
- CO2 - Estimate the space requirements for vertical communication services
- CO3 - Propose the relevant fire safety equipment for a multi-storeyed building
- CO4 - Install the proper system of rain water harvesting and solar water heater system for the given buildings
- CO5 - Suggest the relevant advanced building services system for the given building.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316310	BUILDING SERVICES	BSE	DSE	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 2 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Classify the building as per the provisions mentioned in National Building Code.. TLO 1.2 Develop the BMS for the given type of civil structure for the given context TLO 1.3 Explain the procedure of laying the water supply pipe line for the given specifications. TLO 1.4 Design the pipeline system used to install the Hot water supply system. TLO 1.5 Explain domestic pipe gas system for a residential building.	**Unit - I Introduction to Building Services** 1.1 Introduction to building services, Classification of buildings as per national building code, Necessity of building services, Functional requirements of building. Different types of building services (Enlist) 1.2 Building Management Services - Introduction to BMS (Building Management Services), Role and responsibilities of Engineer 1.3 Importance of plumbing, AHJ (Authority Having Jurisdiction) approval, Plumbing Terminology and fixtures: Terms used in plumbing Different types of plumbing fixtures, valves, shapes/ sizes, capacities, Suitable situation.Use of Water sensors for overhead tanks, Centralized RO system, drinking water cooler system 1.4 Hot water supply system. Introduction, Requirements, Types, Safety Features,Centralised hot water System. (*IKS-Red Fort-Hammam-hot or vapour baths, with heating arrangements) 1.5 Domestic pipe gas supply- introduction, component parts layout of domestic pipe Gas supply ,advantages and disadvantages	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the safety measures required for installing the Lifts TLO 2.2 Mention the factors considered while installing escalator for public building structure with justification TLO 2.3 Draft the specifications required for construction of ramp required for physically handicapped and elderly persons for the given type of the building structure.	**Unit - II Vertical communication** 2.1 Vertical Communication in building- introduction, necessity and types- Lifts: Introduction, Necessity, Types Component parts, Safety measures, Calculation of space enclosure to accommodate lift services, design aspect 2.2 Escalators: Introduction, Necessity, Types, Uses, Component parts, Safety measures, Calculation of space enclosure to accommodate Escalators services, Design aspect 2.3 Ramp: Introduction, Necessity, Gradient calculation, Safety measures, Calculation of space enclosure to accommodate Ramp services, special features for physically handicapped and elderly. (*IKS-Use of climbers and Parambya for vertical communication)	Lecture Using Chalk-Board Presentations Site/Industry Visit Video Demonstrations
3	TLO 3.1 Explain the importance of fire safety in a building. TLO 3.2 Outline the installation layout of Fire detection instruments TLO 3.3 Examine fire safety and evacuation process w.r.t given points TLO 3.4 Describe the NBC provisions related to Fire protection system for a multi-storeyed building TLO 3.5 Understand the provisions of Maharashtra Fire Prevention and Life Safety Measures Act, 2006	**Unit - III Fire Safety** 3.1 Introduction to Fire Safety Definition and importance of fire safety Causes and consequences of fire incident 3.2 Fire prevention safety measures in buildings- Fire detectors (smoke/ heat), manual pull stations, Fire alarm control panel, alarm system audible & visual alarms, Fire suppression systems (sprinklers,) 3.3 Fire Safety Equipment and Systems -Types of fire extinguishers (foam, gas suppression) and their applications, fire balls, Fire hoses, hydrants, and pumps, Emergency Response and Evacuation (*IKS-Use of Ghongadi for fire resistance) 3.4 Fire Safety Regulations and Standards-National Building Code of India (NBC) fire safety norms, Fire safety rules in residential, and Public buildings 3.5 Gr-Maharashtra Act No. III Of 2007 (Maharashtra Fire Prevention and Life Safety Measures Act, 2006.for the type of building A,B,C)	Video Demonstrations Presentations Lecture Using Chalk-Board Site/Industry Visit
4	TLO 4.1 Design the rain water harvesting system for the given structure TLO 4.2 Suggest the relevant Solar system required for the given site condition with justification. TLO 4.3 Explain the applicability of PM – Surya Ghar: Muft Bijli Yojana-with its consequences on beneficiary. TLO 4.4 Explain the Significance of Grey water system for the given building structure	**Unit - IV Natural resources conservation services** 4.1 Components of a RWH system (Catchments, gutters, conduits, filters, Storage facility, Recharge structures etc.), Advantage, Application, potential and factors affecting, planning, designing, construction and maintenance of RWH for residential building 4.2 Concept of SWH (Solar water heating),component parts of various system of SWH (heat transfer, propulsion, passive direct system, active direct system, Do-it-yourself),Layout,design ,principles, specification, installation and maintenance 4.3 PM – Surya Ghar: Muft Bijli Yojana-details & benefits. 4.4 Grey water-introduction, Constitutes,Application,Management and, Distribution Pattern,	Presentations Video Demonstrations Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Select relevant system of lighting for the given building with justification TLO 5.2 propose the relevant light control systems to be adopted in the given context. TLO 5.3 Explain the significance of providing air conditioning system in the given type of building TLO 5.4 Inference the use of smart technologies for improvement of building function	**Unit - V Advance building services** 5.1 Introduction to Electrification: Lighting-Introduction, Necessity, Concept of lighting, types of lighting, factors influencing the brightness of room 5.2 Types of light control (Manual switch, Remote switch, Timer switch and Photo-electric cell switch), Door Bells-Concept, Locations, Types, Need, Applications, Lightning arrester-definition, Uses, Location. 5.3 Overview of HVAC system for building and centralized water cooling system. (@IKS-Jharokhas in HAWA MAHAL,Palace of winds) 5.4 Smart Building Technologies. Charging points for e-vehicles, Domestic surveillance system-component parts, uses IOT in building services, Smart gates, Kitchen Chimneys- Necessity/use, Size & types of chimneys ,selection of appropriate size	Video Demonstrations Presentations Site/Industry Visit Lecture Using Chalk-Board

