VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF CIVIL ENGINEERING

M. Tech. Structural Engineering

(M.Tech. MST)

Curriculum

(*2018-2019 admitted students*)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF CIVIL ENGINEERING

- To be internationally recognized in Civil Engineering through groundbreaking contributions and exceptional leadership for sustainable development of the society.

MISSION STATEMENT OF THE SCHOOL OF CIVIL ENGINEERING

- To pioneer the emerging technology in Civil Engineering.
- To address the complex societal scale challenges in areas of resilient infrastructure, smart and sustainable cities, water and energy security, climate change, mobility of goods and people, and environmental protection.
- To inspire and nurture innovative leaders and entrepreneurs.

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M. Tech. Structural Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems.

2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry.

3. Graduates will function in their profession with social awareness and responsibility.

4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country.

5. Graduates will be successful in pursuing higher studies in engineering or management.

6. Graduates will pursue career paths in teaching or research.

M. Tech. Structural Engineering

PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering Applications

PO_02: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_03: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_04: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_05: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_06: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_07: Having a clear understanding of professional and ethical responsibility

PO_08: Having a good cognitive load management skills related to project management and finance

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M. Tech. Structural Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M. Tech. (Structural Engineering) programme, graduates will be able to

PSO_01: Analyse and design reinforced concrete structures and steel structures as per the standard design of codes.

PSO_02: Address the societal needs by interdisciplinary approach through advanced courses and get exposed to the latest technologies to be industry ready or to pursue advanced research.

PSO_03: Independently carry out research / investigation to solve practical problems and write / present a substantial technical report / document.

M. Tech. Structural Engineering

CREDIT STRUCTURE

Category-wise Credit distribution

Category	Credits
University core (UC)	27
Programme core (PC)	19
Programme elective (PE)	18
University elective (UE)	6
Bridge course (BC)	
Total credits	70

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M. Tech. Structural Engineering

DETAILED CURRICULUM

University Core

S. No.	Course Code	Course Title	L	T	P	J	C
1.	MAT5005	Advanced Mathematical Methods	3	0	0	0	3
2.	ENG5001	Fundamentals of Communication Skills	0	0	2	0	1
3.	ENG5002	Professional and Communication Skills	0	0	2	0	1
4.	FRE5001	Francais fonctionnel	2	0	0	0	2
5.	GER5001	Deutsch fuer Anfaenger	2	0	0	0	2
6.	STS5001	Essentials of Business Etiquettes	3	0	0	0	1
7.	STS 5002	Preparing for Industry	3	0	0	0	1
8.	SET5001	Science, Engineering and Technology Project – I	0	0	0	0	2
9.	SET 5002	Science, Engineering and Technology Project – II	0	0	0	0	2
10.	CLE6099	Master's Thesis	0	0	0	0	16

M. Tech. Structural Engineering

Programme Core

S. No.	Course Code	Course Title	L	T	P	J	C
1.	CLE5001	Theory of Elasticity and Plasticity	3	0	0	0	3
2.	CLE5002	Design of Concrete Structural Systems	3	0	0	4	4
3.	CLE5003	Structural Dynamics	3	2	0	0	4
4.	CLE6014	Finite Element Analysis	2	2	2	0	4
5.	CLE6015	Advanced Design of Steel Structures	2	2	0	4	4

M. Tech. Structural Engineering

Programme Elective

Sl. No.	Course Code	Course Title	L	T	P	J	C
1.	CLE5010	Matrix Methods of Structural Analysis	2	2	0	0	3
2.	CLE5012	Design of Bridges	2	0	0	4	3
3.	CLE5013	Experimental Stress Analysis	3	0	0	0	3
4.	CLE5014	Machine Foundations	2	2	0	0	3
5.	CLE5015	Prefabricated Structures	2	0	0	4	3
6.	CLE5016	Stability of Structures	2	2	0	0	3
7.	CLE6001	Advanced Concrete Materials and Technology	2	0	0	4	3
8.	CLE6002	Advanced Foundation Design	3	0	0	0	3
9.	CLE6004	Repair and Rehabilitation of Structures	3	0	0	0	3
10.	CLE6016	Prestressed Concrete Structures	2	2	0	0	3
11.	CLE6017	Earthquake Resistant Design	2	0	0	4	3
12.	CLE6018	Application of Numerical Methods in Structural Engineering	2	2	0	0	3
13.	CLE6019	Theory and Design of Plates and Shells	2	2	0	0	3
14.	CLE6020	Analysis and Design of Tall Structures	2	0	0	4	3
15.	CLE6021	Structural Optimization	3	0	0	0	3
16.	CLE6022	Urban Planning and Sustainability	3	0	0	0	3
17.	CLE6023	Offshore Structures	2	2	0	0	3
18.	CLE6024	Energy Efficient Buildings	3	0	0	0	3

MAT5005	Advanced Mathematical Methods	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	None	Syllabus version				
		1.0				

Course Objectives:

1. Provide the students with sufficient exposure to advanced mathematical methods and tools that are relevant to engineering research.
2. Improving the computational skills of students by giving sufficient knowledge of analytical and numerical techniques useful for solving problems arising in Mechanical Engineering.
3. Imparting the knowledge of real time applications of Autonomous systems, Non-linear systems of ordinary differential equations and partial differential equations.

Expected Course Outcomes:

At the end of the course students are able to

1. Distinguish and analyse a variety of tools for solving linear systems and finding eigenvalues of these systems.
2. Derive and use the numerical techniques needed for the solution of a given engineering problems
3. Understand and correlate the analytical and numerical methods
4. Demonstrate their ability to write coherent mathematical proofs and scientific arguments needed to communicate the results obtained from differential equation models.
5. Demonstrate the understanding of how physical phenomena are modelled by partial differential equations

Module:1	Eigenvalue Problems	5 hours

Standard Eigen value problems–Eigenvalues and Eigenvectors–Gerschgorin Circles theorem–Rutishauser method, Power method, Inverse Power method.

Module:2	Iteration Methods	6 hours

Sturm sequence, Jacobi method, Given's method, Householder method, Deflation, Lanczo's method.

Module:3	Calculus of Variations	9 hours

Euler-Lagrange's equation –Isoperimetric problems, Rayleigh–Ritz method - Galerkin method.

Module:4	System of First Order Ordinary Differential Equations	6 hours

Linear Systems - Homogeneous linear systems with constant coefficients - Autonomous systems - Phase Plane Phenomena - Critical Points - Stability for linear systems.

Module:5	Nonlinear systems	6 hours

Simple critical points of nonlinear systems-Stability by Liapunov's method –
Non- Linear Mechanics: Conservative systems.