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify the components of building services of given building	1	*Prepare a report on various components of building services of given building	2	CO1
LLO 2.1 Identify the components of water supply system observed in multistory building/public building in relevant video /simulation / photographs	2	*Prepare a report on observed components of water supply system from the given video/simulation / photographs of any multi-story building/ public building in your area.	2	CO1
LLO 3.1 Identify the components of gas supply system observed in the residential/commertial building of relevant video /simulation /photographs	3	*Prepare a report on observed components parts on the layout of gas supply system for a residential / commercial building by viewing the relevant given video/simulation/photographs.	2	CO1
LLO 4.1 Determine the space requirements for the escalator	4	Compute the space requirements for the given type of escalator for the given type of building as per guidelines of national building code	2	CO2
LLO 5.1 Determine the space requirements for the lift for a given residential building (upto,5,10,15 storey)	5	*Compute the space requirements for the lift for the given type of building as per guidelines of national building code	2	CO2
LLO 6.1 Write the specifications & operation of a fire extinguisher.	6	*Prepare a report on the specifications, supplier name, its capacity, fire rating, dimensions, discharge type etc along with the method of using it in case of fire hazard	2	CO3
LLO 7.1 Prepare layout plan /map of Fire safety equipment's	7	Mark the locations of fire safety equipment's installed in a building in your nearby area.	2	CO3
LLO 8.1 Estimate rain water harvesting potential for the given residential building.	8	*Estimate the rain water harvesting potential for the given plan of the residential building (single story load bearing structure) and considering average annual Rainfall of your locality	2	CO4
LLO 9.1 Design the proposed rain water harvesting system for residential building	9	Design the proposed rain water harvesting system for estimated rain water harvesting potential determined in practical no.8 with necessary sketch, diagram, and specifications.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Discuss rain water harvesting system for the given area	10	Design the rain water harvesting system for the given area of the multi-story framed structure residential building. .	2	CO4
LLO 11.1 Design layout of a solar water system	11	*Design layout of a solar water system with diagram for a residential building with given data	2	CO4
LLO 12.1 Collect data of lighting system provided for residential/public building in your area.	12	Prepare a report on lighting system to be provided for residential /public building in your area.	2	CO5
LLO 13.1 Prepare budget for electrical fittings required for a dwelling unit excluding labour cost.	13	*Prepare the budget on the basis of Estimation of the quantities of the electrical fittings, points, switches and wiring system required etc. for the given type of dwelling unit.	2	CO5
LLO 14.1 Write IOT application in a building	14	*Prepare a report on IOT in building services by viewing video /simulation /photographs	2	CO5
LLO 15.1 Determine size & type of chimney for the given residential /public building	15	Determination of size & type of chimney for the given residential /public building by viewing plans	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Visit any three buildings near by your institute and classify them in accordance with the provisions made in National Building Code in report form
- Prepare a sketches consisting of components of modern building services(any five).
- Prepare a report on BMS including a case study
- Prepare a report on modern Fire Safety
- Make a model of rain water harvesting showing its components
- Prepare a report on advance building service

Assignment

- Visit any three buildings near by your institute and classify them in accordance with the provisions made in National Building Code in report form
- Identify the components of building services by inspecting the nearby buildings to prepare a detailed report w.r.t. adequacy, deficiency and exceeding the requirement.
- Collect the technical brochures of the different components of building services from the local market/internet to present in report form
- Visit any building certified by Building Management Services to record the important features that has converted it into green building and submit a report.
- Estimate the RWH and SWH potential for your house and institute building.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Model of a civil engineering structure showing various components.	1,2,3
2	Chart showing details of lift, escalator and ramp.	4,5

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Building Services	CO1	7	2	4	4	10
2	II	Vertical communication	CO2	10	2	8	6	16
3	III	Fire Safety	CO3	10	6	4	6	16
4	IV	Natural resources conservation services	CO4	10	2	4	10	16
5	V	Advance building services	CO5	8	2	4	6	12
Grand Total				**45**	**14**	**24**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Term work (60% weightage to process related and 40 % weightage to product related) , Assignment, Micriproject,Question and Answers in class room.

Summative Assessment (Assessment of Learning)

- Pen and Paper Test. (Written Test),Practical Examination, Oral Exam.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3

CO1	3	3	2	2	2	2				
CO2	3	3	2		2	2				
CO3	3		3	3		3				
CO4	3		3		2		3			
CO5	3	3	3		2	3				

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Mantri, Sandeep	The A to Z of Practical Building Construction and its Management	Satya Prakashan, New Delhi ISBN-13: 978-8176849692
2	Deolalikar, S. G.	Plumbing Design and Practice	McGraw-Hill, New Delhi, 2004 ISBN: 9780074620694
3	Bag, S. P.	Fire Services in India: History, Detection, Protection, Management	Mittal Publications, New Delhi, 1995, ISBN 8170995981
4	Akhil Kumar Das	Principles of Fire Safety Engineering: Understanding Fire and Fire Protection	PHI Learning Pvt. Ltd, New Delhi. 2014, ISB:9788120350380
5	BIS	National Building Code Part1, 4, 8, 9	Bureau of Indian Standard, New Delhi
6	BIS	IS 12183(Part 1):1987 Code of practice for plumbing in multistoried buildings	Bureau of Indian Standard, New Delhi
7	BIS	2022 Uniform plumbing code – India (UPC-I)	Bureau of Indian Standard, New Delhi