Module:6	Partial Differential Equations	5 hours

Classification of Second-Order Partial Differential Equations, Significance of characteristic curves, Canonical Form, Sturm–Liouville problems and Eigen function expansions.

Module:7	Wave equation	6 hours

Displacements in a long string – a long string under its weight – a bar with prescribed force on one end – free vibrations of a string. Method of Separation of variables, Solution by method of Laplace transforms		
Module:8	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours	**45 hours**

Text Book(s)	
1	Differential Equations: Theory, Technique and Practice, G.F. Simmons, S. G. Krantz, Tata Mc GrawHill Publishing, 2007. (Topics from Chapters 10, 11)
2	Elements of Partial differential equations, Ian N. Sneddon, Dover Publications, New York, 2006. (Topics from Chapters 3, 5)
3	Numerical Methods for Scientific and Engineering Computation, M. K. Jain, S. R. K. Iyengar, R. K. Jain, New Age International publishers, 7th edition, New Delhi, 2019. (Topics from Chapter 3, 7)
4	Introductory Methods of Numerical Analysis, S. S. Sastry, PHI Pvt. Ltd., 5th Edition, New Delhi, 2015. (Topics from Chapter 11)
5	The Calculus of Variations, Bruce van Brunt, Springer, 2004. (Topics from Chapters 2, 4, 5)
Reference Books	
1	Differential Equations and Dynamical Systems, Lawrence Perko, 3rd ed., Springer-Verlag, 2001.
2	An introduction to Ordinary Differential Equations, James C. Robinson, Cambridge University Press, New York, 2008 (4th print).
3	Elementary Applied Partial Differential Equations, Richard Haberman, Prentice Hall International, 1998.
4	Numerical Analysis, R. L. Burden and J. D. Faires, 10th Edition, Cengage Learning, India edition, 2015.

Mode of Evaluation: Continuous Assessment Tests, Final Assessment Test, Digital Assignments, Quizzes.			
Recommended by Board of Studies	09-03-2016		
Approved by Academic Council	No. 40	Date	18-03-2016

ENG5001	Fundamentals of Communication Skills	L	T	P	J	C
		0	0	2	0	1
Pre-requisite	Not cleared EPT (English Proficiency Test)	**Syllabus version**				
		v. 1.0				

Course Objectives:

1. To enable learners learn basic communication skills - Listening, Speaking, Reading and Writing
2. To help learners apply effective communication in social and academic context
3. To make students comprehend complex English language through listening and reading

Expected Course Outcome:

1. Enhance the listening and comprehension skills of the learners
2.Acquire speaking skills to express their thoughts freely and fluently
3.Learn strategies for effective reading
4.Write grammatically correct sentences in general and academic writing
5. Develop technical writing skills like writing instructions, transcoding etc.,

Module:1	Listening	**8 hours**
Understanding Conversation,Listening to Speeches,Listening for Specific Information		
Module:2	Speaking	**4 hours**
Exchanging Information,Describing Activities, Events and Quantity		
Module:3	Reading	**6 hours**
Identifying Information,Inferring Meaning,Interpreting text		
Module:4	Writing: Sentence	**8hours**
Basic Sentence Structure,Connectives,Transformation of Sentences,Synthesis of Sentences		
Module:5	Writing: Discourse	**4hours**
Instructions, Paragraph, Transcoding		
	Total Lecture hours	**30 hours**

Text Book(s)

1. Redston, Chris, Theresa Clementson, and Gillie Cunningham. *Face2face Upper Intermediate Student's Book.* 2013, Cambridge University Press.

Reference Books

1. Chris Juzwiak .*Stepping Stones: A guided approach to writing sentences and Paragraphs (Second Edition)*, 2012, Library of Congress.
2. Clifford A Whitcomb & Leslie E Whitcomb, *Effective Interpersonal and Team Communication Skills for Engineers*, 2013, John Wiley & Sons, Inc., Hoboken: New Jersey.
3. ArunPatil, Henk Eijkman &Ena Bhattacharya, *New Media Communication Skills for Engineers and IT Professionals*,2012, IGI Global, Hershey PA.
4. Judi Brownell, *Listening: Attitudes, Principles and Skills*, 2016, 5th Edition, Routledge:USA
5. John Langan, Ten Steps to Improving College Reading Skills, 2014, 6th Edition, Townsend Press:USA
6. Redston, Chris, Theresa Clementson, and Gillie Cunningham. *Face2face Upper Intermediate Teacher's Book*. 2013, Cambridge University Press.

Authors, book title, year of publication, edition number, press, place

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Familiarizing students to adjectives through brainstorming adjectives with all letters of the English alphabet and asking them to add an adjective that starts with the first letter of their name as a prefix.	**2 hours**
2.	Making students identify their peer who lack Pace, Clarity and Volume during presentation and respond using Symbols.	**4 hours**
3.	Using Picture as a tool to enhance learners speaking and writing skills	**2 hours**
4.	Using Music and Songs as tools to enhance pronunciation in the target language / Activities through VIT Community Radio	**4 hours**
5.	Making students upload their Self- introduction videos in Vimeo.com	**4 hours**
6.	Brainstorming idiomatic expressions and making them use those in to their writings and day to day conversation	**4 hours**
7.	Making students Narrate events by adding more descriptive adjectives and add flavor to their language / Activities through VIT Community Radio	**4 hours**
8	Identifying the root cause of stage fear in learners and providing remedies to make their presentation better	**4 hours**
9	Identifying common Spelling & Sentence errors in Letter Writing and other day to day conversations	**2 hours**
10.	Discussing FAQ's in interviews with answers so that the learner gets a better insight in to interviews / Activities through VIT Community Radio	**2 hours**
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Online Quizzes, Presentation, Role play, Group Discussions, Assignments, Mini Project

Recommended by Board of Studies	22-07-2017		
Approved by Academic Council	No. 46	Date	24-8-2017

ENG5002	Professional and Communication Skills	L	T	P	J	C
Pre-requisite	ENG5001	0	0	2	0	1
		Syllabus version				
		v. 1.1				

Course Objectives:

1. To enable students to develop effective Language and Communication Skills
2. To enhance students' Personal and Professional skills
3. To equip the students to create an active digital footprint

Expected Course Outcome:

1. Improve inter-personal communication skills
2. Develop problem solving and negotiation skills
3. Learn the styles and mechanics of writing research reports
4. Cultivate better public speaking and presentation skills
5. Apply the acquired skills and excel in a professional environment

Module:1	**Personal Interaction**	**2hours**
Introducing Oneself- one's career goals,Activity: SWOT Analysis		
Module:2	**Interpersonal Interaction**	**2 hours**
Interpersonal Communication with the team leader and colleagues at the workplace, Activity: Role Plays/Mime/Skit		
Module:3	**Social Interaction**	**2 hours**
Use of Social Media, Social Networking, gender challenges Activity: Creating LinkedIn profile, blogs		
Module:4	**Résumé Writing**	**4 hours**
Identifying job requirement and key skills Activity: Prepare an Electronic Résumé		
Module:5	**Interview Skills**	**4 hours**
Placement/Job Interview, Group Discussions Activity: Mock Interview and mock group discussion		
Module:6	**Report Writing**	**4 hours**
Language and Mechanics of Writing Activity: Writing a Report		
Module:7	**Study Skills: Note making**	**2hours**
Summarizing the report Activity: Abstract, Executive Summary, Synopsis		
Module:8	**Interpreting skills**	**2 hours**
Interpret data in tables and graphs Activity: Transcoding		
Module:9	**Presentation Skills**	**4 hours**
Oral Presentation using Digital Tools Activity: Oral presentation on the given topic using appropriate non-verbal cues		
Module:10	**Problem Solving Skills**	**4 hours**
Problem Solving & Conflict Resolution Activity: Case Analysis of a Challenging Scenario		

	Total Lecture hours	**30hours**

Text Book(s)	
1	Bhatnagar Nitin and Mamta Bhatnagar, *Communicative English For Engineers And Professionals*, 2010, Dorling Kindersley (India) Pvt. Ltd.
Reference Books	
1	Jon Kirkman and Christopher Turk, *Effective Writing: Improving Scientific, Technical and Business Communication*, 2015, Routledge
2	Diana Bairaktarova and Michele Eodice, *Creative Ways of Knowing in Engineering*, 2017, Springer International Publishing
3	Clifford A Whitcomb & Leslie E Whitcomb, *Effective Interpersonal and Team Communication Skills for Engineers*, 2013, John Wiley & Sons, Inc., Hoboken: New Jersey.
4	ArunPatil, Henk Eijkman &Ena Bhattacharya, *New Media Communication Skills for Engineers and IT Professionals*,2012, IGI Global, Hershey PA.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

List of Challenging Experiments (Indicative)		
1.	SWOT Analysis – Focus specially on describing two strengths and two weaknesses	**2 hours**
2.	Role Plays/Mime/Skit -- Workplace Situations	**4 hours**
3.	Use of Social Media – Create a LinkedIn Profile and also write a page or two on areas of interest	**2 hours**
4.	Prepare an Electronic Résumé and upload the same in vimeo	**2 hours**
5.	Group discussion on latest topics	**4 hours**
6	Report Writing – Real-time reports	**2 hours**
7	Writing an Abstract, Executive Summary on short scientific or research articles	**4 hours**
8	Transcoding – Interpret the given graph, chart or diagram	**2 hours**
9	Oral presentation on the given topic using appropriate non-verbal cues	**4 hours**
10	Problem Solving -- Case Analysis of a Challenging Scenario	**4 hours**
	Total Laboratory Hours	**30 hours**

Mode of evaluation: Online Quizzes, Presentation, Role play, Group Discussions, Assignments, Mini Project			
Recommended by Board of Studies	22-07-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

FRE5001	FRANCAIS FONCTIONNEL	L	T	P	J	C
		2	0	0	0	2
Pre-requisite	**Nil**	**Syllabus version**				
		v.1				

Course Objectives:

The course gives students the necessary background to:

1. Demonstrate competence in reading, writing, and speaking basic French, including knowledge of vocabulary (related to profession, emotions, food, workplace, sports/hobbies, classroom and family).
2. Achieve proficiency in French culture oriented view point.

Expected Course Outcome:

The students will be able to

1. Remember the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations, interrogations etc.
2. Create communicative skill effectively in French language via regular / irregular verbs.
3. Demonstrate comprehension of the spoken / written language in translating simple sentences.
4. Understand and demonstrate the comprehension of some particular new range of unseen written materials.
5. Demonstrate a clear understanding of the French culture through the language studied.

Module:1	**Saluer, Se présenter, Etablir des contacts**	**3 hours**

Les Salutations, Les nombres (1-100), Les jours de la semaine, Les mois de l'année, Les Pronoms Sujets, Les Pronoms Toniques, La conjugaison des verbes réguliers, La conjugaison des verbes irréguliers- avoir / être / aller / venir / faire etc.

Module:2	**Présenter quelqu'un, Chercher un(e) correspondant(e), Demander des nouvelles d'une personne.**	**3 hours**

La conjugaison des verbes Pronominaux, La Négation,
L'interrogation avec *'Est-ce que ou sans Est-ce que'*.

Module:3	**Situer un objet ou un lieu, Poser des questions**	**4 hours**

L'article (défini/ indéfini), Les prépositions (à/en/au/aux/sur/dans/avec etc.), L'article contracté, Les heures en français, La Nationalité du Pays, L'adjectif (La Couleur, l'adjectif possessif, l'adjectif démonstratif/ l'adjectif interrogatif (quel/quelles/quelle/quelles), L'accord des adjectifs avec le nom, L'interrogation avec Comment/ Combien / Où etc.,

Module:4	**Faire des achats, Comprendre un texte court, Demander et indiquer le chemin.**	**6 hours**

La traduction simple :(français-anglais / anglais –français)

Module:5	**Trouver les questions, Répondre aux questions générales en français.**	**5 hours**

L'article Partitif, Mettez les phrases aux pluriels, Faites une phrase avec les mots donnés, Exprimez les phrases données au Masculin ou Féminin, Associez les phrases.

Module:6	**Comment ecrire un passage**	**3 hours**

Décrivez :

La Famille /La Maison, /L'université /Les Loisirs/ La Vie quotidienne etc.

Module:7	**Comment ecrire un dialogue**	**4 hours**

Dialogue:

a) Réserver un billet de train
b) Entre deux amis qui se rencontrent au café
c) Parmi les membres de la famille
d) Entre le client et le médecin

Module:8	**Invited Talk: Native speakers**	**2 hours**
	Total Lecture hours	**30 hours**

Text Book(s)	
1.	Echo-1, Méthode de français, J. Girardet, J. Pécheur, Publisher CLE International, Paris 2010.
2	Echo-1, Cahier d'exercices, J. Girardet, J. Pécheur, Publisher CLE International, Paris 2010.
Reference Books	
1.	CONNEXIONS 1, Méthode de français, Régine Mérieux, Yves Loiseau,Les Éditions Didier, 2004.
2	CONNEXIONS 1, Le cahier d'exercices, Régine Mérieux, Yves Loiseau, Les Éditions Didier, 2004.
3	ALTER EGO 1, Méthode de français, Annie Berthet, Catherine Hugo, Véronique M. Kizirian, Béatrix Sampsonis, Monique Waendendries , Hachette livre 2006.