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=Zo84UaSVFCM&t=2s	Identification of components of water supply system observed in multistory building relevant
2	https://www.youtube.com/watch?v=tW2w14YIQ98	Design the proposed rain water harvesting system for residential building
3	https://www.youtube.com/watch?app=desktop&v=SuzRufz4hQo	IOT application in a building
4	https://www.youtube.com/watch?v=fkki04h8TCM	Determination of size & type of chimney for the given residential /public building
5	https://www.youtube.com/watch?v=0LNklcBhl_Q&list=PLp6ek2hDcoNCb0R8gxk1WzpTN94eXs9vb	Fire protection, maintenance in building services

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

EARTHQUAKE RESISTANT BUILDING **Course Code : 316311**

Programme Name/s	**: Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/**
Programme Code	**: CE/ CR/ CS/ LE**
Semester	**: Sixth**
Course Title	**: EARTHQUAKE RESISTANT BUILDING**
Course Code	**: 316311**

I. RATIONALE

The construction of a building or structure is prone to sudden collapse if enough care has not been taken against the sudden ground shaking i.e earthquakes and therefore it is an immediate priority of a civil engineer to address this issue to reduce or prevent structural damage and human deaths and injuries. Seismic design is a critical aspect of building construction, especially in areas prone to earthquakes. A civil Engineer must have basic knowledge regarding the specific guidelines and code provisions to ensure the safety and stability of structures. This course is specifically designed to develop the basic competency among the students to deal with this challenge by incorporating various key techniques, including base isolation, energy dissipation systems, and reinforcement methods etc, enabling students to design structures that can withstand earthquakes effectively.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences: Design an earthquake resistant buildings using relevant IS code provisions.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Describe the various seismic zones with reference to periods and magnitude of earthquake intensity.
- CO2 - Explain the effects of earthquakes on building structures with its causes.
- CO3 - Design an earthquake-resistant building using relevant planning and design principles
- CO4 - Analyze the performance of given structure during earthquakes.
- CO5 - Apply the relevant IS code provisions for safety and serviceability of the given structure in given situation.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316311	EARTHQUAKE RESISTANT BUILDING	ERB	DSE	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the given terms related to Earthquakes TLO 1.2 Classify seismic waves on the basis of given criteria in the given situation. TLO 1.3 Identify the seismic zone of given area on seismic zone map. TLO 1.4 Explain the Identify the seismic zone of given area on seismic zone map, significance of term, “period” with other allied concepts used in Earthquakes TLO 1.5 Evaluate the impact of the earthquake based on its magnitude and intensity w.r.t given scale.	**Unit - I Overview of Earthquake phenomenon** 1.1 Definition and meaning of terms: Focus, Epicenter, Focal depth, foreshocks, aftershocks, 1.2 Seismic waves – Types and propagation , Body waves ,P waves and S waves ,Surface waves L and R waves, Propagation of Seismic Waves, pathways , reflection and refraction and shadow zones 1.3 Enlist the various seismic zones of India, classifying them into moderate to severe zones 1.4 Natural period, fundamental natural period, nodal natural period, response spectrum, seismic mass, seismic weight, structural response factor, time 1.5 Earthquake magnitude, intensity, and measurement (Richter scale, Mercalli scale) and risk assessment	Video Demonstrations Presentations Hands-on

EARTHQUAKE RESISTANT BUILDING **Course Code : 316311**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the effects of earthquakes on buildings with its causes. TLO 2.2 Describe the process of formation of earth and its core in the given situation. TLO 2.3 Determine the intensity of earthquake using elastic rebound theory method. TLO 2.4 Compare the different types of failures occurred due to earthquakes in the specified zone based on the given criteria.	**Unit - II Causes and effects of earthquake** 2.1 Causes and effects of earthquake 2.2 Formation of earth and its cores, Formation, types and movement of tectonic plates, procedure of formation of the tectonic plates for the given earthquake zone. 2.3 Elastic rebound theory, Types of earthquakes and Faults. 2.4 Primary and secondary effects: Ground shaking, liquefaction, landslides, tsunamis and fire	Video Demonstrations Presentations Case Study
3	TLO 3.1 Explain the Principles of planning for earthquake resistant structures TLO 3.2 Select the safe location for the proposed building based on soil investigations. TLO 3.3 Select the correct geometric shapes of the given buildings to improve its resistance against earthquake with justification TLO 3.4 Explain the role of damping on resistance to earthquake using the relevant method of base isolation techniques	**Unit - III Planning and design aspects** 3.1 Principles of earthquake-resistant planning: Site Selection and Soil Assessment, Building Design and Structural Configuration 3.2 Site selection and soil considerations for buildings 3.3 Building configuration: Importance of shape, symmetry, and stiffness Load path and lateral load resistance in building 3.4 Role of damping systems, Types of dampers , tuned mass dampers , viscous dampers and friction dampers base isolation techniques using Elastomeric bearings, sliding plates, ball bearings and springs	Video Demonstrations Case Study Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Correlate the damages occurred in the given type of building with its intensity in the given seismic zone. TLO 4.2 Interpret the earthquake to identify the causes of the failure w.r.t the given seismic zone. TLO 4.3 Compare damages of buildings at two different seismic zones for the given type of masonry building TLO 4.4 Compare the earthquakes of similar intensity with reference to the given data including its impact on concrete structure	**Unit - IV Earthquakes affected masonry and concrete buildings** 4.1 Behavior of masonry and reinforced concrete structures during earthquakes 4.2 Earthquake-resistant construction techniques for masonry buildings: Material Selection, Structural Configuration, Reinforcement Techniques, Construction Practices 4.3 Common failures in concrete and masonry buildings due to earthquakes: Sliding of roof support, falling of infill walls, crushing of column ends, and diagonal cracking of column beam joints, pulling out of reinforcement bars, foundation sinking and tilting 4.4 Retrofitting Methods for concrete and masonry Buildings: Grouting, Reinforced Concrete (RC) Jacketing, Steel Bracing, Fiber-Reinforced Polymer (FRP) wrapping, wall Strengthening with Wire mesh, Methods for strengthening and retrofitting existing structures like shear walls, infill walls and steel braces, Reinforced concrete (RC) Jacketing	Video Demonstrations Case Study Presentations Hands-on Flipped Classroom
5	TLO 5.1 Explain the relevant provisions of IS codes for construction of Earthquake resistant building for the given seismic zone. TLO 5.2 Explain the relevant method of retrofitting for the given damaged building affected by earthquake TLO 5.3 Undertake the relevant damage assessment techniques to evaluate the structural safety of the affected building TLO 5.4 Undertake the relevant Disaster management policies Community awareness Programs and Community awareness programs	**Unit - V Codal provisions and management Strategies** 5.1 Codal Provisions and Design Philosophy (IS 13920 2016, IS: 1893 (part I)-2002, IS:4326:2003) 5.2 Retrofitting Methods for Masonry Buildings, Grouting , Reinforced Concrete (RC) Jacketing, Steel Bracing, Fiber-Reinforced Polymer (FRP) Wrapping ,Wall Strengthening with Wire Mesh ,Base Isolation 5.3 Damage assessment and Structural safety evaluation-Immediate response and rescue Operations. Repair, rehabilitation, and retrofitting techniques 5.4 Disaster management policies, Objectives of Disaster Management Policies, Key Components of Disaster Management Policies, United States: Stafford Act (1988) India: Disaster Management Act (2005) Japan: Basic act on disaster management (1961), European Union Civil protection Mechanism (UCPM) ,Education and Training ,Capacity Building, First Aid and Basic Life Support Training , Search and Rescue Training , Fire Safety Training, Mock Drills and Simulation Exercises •Early Warning Systems, Community-Based Disaster Risk Reduction (CBDRR)	Video Demonstrations Case Study Presentations Hands-on Site/Industry Visit Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Prepare a detailed report distinguishing between P-waves, S-waves, and surface waves based on the given earthquake data from the given seismograph	1	*Identify the types of waves from the given seismograph.	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Mark four seismic zones on a printed map of India as per IS: 1893-2002 with color code.	2	*Use IS:1893-2002 guidelines to mark seismic zones	2	CO1
LLO 3.1 Draw the Seismic load distribution diagram for a Multi-Story Buildings G+4) Using a Shake Table.	3	Use a shake table to create load distribution diagram for given structure.	2	CO2
LLO 4.1 Prepare a report on earthquake simulations by observing videos to note structure's response to dynamic forces w.r.t shape and size of any two buildings in the given earthquake zone	4	*Undertake earthquake simulations for testing the stability of the structure having specific shape and size.	2	CO2
LLO 5.1 Prepare a report on impact of earthquake on the bearing capacity of soil present below the damaged structure.	5	*Prepare a report on impact of earthquake on the bearing capacity of soil present below the damaged structure.	2	CO3
LLO 6.1 Analyze the given soil sample and Prepare a report using Ground shaking techniques to observe effect of soil properties on intensity and behavior of seismic waves.	6	Analyze the given soil sample using ground shaking techniques with its impact on earthquake intensity.	2	CO3
LLO 7.1 Draw typical sketches on minimum five types of beam, column and beam-column joint with reinforcement details for making the structure earthquake resistant as per I.S. 13920-2016).	7	*Draw detailing of Reinforcement for Earthquake Resistance structure (As per IS: 13920-1993)	2	CO4
LLO 8.1 Draw minimum 3 typical sketches out of steel bracing, jacketing, and both fiber wrapping techniques used in retrofitting of Existing Structures and prepare a report commenting on the same.	8	*Draw the typical sketches of steel bracing, jacketing, and both fiber wrapping techniques used in retrofitting of Existing Structures with comments.	2	CO4
LLO 9.1 Draw minimum five sketches to represent the methods to strengthen steel structure with roof truss against earthquake damages with a brief note on it.	9	*Strengthening of steel structures with roof trusses against earthquake damages.	2	CO4
LLO 10.1 Draw minimum five sketches to represents the methods to strengthen steel structure with gable frame against earthquake damages with a brief note on it.	10	*Strategy framework to safeguard structures against earthquake damage.	2	CO4
LLO 11.1 Prepare a brief report on the effect of earthquake on Structural (minimum 3)and Non-Structural Components of building. (minimum 3)	11	Impact of earthquake on Structural and Non-Structural Components of building	2	CO5
LLO 12.1 Prepare a brief report on the effect of earthquake on Structural (minimum 3)and Non-Structural Components of building. (minimum 3)	12	Interprete Seismic codes in earthquake resistant design of buildings	2	CO5
LLO 13.1 Analyse the relevant videos and data to assess the structural damage occurred after earthquake in the given seismic zone. Give suggestions to repair the damaged structure.	13	Interprete damage mechanism and repair techniques using videos etc.	2	CO5
LLO 14.1 Identify the failure pattern observed in the video /simulation/ photographs due to earthquake with your comments.	14	Identification of failure pattern due to Earthquakes	2	CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 15.1 Identify the weak floors prone to collapse due to earthquake to analyze soft story and stiffness irregularities.	15	Use of soft story and stiffness irregularities to address structural weaknesses	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Prepare a report on the measurement of earthquake magnitude and intensity using case studies comparing the Richter and Mercalli scales with real earthquake data.
- Collect data of any three non-destructive equipments and prepare a report giving technical specifications, make, cost, nature of test, degree of accuracy of results etc.
- Visit web site of prominent institutes (IIT Kanpur) having research and development cell on earthquake engineering and prepare a report.
- Visit seismic data analysis and measurement centre of Government of Maharashtra for your district and prepare a report
- Prepare a report on the use of Dugong Technique to construct Earthquake resistant building
- Prepare a detailed report on construction and testing of masonry walls with and without Reinforcement
- Prepare a detailed report on comparing seismic performance of reinforced and unreinforced brick walls.
- Prepare a detailed report after conducting a field survey to assess structural damage and suggest repair methods for any two damaged buildings
- Prepare a detailed report on the testing of reinforced concrete beams for seismic resistance, applying cyclic loads to study ductility and energy absorption.
- Prepare a detailed report on the analysis of a simple building structure using response spectrum method using freeware software such as STAAD.Pro, ETABS etc. to perform seismic analysis.