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies			
Approved by Academic Council	No 41	Date	17-06-2016

GER5001	Deutsch für Anfänger	L	T	P	J	C
		2	0	0	0	2
Pre-requisite	**NIL**	**Syllabus version**				
		v.1				

Course Objectives:

The course gives students the necessary background to:

1. Enable students to read and communicate in German in their day to day life
2. Become industry-ready
3. Make them understand the usage of grammar in the German Language.

Expected Course Outcome:

The students will be able to

1. Create the basics of German language in their day to day life.
2. Understand the conjugation of different forms of regular/irregular verbs.
3. Understand the rule to identify the gender of the Nouns and apply articles appropriately.
4. Apply the German language skill in writing corresponding letters, E-Mails etc.
5. Create the talent of translating passages from English-German and vice versa and To frame simple dialogues based on given situations.

Module:1		**3 hours**

Einleitung, Begrüssungsformen, Landeskunde, Alphabet, Personalpronomen, Verb Konjugation, Zahlen (1-100), W-fragen, Aussagesätze, Nomen – Singular und Plural

Lernziel:

Elementares Verständnis von Deutsch, Genus- Artikelwörter

Module:2		**3 hours**

Konjugation der Verben (regelmässig /unregelmässig) die Monate, die Wochentage, Hobbys, Berufe, Jahreszeiten, Artikel, Zahlen (Hundert bis eine Million), Ja-/Nein- Frage, Imperativ mit Sie

Lernziel :

Sätze schreiben, über Hobbys erzählen, über Berufe sprechen usw.

Module:3		**4 hours**

Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, unbestimmterArtikel), trennnbare verben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlzeiten, Lebensmittel, Getränke

Lernziel :

Sätze mit Modalverben, Verwendung von Artikel, über Länder und Sprachen sprechen, über eine Wohnung beschreiben.

Module:4		**6 hours**

Übersetzungen : (Deutsch – Englisch / Englisch – Deutsch)

Lernziel :

Grammatik – Wortschatz – Übung

Module:5		**5 hours**

Leseverständnis,Mindmap machen,Korrespondenz- Briefe, Postkarten, E-Mail

Lernziel :

Wortschatzbildung und aktiver Sprach gebrauch

Module:6	.	**3 hours**

Aufsätze :

Meine Universität, Das Essen, mein Freund oder meine Freundin, meine Familie, ein Fest in

Deutschland usw		
Module:7		**4 hours**
Dialoge: a) Gespräche mit Familienmitgliedern, Am Bahnhof, b) Gespräche beim Einkaufen ; in einem Supermarkt ; in einer Buchhandlung ; c) in einem Hotel - an der Rezeption ;ein Termin beim Arzt. d) Treffen im Cafe		
Module:8		**2 hours**
Guest Lectures/Native Speakers / Feinheiten der deutschen Sprache, Basisinformation über die deutschsprachigen Länder		
	Total Lecture hours	**30 hours**

Text Book(s)	
1.	**Studio d A1 Deutsch als Fremdsprache, Hermann Funk, Christina Kuhn, Silke Demme : 2012**
Reference Books	
1	Netzwerk Deutsch als Fremdsprache A1, Stefanie Dengler, Paul Rusch, Helen Schmtiz, Tanja Sieber, 2013
2	Lagune ,Hartmut Aufderstrasse, Jutta Müller, Thomas Storz, 2012.
3	Deutsche SprachlehrefürAUsländer, Heinz Griesbach, Dora Schulz, 2011
4	ThemenAktuell 1, HartmurtAufderstrasse, Heiko Bock, MechthildGerdes, Jutta Müller und Helmut Müller, 2010
	www.goethe.de wirtschaftsdeutsch.de hueber.de, klett-sprachen.de www.deutschtraning.org

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies			
Approved by Academic Council	No. 41	Date	17-06-2016

STS5001	Essentials of Business etiquettes	L	T	P	J	C
		3	0	0	0	1
Pre-requisite		**Syllabus version**				
		2				

Course Objectives:

1. To develop the students' logical thinking skills
2. To learn the strategies of solving quantitative ability problems
3. To enrich the verbal ability of the students
4. To enhance critical thinking and innovative skills

Expected Course Outcome:

1. Enabling students to use relevant aptitude and appropriate language to express themselves
2. To communicate the message to the target audience clearly

Module:1	**Business Etiquette: Social and Cultural Etiquette and Writing Company Blogs and Internal Communications and Planning and Writing press release and meeting notes**	**9 hours**

Value, Manners, Customs, Language, Tradition, Building a blog, Developing brand message, FAQs', Assessing Competition, Open and objective Communication, Two way dialogue, Understanding the audience, Identifying, Gathering Information,. Analysis, Determining, Selecting plan, Progress check, Types of planning, Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph., Body – Make it relevant to your audience,

Module:2	**Study skills – Time management skills**	**3 hours**

Prioritization, Procrastination, Scheduling, Multitasking, Monitoring, Working under pressure and adhering to deadlines

Module:3	**Presentation skills – Preparing presentation and Organizing materials and Maintaining and preparing visual aids and Dealing with questions**	**7 hours**

10 Tips to prepare PowerPoint presentation, Outlining the content, Passing the Elevator Test, Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation, Importance and types of visual aids, Animation to captivate your audience, Design of posters, Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions

Module:4	**Quantitative Ability -L1 – Number properties and Averages and Progressions and Percentages and Ratios**	**11 hours**

Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position, Averages, Weighted Average, Arithmetic Progression, Geometric Progression, Harmonic Progression, Increase & Decrease or successive increase, Types of ratios and proportions

Module:5	**Reasoning Ability-L1 – Analytical Reasoning**	**8 hours**

Data Arrangement(Linear and circular & Cross Variable Relationship), Blood Relations, Ordering/ranking/grouping, Puzzle test, Selection Decision table

Module:6	**Verbal Ability-L1 – Vocabulary Building**	**7 hours**

Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies

	Total Lecture hours	**45 hours**

Reference Books

1. Kerry Patterson, Joseph Grenny, Ron McMillan, Al Switzler(2001) Crucial Conversations:

	Tools for Talking When Stakes are High. Bangalore. McGraw-Hill Contemporary		
2.	Dale Carnegie,(1936) How to Win Friends and Influence People. New York. Gallery Books		
3.	Scott Peck. M(1978) Road Less Travelled. New York City. M. Scott Peck.		
4.	FACE(2016) Aptipedia Aptitude Encyclopedia. Delhi. Wiley publications		
5.	ETHNUS(2013) Aptimithra. Bangalore. McGraw-Hill Education Pvt. Ltd.		
Websites:			
1.	www.chalkstreet.com		
2.	www.skillsyouneed.com		
3.	www.mindtools.com		
4.	www.thebalance.com		
5.	www.eguru.ooo		
Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)			
Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45	Date	15/06/2017

STS 5002	Preparing for Industry	L	T	P	J	C
		3	0	0	0	1
Pre-requisite		**Syllabus version**				
		2				

Course Objectives:

1. To develop the students' logical thinking skills
2. To learn the strategies of solving quantitative ability problems
3. To enrich the verbal ability of the students
4. To enhance critical thinking and innovative skills

Expected Course Outcome:

1. Enabling students to simplify, evaluate, analyze and use functions and expressions to simulate real situations to be industry ready.