Assignment

- Prepare a detailed report on the four virtues of Earthquake resistant buildings
- Prepare a detailed report on Introduction to IS 1893 Part I , Box action and different types of bands
- Study the effect of earthquake on minimum two reservoirs/dams and prepare a report focusing on its earthquake preparedness
- Study any two case studies of past earthquakes in India and prepare a report comparing the damages caused to concrete and masonry buildings
- Prepare a detailed report on Importance of beam column joints
- Prepare a detailed report on Importance of buildings with shear walls
- Prepare a report on the basic principle of seismic isolation and its application
- Prepare a detailed report on post-earthquake damage assessment and rehabilitation of the earthquake at killari, in Latur district
- Study any two case studies of past earthquakes in Maharashtra and prepare a report comparing the damages caused to concrete and masonry buildings
- Study any two case studies of past earthquakes in the World and prepare a report comparing the damages caused to concrete and masonry buildings
- Prepare a detailed report on minimum five ductility considerations as per IS 13920 :1993, and comment on its implementation in earthquake resistant structures
- Study the behavior of buildings with open parking during earthquake, considering any past earthquake in India and prepare a report on its pros and cons .

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Seismometers- Frequency 500 Hz to 0.00118 Hz (1/500 = 0.002 seconds per cycle, to 1/0.00118 = 850 seconds per cycle).	1
2	Sample Seismograph	1
3	Ultrasonic Pulse velocity	13
4	Rebound Hammer	13
5	Shake Table - a table capable of handling a scaled model's weight and simulating earthquake ground motions, typically with a table size of at least 3.26 x 2.26 meters and a triaxial capability for multi-directional testing	4

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Overview of Earthquake phenomenon	CO1	6	2	4	4	10
2	II	Causes and effects of earthquake	CO2	8	2	4	6	12
3	III	Planning and design aspects	CO3	9	4	4	6	14
4	IV	Earthquakes affected masonry and concrete buildings	CO4	12	4	6	8	18
5	V	Codal provisions and management Strategies	CO5	10	2	6	8	16
Grand Total				**45**	**14**	**24**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Assignments
- Term work
- microprojects
- Term work
- SLH(60% weightage to process and 40% weightage to product)
- Question and Answer

Summative Assessment (Assessment of Learning)

- Written test (Pen and paper test)
- Practical exam

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	2								
CO2		2			2	-				
CO3			2		2					
CO4		2	2	2	2	2				
CO5			2		2	2				

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Agarwal Pankaj, Shrikhande Manish	Earthquake Resistant Design of Structures	PHI Learning, Delhi,2011 ,ASIN: B00K7YFYVEISBN-13 9788120328921
2	Duggal, S. K.	Earthquake Resistant Design of Structures	Oxford University Press, Delhi, 2013 ISBN-13 9780198083528
3	Jai Krishna , A. R. Chandrashekharan Chandra, B.	Elements of Earthquake Engineering	South Asian Publishers Pvt Ltd, Delhi, 2014ISBN13 9788180142192
4	A.K.Chopra	Dynamics of structures	Pearson , New Delhi ISBN: 813171329
5	Mario Paz	Structural dynamics theory and computation	Springer (India) P. Ltd., ISBN:8181287724
6	BUREAU OF INDIAN STANDARDS	IS 1893:PartI :2002 Indian Standard CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES PART 1 GENERAL PROVISIONS AND BUILDINGS (Ffth Revision)	BUREAU OF INDIAN STANDARDS MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG NEW DELHI 110002
7	BUREAU OF INDIAN STANDARDS	IS 4326:2003 EARTHQUAKE RESISTANT DESIGN AND CONSTRUCTION OF BUILDINGS — CODE OF PRACTICE (Second Revision (Incorporating Amendment Nos. 1, 2 & 3) UDC 699.841 (026)	B U R E A U O F I N D I A N S T A N D A R D S MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG NEW DELHI 110002
8	BUREAU OF INDIAN STANDARDS	IS 13920 : 2016: Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces - Code of Practice (First Revision)	BUREAU OF INDIAN STANDARDS MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG NEW DELHI 110002

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description

EARTHQUAKE RESISTANT BUILDING **Course Code : 316311**

Sr.No	Link / Portal	Description
1	https://www.nicee.org/EQTips.php	National Information Centre of Earthquake Engineering at IIT Kanpur, INDIA
2	https://archive.nptel.ac.in/courses/105/101/105101004/	Introduction to Earthquake Engineering , syllabus coordinated by IIT Mumbai- Online NPTEL -E content
3	https://pib.gov.in/PressReleasePage.aspx?PRID=1740656	National Centre for Seismology under Ministry of Earth Sciences is the nodal agency of Government of India (GoI), for monitoring earthquakes in and around the country
4	https://iricen.gov.in/LAB/res/pdf/test-31.pdf	Rebound hammer test
5	https://dailycivil.com/ultrasonic-pulse-velocity-test-upv-test/	Ultrasonic pulse velocity test