Module:1	**Interview skills – Types of interview and Techniques to face remote interviews and Mock Interview**	**3 hours**

Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview, Video interview¸ Recorded feedback, Phone interview preparation, Tips to customize preparation for personal interview, Practice rounds

Module:2	**Resume skills – Resume Template and Use of power verbs and Types of resume and Customizing resume**	**2 hours**

Structure of a standard resume, Content, color, font, Introduction to Power verbs and Write up, Quiz on types of resume, Frequent mistakes in customizing resume, Layout - Understanding different company's requirement, Digitizing career portfolio

Module:3	**Emotional Intelligence - L1 – Transactional Analysis and Brain storming and Psychometric Analysis and Rebus Puzzles/Problem Solving**	**12 hours**

Introduction, Contracting, ego states, Life positions, Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure, Round robin brainstorming, Skill Test, Personality Test, More than one answer, Unique ways

Module:4	**Quantitative Ability-L3 – Permutation-Combinations and Probability and Geometry and mensuration and Trigonometry and Logarithms and Functions and Quadratic Equations and Set Theory**	**14 hours**

Counting, Grouping, Linear Arrangement, Circular Arrangements, Conditional Probability, Independent and Dependent Events, Properties of Polygon, 2D & 3D Figures, Area & Volumes, Heights and distances, Simple trigonometric functions, Introduction to logarithms, Basic rules of logarithms, Introduction to functions, Basic rules of functions, Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations, Basic concepts of Venn Diagram

Module:5	**Reasoning ability-L3 – Logical reasoning and Data Analysis and Interpretation**	**7 hours**

Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic, Data Sufficiency, Data interpretation-Advanced, Interpretation tables, pie charts & bar chats

Module:6	**Verbal Ability-L3 – Comprehension and Logic**	**7 hours**

Reading comprehension, Para Jumbles, Critical Reasoning (a) Premise and Conclusion, (b) Assumption & Inference, (c) Strengthening & Weakening an Argument

Total Lecture hours	**45 hours**

Reference Books

1.	Michael Farra and JIST Editors(2011) Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Saint Paul, Minnesota. Jist Works
2.	Daniel Flage Ph.D(2003) The Art of Questioning: An Introduction to Critical Thinking. London. Pearson
3.	David Allen(2002) Getting Things done : The Art of Stress -Free productivity. New York City. Penguin Books.
4.	FACE(2016) Aptipedia Aptitude Encyclopedia.Delhi. Wiley publications
5.	ETHNUS(2013) Aptimithra. Bangalore. McGraw-Hill Education Pvt. Ltd.

Websites:

1.	www.chalkstreet.com
2.	www.skillsyouneed.com
3.	www.mindtools.com
4.	www.thebalance.com
5.	www.eguru.ooo

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays,
3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45	Date	15/06/2017

Course code	SCIENCE, ENGINEERING AND TECHNOLOGY PROJECT– I	L	T	P	J	C
SET 5001						2
Pre-requisite		Syllabus Version				
Anti-requisite		1.10				

Course Objectives:

1. To provide opportunity to involve in research related to science / engineering
2. To inculcate research culture
3. To enhance the rational and innovative thinking capabilities

Expected Course Outcome:

On completion of this course, the student should be able to:

1. Identify problems that have relevance to societal / industrial needs
2. Exhibit independent thinking and analysis skills
3. Demonstrate the application of relevant science / engineering principles

Modalities / Requirements

1. Individual or group projects can be taken up
2. Involve in literature survey in the chosen field
3. Use Science/Engineering principles to solve identified issues
4. Adopt relevant and well-defined / innovative methodologies to fulfill the specified objective
5. Submission of scientific report in a specified format (after plagiarism check)

Student Assessment : Periodical reviews, oral/poster presentation

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

SET 5002	SCIENCE, ENGINEERING AND TECHNOLOGY PROJECT– II	L	T	P	J	C
						2
Pre-requisite		**Syllabus Version**				
Anti-requisite		1.10				

Course Objectives:

1. To provide opportunity to involve in research related to science / engineering
2. To inculcate research culture
3. To enhance the rational and innovative thinking capabilities

Expected Course Outcome:

On completion of this course, the student should be able to:

1. Identify problems that have relevance to societal / industrial needs
2. Exhibit independent thinking and analysis skills
3. Demonstrate the application of relevant science / engineering principles

Modalities / Requirements

1. Individual or group projects can be taken up
2. Involve in literature survey in the chosen field
3. Use Science/Engineering principles to solve identified issues
4. Adopt relevant and well-defined / innovative methodologies to fulfill the specified objective
5. Submission of scientific report in a specified format (after plagiarism check)

Student Assessment : Periodical reviews, oral/poster presentation

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE6099 Masters Thesis		L	T	P	J	C
		0	0	0	0	16
Pre-requisite	**As per the academic regulations**	**Syllabus version**				
		1.0				

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field and also to give research orientation

Expected Course Outcome:

At the end of the course the student will be able to

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing
5. Synthesise the results and arrive at scientific conclusions / products / solution
6. Document the results in the form of technical report / presentation

Contents

1. Capstone Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Project can be for two semesters based on the completion of required number of credits as per the academic regulations.
3. Should be individual work.
4. Carried out inside or outside the university, in any relevant industry or research institution.
5. Publications in the peer reviewed journals / International Conferences will be an added advantage

Mode of Evaluation: Periodic reviews, Presentation, Final oral viva, Poster submission

Recommended by Board of Studies	10.06.2016		
Approved by Academic Council	No. 41	Date	17.06.2016

CLE5001	THEORY OF ELASTICITY AND PLASTICITY	L	T	P	J	C
		3	0	0	0	3
Pre-requisite		**Syllabus version**				
		1.1				

Course Objectives:

1. To Analyse the stresses and strains for two dimensional and three dimensional elements
2. To Understand the equilibrium and compatibility condition
3. To Understand the compatibility conditions in polar coordinates
4. To Solve the problems on Torsion for different shaped bars
5. To Understand the concept of plasticity

Expected Course Outcome:

At the end of the course, the student will be able to

1. Analyse the stresses and strains for elasticity approach.
2. Solve two dimensional elements problems in Cartesian coordinates
3. Understand the bending of cantilever beams and circular arc beams
4. Know the 3D problems in Cartesian coordinates
5. Understand the compatibility conditions in polar coordinates
6. Solve the problems on Torsion for different shaped bars.
7. Understand the concept of plastic analysis and yield criteria.

Module: 1	**Elasticity**	**6 hours**

Analysis of Stress and Strain - Elasticity approach – Definition and notation of stress – Components of stress and strain – Generalized Hooke's law

Module: 2	**Elasticity Solutions**	**5 hours**

Plane stress and plain strain problems with practical examples - Equations of equilibrium and compatibility conditions in Cartesian coordinates – Two dimensional Problems in Cartesian Coordinates

Module: 3	**Cartesian Coordinates**	**6 hours**

Airy's stress function - Bending of cantilever beams- Axi-symmetrical problems - Thick cylinder under uniform pressure - Circular arc beams subjected to pure bending.

Module: 4	**Elasticity 3D Solution**	**8 hours**

Principal stresses and strains for three dimensional element – Equations of equilibrium and compatibility conditions for 3D problems in Cartesian co-ordinates - Transformation of stresses and strains.

Module: 5	**Polar Co-ordinates**	**6 hours**

Equations of equilibrium and compatibility conditions in Polar coordinates- Axi-symmetrical problems-bending of curved bars

Module: 6	**Torsion-Non-Circular Sections**	**6 hours**

Torsion - Torsion of various shaped bars - Pure torsion of prismatic bars - Prandtle's membrane analogy - Torsion of thin walled tubes and hollow shafts

Module: 7	**Plasticity and Theory of Failure**	**6 hours**

Introduction to plasticity – Stress – Strain diagram – Plastic analysis – Yield criteria – St. Venant'stheory – Von mises criterion – Plastic work – Strain hardening

Module:8	**Contemporary issues:**	**2 hours**

	Total Lecture hours	**45 hours**

Text Book(s)

1. Timoshenko and Goodier, (2000), Theory of Elasticity, McGraw Hill Company, New York.

Reference Books			
1.	Mendelson, A., (2002), Plasticity: Theory and Applications, Mac Millanand Co., New York.		
2.	Sadhu Singh, (2004), Theory of Plasticity, Dhanpat Rai sons Private Limited, New Delhi.		
3.	Ansel. C. Ugural and Saul. K. Fenster, (2003), Advanced Strength and Applied Elasticity, Fourth Edition, Prentice Hall Professional technical Reference, New Jersey		
4.	Chakrabarty. J, (2006), Theory of Plasticity, Third Edition, Elsevier Butterworth - Heinmann – UK.		
Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE5002	DESIGN OF CONCRETE STRUCTURAL SYSTEMS	L	T	P	J	C
		3	0	0	4	4
Pre-requisite	**Nil**	**Syllabus version**				
		1.1				

Course Objectives:

1. To know the elastic and inelastic behaviour of beam.
2. To analyze the frame for various loading conditions.
3. To give an exposure to the various structural systems like flat slab, Deep beam, corbels and shear wall.

Expected Course Outcome:

1. Analyse the beam for deflection and estimation of crack width.
2. Analyse the multistorey frame for various loading condition.
3. Evaluate the plastic moment capacity of continuous beam.
4. Design the deep beam and corbels.
5. Design the flat slab, spandrel beam.
6. Design the slender column using SP16.
7. Analyse the shear wall structure.

Module:1	**Basic Design Concepts**	**6 hours**
Limit state method - Design of beams- Short-term and long-term deflection of reinforced concrete beams and slab- Estimation of crack width in reinforced concrete members		
Module:2	**Frame Analysis and Design**	**6 hours**
Static and dynamic loading of structures		
Module:3	**Inelastic Behaviour of Concrete Beams**	**6 hours**
Moment curvature relationship – plastic hinge formation-moment redistribution in continuous beams		
Module:4	**Deep Beams and Corbels**	**6 hours**
Strut and tie method of analysis for corbels and deep beams, Design of corbels, Design of deep beams		
Module:5	**Flat Slab**	**7 hours**
Design of flat slabs and flat plates according to IS method – Check for shear - Design of spandrel beams -Yield line theory and Hillerborg's strip method of design of slabs - Grid floor		
Module:6	**Slender Columns**	**6 hours**
Design of slender columns subjected to combined bending moment and axial force using IS 456-2000 and SP 16		
Module:7	**Shear Wall**	**6 hours**
Analysis and design of shear wall framed buildings		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)

1.	Subramanian. N., (2013), Design Of Reinforced Concrete Structures, Oxford University Press, New Delhi.

Reference Books

1.	Gambhir. M. L., (2012), Design of Reinforced Concrete Structures, Prentice Hall of India, New Delhi.

2.	Varghese. P.C., (2011), Advanced Reinforced Concrete Design, PHI Learning Pvt. Ltd., New Delhi.			
3.	IS 456 Plain and Reinforced Concrete - Code of Practice			
4.	IS 13920 Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces -Code of Practice			
5.	IS 1893 Criteria for earthquake resistant design of structures-Code of Practice			
6.	SP 16- Design Aids for Reinforced Concrete			
Sample list of projects for 'J' component				
1.	Seismic Behavior and Design of RC Shear Walls			
2.	Influence of orientation of shear walls on structural behavior of RC buildings			
3.	Design of flat slab for a commercial building			
4.	Comparison of structural behavior of conventional roof and flat slab system			
5.	Design of a deep beam for an aesthetic building			
			Total Laboratory Hours	**60 Hours**
Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test				
Recommended by Board of Studies	27.09.2017			
Approved by Academic Council	No. 47	Date	05-10-2017	

CLE5003	STRUCTURAL DYNAMICS	L	T	P	J	C
		3	2	0	0	4
Pre-requisite	**Nil**	**Syllabus version**				
		1.1				

Course Objectives:

1. To know various dynamic forces acting on a building and their response.
2. To obtain knowledge on modes of failure and remedial solutions.
3. To study the analysis procedure for calculating the response of structures.
4. To understand the linear and no-linear behaviour of structures.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Differentiate static and dynamic behavior of structures and their physical properties.
2. Identify and model a single degree of freedom system subjected to dynamic load.
3. Evaluate the response of single storied building subjected to dynamic load.
4. Identify and model a multi degree of freedom system subjected to dynamic load.
5. Evaluate the response of multi-storied building subjected to dynamic load.
6. Evaluate the dynamic behavior of beams.
7. Describe the nonlinearity of a system by various techniques.