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

SOLID WASTE MANAGEMENT **Course Code : 316312**

Programme Name/s	**: Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/**
Programme Code	**: CE/ CR/ CS/ LE**
Semester	**: Sixth**
Course Title	**: SOLID WASTE MANAGEMENT**
Course Code	**: 316312**

I. RATIONALE

Effective solid waste management (SWM) is required for maintaining a healthy, sustainable environment and ensuring the well-being of human populations. With rapid urbanization, industrialization, and increased consumption, the generation of solid waste has significantly risen, leading to severe environmental and health concerns. Proper management of solid waste is essential to mitigate its negative impacts and support sustainable development. As the global population continues to grow, effective waste management is key feature for conserving landfill space, reducing waste generation, and promoting sustainability. By adopting practices such as reducing, reusing, and recycling, communities can contribute to resource conservation and climate change mitigation.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
Implement Solid Waste Management Techniques to reduce Environmental Footprint in Compliance with its Regulations.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify the different types of solid wastes.
- CO2 - Select the relevant methods of storage, collection, segregation and transportation for given solid wastes.
- CO3 - Execute an action plan for disposal of solid wastes.
- CO4 - Implement the relevant method for disposal of Bio-medical, Industrial and E-waste.
- CO5 - Select the relevant laws related to solid waste management.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316312	SOLID WASTE MANAGEMENT	SWM	DSE	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 2 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Classify the solid waste on the basis of its source of collection. TLO 1.2 Distinguish solid waste on the basis of their characteristics. TLO 1.3 Analyze the impact of solid waste on environment. TLO 1.4 Draw the labelled sketch of hierarchy of waste management. TLO 1.5 Propose the organization chart required to manage solid waste for the given village / town / city of your locality.	**Unit - I Introduction to Solid Waste Management** 1.1 Overview of Solid Waste- Definition, types and sources of– Domestic Waste, Commercial waste, Industrial waste, Market waste, Agricultural waste, Biomedical waste, E-waste, Institutional waste. 1.2 Characteristics of Solid Waste: Physical, Chemical, and Biological properties, Classification of solid waste- Hazardous waste and Non-hazardous waste. 1.3 Impact of Solid Waste on Environment and Human health. 1.4 Solid waste management hierarchy: Prevent, Reduce, Reuse, Recycle, Recover and Dispose (IKS*- Crafts, Tools made of animal bones, shells and plant materials) 1.5 Organization pattern of solid waste management system, and Steps involved in the development of a Solid Waste Management System.	Lecture Using Chalk-Board Presentations Video Demonstrations Case Study Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Describe the factors affecting generation of given type of solid wastes. TLO 2.2 Suggest the relevant method of storage of solid waste for the given site conditions. TLO 2.3 Explain the relevant method of collecting the solid waste in the given situation. TLO 2.4 Suggest the relevant transportation system for transporting the municipal solid waste at the given location with justification. TLO 2.5 Justify the importance of Transfer station in collection and transportation of Solid Waste. TLO 2.6 Illustrate the different methods of segregation depending on type of solid waste. TLO 2.7 Implement the Recent techniques for segregation of solid waste in the given area. TLO 2.8 Analyze the financial requirement for solid waste management for a city or town.	**Unit - II Aspects of Solid Waste Management** 2.1 Waste generation, Factors Affecting Waste Generation: Population growth, urbanization, lifestyle, economic development etc. 2.2 Storage practices of solid waste generated, Tools and Equipment-Litter Bin, Broom, Shovels, Handcarts, Mechanical Road sweepers, Community bin - like movable and stationary bin. 2.3 Waste Collection Systems: a) Manual: Curb system, Alley, Setout and setback system b) Automated Collection Systems: Techniques, challenges, and innovations. 2.4 Transportation of municipal waste- Importance of Efficient Transportation, Transportation vehicles- Trucks, dumpsters, and other specialized vehicles. 2.5 Transfer station- meaning, necessity, location. 2.6 Segregation of Solid waste, its importance, reducing waste, improving recycling efficiency, Methods of Segregation: Manual and automated sorting. 2.7 Recent Innovations in segregation: Robotic sorting systems, AI in waste management-optical sorting, and smart bins. 2.8 Economic and financial aspects of waste management.	Lecture Using Chalk-Board Presentations Video Demonstrations Case Study Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Suggest a relevant method of disposal of solid waste in given situation. TLO 3.2 Explain the principles of composting of Solid Waste. TLO 3.3 Describe the different steps of executing the relevant method of composting. TLO 3.4 Explain the factors considered for site selection of landfill. TLO 3.5 Explain the relevant operating method of sanitary land filling. TLO 3.6 Discuss the role of Bioreactor landfills, methane capture, leachate treatment in Municipal solid waste management system. TLO 3.7 Use the relevant incineration method for disposal of given type of solid waste TLO 3.8 Discuss the key applications of pyrolysis in solid waste management.	**Unit - III Treatment and Disposal of Solid Waste** 3.1 Solid waste disposal methods and its importance-Composting, Landfill, Incineration and Energy Generation 3.2 Concept, Principles, and Factors affecting the composting 3.3 Methods of composting: Manual Composting – Bangalore method, Indore Method, Vermicomposting (IKS*-Bio-fertilizers, organic farming) Mechanical Composting – Dano Process 3.4 Land filling techniques, methods and Factors to be considered for site selection of landfills. 3.5 Land filling methods :Area method, Trench method, Ramp method, Advantages and disadvantages of landfill method 3.6 Recent Developments: Bioreactor Landfills, Methane capture, Leachate treatment 3.7 Incineration of solid waste: Introduction, Types of incinerators - Flash, Multiple chamber Incinerators, Advantages and disadvantages of incineration process 3.8 Pyrolysis of waste – Purpose, process and Applications	Lecture Using Chalk-Board Presentations Video Demonstrations Case Study Site/Industry Visit