Module:1	**Introduction**	**6 hours**

History of vibration - Dynamic analysis and their importance to structural engineering problems - Degrees of freedom - D'Alembert's principle - Lagrange's equation - Simple harmonic motion.

Module:2	**Single Degree of Freedom**	**6 hours**

Mathematical model for SDOF systems - Free vibration - Undamped - Damped - Critical damping - Measurement of damping - Vibration measuring instruments.

Module:3	**Response of SDOF Systems**	**6 hours**

Response of SDOF system to Harmonic Loading, Periodic loading and Impulse Loading - Transmissibility - Fourier series - Duhamel's integral - Numerical integration.

Module:4	**Multi Degree of Freedom System**	**7 hours**

Equation of motion - Free vibration - Undamped - Damped - Evaluation of structural property matrices - Mode shape - Orthogonality relationship.

Module:5	**Response of MDOF Systems**	**6 hours**

Rayleigh's method - Rayleigh-Ritz method - Stodola's method - Stiffness method - Mode superposition method.

Module:6	**Continuous Systems**	**6 hours**

Differential equation of motion - Transverse vibration - Axial vibration - Natural frequency and mode shape of simple beams with different end conditions – Variable cross section beams - Orthogonality relationship.

Module:7	**Non-linear Numerical Techniques**	**6 hours**

Wilson Theta method - Newmark Beta method –Runge-Kutta method.

Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours	**45 hours**
	Tutorial Hours	**30 hours**

Minimum of three problems to be worked out by students in every tutorial class.

Text Book(s)

1. Mario Paz and William Leigh (2010), Structural Dynamics - Theory and Computation, Springer.

Reference Books			
1.	Clough and Penzien (2015), Dynamics of Structures, CBS Publishers and Distributors, New Delhi.		
2.	Chopra. A. K. (2011), Dynamics of Structures - Theory and Applications to Earthquake Engineering, 4th edition, Prentice Hall, London.		
3.	Roy R.Craig, Jr. Andrew J. Kurdila (2011), Fundamentals of Structural Dynamics, John Wiley and Sons, London.		
Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE6014	FINITE ELEMENT ANALYSIS	L	T	P	J	C
		2	2	2	0	4
Pre-requisite	**CLE5001 Theory of Elasticity and Plasticity**	**Syllabus version**				
		1.1				

Course Objectives:

1. To have a detailed knowledge and understanding of the fundamental concepts of finite element methods
2. To introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
3. To develop proficiency in the application of the finite element methods (modeling, analysis, and interpretation of results) to realistic engineering problems

Expected Course Outcome:

Upon completing this course, the students will be able to:

1. Understand the fundamental theory of finite element methods
2. Develop the ability to generate the governing FE equations for systems governed by partial differential equation
3. Demonstrate the role and significance of shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation
4. Acquire knowledge in direct and formal (basic energy and weighted residual) methods for deriving finite element equations
5. Have insights into the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements
6. Identify appropriate space (planar (plane stress or strain), axisymmetric, or spatial), idealization (type of element), and modeling techniques
7. Understand the professional level finite element software to solve the engineering problems

Module:1	**Introduction**	**4 hours**

Background – General description of the method – Analysis procedure - Principles of elasticity Stress and strain vectors – Strain displacement equations – Linear constitutive equations – Overall stiffness matrix – Overall load matrix

Module:2	**Theory of Finite Element**	**4 hours**

Concept of an element – Various element shapes – Displacement models – Approximation displacements by polynomials – Convergence requirements – Shape functions – Element strains and stresses – Analysis of beams

Module:3	**Natural Coordinates**	**4 hours**

Area and volume coordinates- Discretisation of a body or structure – Minimization of band width – Construction of stiffness matrix and loads for the assemblage – Boundary conditions – Mesh generation.

Module:4	**Two and Three Dimensional Problems**	**5 hours**

Analysis of plane truss, space truss, plane frame and grid- Axisymmetric elements

Module:5	**Plane Stress and Plane Strain Conditions**	**5 hours**

CST, LST & QST elements - solutions of problems

Module:6	**Isoparametric Formulation**	**4 hours**

Iso parametric Bar element - Plane bilinear isoparametric element - Plane stress element - Quadratic plane elements - Application of Gauss Quadrature formulation –Lagrange's and serendipity elements

Module:7	**Introduction to 3-D Elements**	**2 hours**

Three dimensional elasticity-Governing differential equations- Higher order Isoparametric solid elements		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours	**30 hours**

Tutorial

- Minimum of 2 Problems to be worked out by Students in Every Tutorial Class
- Another 2 Problems to be given as Home Work.

Tutorial Class Module 1: 2 hrs
Tutorial Class Module 2 : 4 hrs
Tutorial Class Module 3 : 5 hrs
Tutorial Class Module 4 : 5 hrs
Tutorial Class Module 5 : 4 hrs
Tutorial Class Module 6 : 5 hrs
Tutorial Class Module 7 : 5 hrs

Total Lecture hours	**30 hours**

Text Book(s)

1.	Krishnamoorthy, C.S, "Finite Element Analysis ; Theory and programming", Tata McGraw Hill Publishing Co. Ltd., (2017)

Reference Books

1.	Cook R.D., Malkas D.S. &Plesha M.E, "Concepts and applications of Finite Element Analysis", John Wiley &Sons., (2007)
2.	Reddy,J, "An Introduction to Finite Element Methods", McGraw Hill Co., (2013).
3.	Zeinkeiwich O.C.,R.L.Tayler " The Finite Element Method for Solid and Structural Mechanics", Butterworth-Heinemann,(2013).

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

List of Challenging Experiments (Indicative)		**3 hrs**
1	Discretisation of geometry	**3 hrs**
2	Meshing a rectangular plate using 4 node elements	**3 hrs**
3	Meshing a circular plate using 3 node and 4 node elements	**3 hrs**
4	Analysis of a spring assembly using 1D elements	**3 hrs**
5	Analysis of an assembly of bar elements	**3 hrs**
6	Analysis of a stepped bar	**3 hrs**
7	Analysis of a plane truss	**2 hrs**
8	Analysis of a space truss	**2 hrs**
9	Analysis of a fixed-fixed beam	**2 hrs**
10	Analysis of a 2D frame	**2 hrs**
11	Analysis of a 3D frame	**2 hrs**
12	Analysis of a grid	**2 hrs**

		Total Laboratory Hours	**30 hours**
Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No.47	Date	05-10-2017

CLE6015	ADVANCED DESIGN OF STEEL STRUCTURES	L	T	P	J	C
		2	2	0	4	4
Pre-requisite	**CLE5002 Design of Concrete Structural Systems**	**Syllabus version**				
		1.1				

Course Objectives:

1. To classify the structures and analyse the frame for wind loads.
2. To design the welded connections and to give exposure to fatigue.
3. To design light gauge steel members, steel – concrete composite and hollow sections.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Classify the structures and wind load analysis for frames.
2. Design the welded connections.
3. Understand the fatigue and the factors that influence fatigue.
4. Analyse and design the beams and frames using plastic method.
5. Design the Light gauge structures.
6. Design the Steel- Concrete Composite sections.
7. Design the Hollow sections.