4	TLO 4.1 Apply suitable management technique for safe disposal and treatment of biomedical waste. TLO 4.2 Apply suitable management technique for safe disposal and treatment of Industrial waste. TLO 4.3 Apply suitable management technique for safe disposal and treatment of E- waste TLO 4.4 Explain various energy recovery methods, including heat recovery units, power generation from waste, and biofuels and their efficiency in sustainable waste management practices. TLO 4.5 Apply recent developments in waste-to-energy (WTE) technologies, including modern WTE plants and small-scale decentralized systems, and evaluate their effectiveness, scalability in sustainable waste management and energy recovery.	**Unit - IV Waste Management Systems** 4.1 Biomedical Waste Management-Definition, Sources and generation of Biomedical waste, Classification and Management technologies for Biomedical waste. 4.2 Industrial Waste Management-Definition, Sources and generation of Industrial Waste, classification and Management technologies for Industrial Waste. 4.3 E- Waste Management - Definition, Sources and generation of E- Waste Management, Classification and Management technologies for E- Waste Management. 4.4 Energy Recovery Methods: Heat recovery Units, Power generation, Biofuels, Refuse-Derived Fuel (RDF) 4.5 Recent Developments: Modern WTE plants, small-scale decentralized systems.	Lecture Using Chalk-Board Presentations Video Demonstrations Case Study Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain Role of CPCB (Central Pollution Control Board) and MPCB (Maharashtra Pollution Control Board) in managing the given type of solid waste. TLO 5.2 Illustrate the relevant major provisions of Municipal Solid Waste Management Rules, 2016 for disposal of the given type of solid waste. TLO 5.3 Explain the different major provisions of Biomedical Waste Management Rules, 2016 for managing the given type of bio-medical waste. TLO 5.4 Illustrate the relevant major provisions of E-Waste management rules 2016 TLO 5.5 Explain the salient features of Hazardous and other wastes Management Rules, 2016 for the disposal of the given type of waste. TLO 5.6 Illustrate the relevant major provisions of Plastic Waste management rules 2016 TLO 5.7 Illustrate the relevant major provisions of Construction and Demolition Waste management rules 2016 TLO 5.8 Explain Extended Producer Responsibility (EPR) and articulate its principles, key objectives, and Role in waste management TLO 5.9 Discuss the role of NGOs in social, environmental, and economic impacts of initiatives in solid waste management	**Unit - V Legal Aspects of Solid Waste Management** 5.1 Role of agencies in management of solid waste from various sources : Central Pollution Control Board Maharashtra Pollution Control Board Municipal Corporations, Nagar Panchyat, Gram Panchayat etc 5.2 Municipal Solid Waste Management Rules, 2016 5.3 Biomedical Waste Management Rules, 2016 5.4 E- Waste Management Rules, 2016 5.5 Hazardous and other wastes Management Rules, 2016 5.6 Plastic Waste Management Rules, 2016 5.7 Construction and demolition Waste Management Rules, 2016 5.8 Extended Producer Responsibility (EPR) -The role of extended producer responsibility (EPR) in promoting, recycling, concepts, benefits of EPR 5.9 Role of NGO's and community participation in Solid waste management	Lecture Using Chalk-Board Presentations Video Demonstrations Case Study Site/Industry Visit Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Analyze the impact of Solid waste on environment and Human health	1	*Prepare a report on the improper solid waste management and its impact on human health focusing on the effects of waste exposure, pollution, and disease transmission in rural/urban/metrocities.	2	CO1
LLO 2.1 Identify the recent innovations in segregation of Solid waste.	2	Undertake the survey through internet to prepare a report with relevant photos on recent innovations in the segregation of solid waste, focusing on effective methods, tools, and technologies in rural /urban/metro cities	2	CO2
LLO 3.1 Identify the different methodologies employed by cities, municipalities, and organizations for solid waste collection and transportation.	3	*Undertake the survey through internet to prepare a report on the methodology used in collection and transportation of Solid waste including equipment's, specifications used in rural /urban/metro cities	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Apply knowledge of solid waste management best practices to design the organizational structure, ensuring that the staff, equipment, and machinery are optimally distributed to meet operational demands	4	Design the organization chart for the agency managing solid waste for a given area with respect to population to be served, pattern, equipment, manpower used.	2	CO1
LLO 5.1 Explain the working of vermicomposting plant.	5	*Prepare a report on observations along with relevant photographs and comments on working of Vermicomposting plant by visiting the Vermicomposting plant in your city/Vicinity or by viewing relevant video/simulation.	2	CO3
LLO 6.1 Analyze the landfill techniques used in Solid waste management.	6	Prepare a report on observations along with your comments on solid waste management system by landfills techniques by viewing the relevant video/simulation/visit.	2	CO3
LLO 7.1 Explain the methods of waste management employed by the plant, from collection and transportation to sorting, treatment, and disposal.	7	*Prepare a report along with relevant photographs and comments on disposal of municipal solid waste by visiting to Municipal Solid waste plant in your City/Vicinity or by viewing relevant video/simulation.	2	CO3
LLO 8.1 Explain the methods of waste management employed by the plant, from collection and transportation to sorting, treatment, and disposal of biomedical waste.	8	*Prepare a report along with relevant photographs and comments on disposal of bio-medical waste by visiting to bio-medical waste plant in your City/Vicinity or by viewing relevant video/simulation.	2	CO4
LLO 9.1 Describe the biogas production technology, including the type of digester and other equipment involved	9	*Prepare a report along with photographs and comments on working of Bio gas plant by visiting to Bio gas Plant in your City/Vicinity or by viewing relevant video/simulation.	2	CO3
LLO 10.1 Discuss any innovative technologies that could enhance e-waste recycling.	10	Prepare a report along with relevant photographs and comments on the disposal of E-waste by viewing the relevant video/simulation.	2	CO4
LLO 11.1 Illustrate the treatment methods used to manage or reduce industrial waste, such as chemical treatment, biological treatment, or thermal treatment	11	Prepare a report on your observations along with relevant photographs and comments on the disposal of Industrial waste by viewing the relevant video/simulation.	2	CO4
LLO 12.1 Explain various recent technologies used in energy recovery from solid waste.	12	*Undertake the survey through internet to prepare a report on recent energy recovery methods from solid waste, highlighting the various technologies and processes used to convert waste into energy.	2	CO4
LLO 13.1 Interpret provisions of Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB)	13	*Compile the relevant provisions of Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) pertaining to solid waste management.	2	CO5
LLO 14.1 Examine the Extended Producer Responsibility policy (EPR) in promoting recycling and sustainable waste management.	14	Prepare a report on a role of Extended Producer Responsibility (EPR) in promoting recycling and sustainable waste management.	2	CO5

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 15.1 Enlist the NGO's involved in solid waste management program and submit the findings on their involvement in communities.	15	Undertake the survey through internet and prepare a report by exploring various strategies and models used by NGOs to engage communities in solid waste management.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Prepare charts showing tools, equipment, vehicles and machineries used in solid waste management practices.
- Write a report on case studies for solid waste management practices in Rural/Urban Aera
- Prepare detailed photographic report on impact of solid waste on environment.
- Collect information on recent developments in Solid waste management such as bioreactors, methane capture etc.
- Write a report on the Role of NGO's and community participation in Solid waste management.
- Write a detailed report on Energy recovery concept in solid waste management.
- Collect the relevant technical and commercial information of minimum four tools, equipment, used for collection of solid waste with specification.

Micro project

- Prepare compost using decomposable waste material at your home/institute adopting appropriate method.
- Prepare vermicompost using decomposable waste material and worms at your home/institute.
- Prepare a report on route used for collection and transportation of solid waste of your city/Village.
- Prepare a report on solid waste management practices adopted in your institute campus.
- Develop a specific model regarding solid waste management practices
- Prepare models concerned with solid waste management practices like incineration, pyrolysis etc.
- Write a detailed report on legal aspects about Municipal Solid Waste Management Rules, 2016
- Write a detailed report on legal aspects about Biomedical Waste Management Rules, 2016
- Write a detailed report on legal aspects about Construction and demolition Waste Management Rules, 2016
- Prepare a report on Waste Management Softwares based on Data tracking, optimization, and monitoring tools.
- Prepare a report on Smart cities waste management using Integration of IoT, AI, and big data.
- Prepare a report on Advancements in AI and robotics for automated waste sorting.
- Prepare a report on Use of drones and robotics in waste management systems
- Prepare a report on Refused Derived Fuel (RDF)

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Use of specific models and charts for explanation regarding solid waste management practices and Computer System for video demonstrations and simulation	1,2,3,4,5,6,7,9,10,11,12,13,14,15
2	Specific Uniform, Helmet, Goggle, Hand Gloves, Face mask etc. for visits	5,7,8,9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Solid Waste Management	CO1	4	2	4	0	6
2	II	Aspects of Solid Waste Management	CO2	12	4	4	10	18
3	III	Treatment and Disposal of Solid Waste	CO3	15	2	8	12	22
4	IV	Waste Management Systems	CO4	8	0	8	6	14
5	V	Legal Aspects of Solid Waste Management	CO5	6	2	4	4	10
Grand Total				**45**	**10**	**28**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Termwork, Assignment, Microproject (60% Weightage to process and 40% weightage to product), Question and Answer.

Summative Assessment (Assessment of Learning)

- Practical Examination, Oral Examination, Pen and Paper Test.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	-	-	-	1	1	2			
CO2	2	2	2	3	3	1	1			
CO3	2	3	3	2	2	2	1			
CO4	2	2	2	2	2	2	1			
CO5	2	-	-	-	2	-	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number

SOLID WASTE MANAGEMENT **Course Code : 316312**

Sr.No	Author	Title	Publisher with ISBN Number
1	Ashok K. Rathoure	Zero Waste: Management Practices for Environmental Sustainability	ISBN: 9780367180393
2	M.S. Bhatt and Asheref Illiyan	Solid Waste Management: An Indian Perspective	Synergy Books India ISBN-10 :789382059059 ISBN-13 : 978-9382059059
3	Sasikumar K	Solid Waste Management	Prentice Hall India Learning Private Limited, ISBN-10: 9788120338692 , ISBN-13 : 978-8120338692
4	Dr. Ranjita Roy Sarkar	Waste to Energy Efficient Municipal Solid Waste Management	Abhijeet Publications ISBN-10:9392816715 ISBN-13 : 978-9392816710
5	Dr. Harshita Jain, Dr. Renu Dhupper	Sustainable Solid Waste Management	S.K. Kataria & Sons ISBN:978-81-963589-2-1

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/105/103/105103205/	NPTEL Video Lecture on Municipal Solid Waste management by IIT
2	https://nptel.ac.in/courses/105105160	NPTEL Video Lecture on Integrated Waste Management for a Smart City by IIT
3	https://onlinecourses.swayam2.ac.in/cec20_ge34/preview	Swayam Portal Video Lecture on Solid and hazardous Waste Management
4	https://www.mospi.gov.in/sites/default/files/main_menu/Seminar/Policy%20on%20Waste%20Management%20-%20MOEFCC.pdf	Presentation on Policy on Waste Management by Government of India Ministry of Environment, Forest & Climate Change
5	https://mpcb.gov.in/wastes-management/municipal-solid-waste	Rules/Regulations/Notifications/Memorandum on Solid waste management by Maharashtra Pollution Control Board

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students