Module:1	**Stability and Plate Buckling**	**4 hours**

Classification of structures-wind load analysis

Module:2	**Beam- column Connections/Semi Rigid Connections**	**4 hours**

Throat and Root Stresses in Fillet Welds – Seated Connections Unstiffened and Stiffened seated Connections – Moment Resistant Connections – Clip angle Connections – Split beam Connections – Framed Connections

Module:3	**Fatigue**	**4 hours**

Types of fatigue leading and failure- Fatigue test, endurance limit- S-N diagram- Various failure relations- Factors influencing fatigue strength- Influence of stress concentration on fatigue test

Module:4	**Plastic Analysis and Design of Structures**	**4 hours**

Introduction - Shape factors - Mechanisms - Plastic hinge - Analysis of beams and portal frames - Design of fixed and continuous beams.

Module:5	**Design of Light Gauge Steel Structures**	**4 hours**

Types of cross sections - Local buckling and lateral buckling - Design of compression and tension members - Beams - Deflection of beams- Cold formed steel structures-Pre-engineered metal buildings- long span structures.

Module:6	**Design of Steel -concrete Composite Sections**	**4 hours**

Design of beam – columns- composite slabs

Module:7	**Design of Steel Members with Hollow Sections**	**4 hours**

Design of structural steel hollow sections

Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours	**30 hours**

Tutorial

- Minimum of 2 Problems to be worked out by Students in Every Tutorial Class
- Another 2 Problems to be given as Home Work.

Tutorial Class Module 1: 2 hrs

Tutorial Class Module 2 : 4 hrs

Tutorial Class Module 3 : 5 hrs

Tutorial Class Module 4 : 5 hrs Tutorial Class Module 5 : 4 hrs Tutorial Class Module 6 : 5 hrs Tutorial Class Module 7 : 5 hrs			
		Total Lecture hours	**30 hours**
Text Book(s)			
1.	GalyordandGalyord (2012), Design of Steel Structures, Tata McGraw Hill, Education		
Reference Books			
1.	Duggal.S.K., (2014), Limit State Design of Steel Structures, Tata McGraw-Hill Education, New Delhi.		
2.	Subramanian. N., (2011), Design of Steel Structures, Oxford University Press, New Delhi.		
3.	Bhavikatti. S.S., (2012), Design of Steel Structures, I.K. International Publishing House Pvt. Ltd. New Delhi.		
4.	IS 800 General Construction in Steel — Codeof Practice		
5.	IS 801Code of Practice for use of Cold-Formed Light Gauge Steel Structural Members in General Building Construction		
6.	IS 811Specification for Cold formed light gauge structural Steel sections		
7.	IS 11384 Code of practice for composite construction in structural steel and concrete		
List of J projects			
1.	Design of a Steel Industrial Building		
2.	Design of a Steel hanger building		
3.	Design of connection details in Steel Space Structures		
4.	Design of a Steel parking Structure		
5.	Analysis and design of steel chimney		
6.	Analysis and design of a steel tower		
		Total Laboratory Hours	**60 hours**
Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final As			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE5010	MATRIX METHODS OF STRUCTURAL ANALYSIS	L	T	P	J	C
		2	2	0	0	3
		Syllabus version				
		1.1				

Course Objectives:

1. To understand the significance of degrees of freedom and the concept of principle of superposition
2. To recognize the concept of strain energy and principle of virtual work
3. To learn the transformation of system matrices and element matrices for the determinate and indeterminate structures.
4. To analyse the forces in structures like continuous beam, truss and frames using stiffness and flexibility method.
5. To comprehend the behaviour of structures due to thermal expansion and lack of fit.

Expected Course Outcome:

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

1. Apply the basic concepts of matrix methods in structural analysis
2. Develop stiffness and flexibility matrices
3. Analyse the structures using flexibility and stiffness method
4. Analyse space truss and frame
5. Analyse grid structures
6. Compute the forces in various members due to lack of fit and thermal expansion

Module:1	Energy Concepts	4 hours

Transformation of Coordinates - Basic assumptions - Types of loads - Compatibility conditions - Static and kinematic indeterminacy - Principles of superposition - Strain energy - Stiffness for beam element from strain energy

Module:2	Matrix Methods	4 hours

Properties of stiffness and flexibility matrices- solution of simple problems

Module:3	Flexibility Method	4 hours

Flexibility method applied to statically indeterminate structures - Analysis of continuous beam, plane truss and plane frame

Module:4	Stiffness Method	4 hours

Stiffness method applied to kinematically indeterminate structures - Analysis of continuous beam, plane truss and plane frame

Module:5	Space Truss	4 hours

Analysis of space truss and space frame by stiffness matrix method

Module:6	Grid Structures	4 hours

Analysis of grid by matrix methods- Special analysis procedures - static condensation and sub structuring - initial and thermal stresses.

Module:7	Special Conditions	4 hours

Effects of temperature change and lack of fit. Related numerical problems by flexibility and

stiffness method		
Module:8	**Contemporary issues**	**2 hours**
Total Lecture hours		**30 hours**
Tutorial ➢ Minimum of 2 Problems to be worked out by Students in Every Tutorial Class ➢ Another 2 Problems to be given as Home Work. Tutorial Class Module 1: 5hrs Tutorial Class Module 2 : 5hrs Tutorial Class Module 3 : 4hrs Tutorial Class Module 4 : 4hrs Tutorial Class Module 5 : 4hrs Tutorial Class Module 6 : 4hrs Tutorial Class Module 7 : 4hrs		**30 hours**

Text Book(s)	
1.	Bhavikatti S S, (2011), Matrix Methods of Structural Analysis, IK Publishing, India
Reference Books	
1.	Natarajan C, Revathi P., (2014),Matrix Methods of Structural Analysis: Theory and Problems, PHI,Prentice Hall of India, New Delhi.
2.	Godbole P. N., Sonparote R. S., Dhote S. U., (2014), Matrix Methods of Structural Analysis, PHI Learning Pvt. Ltd., New Delhi.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE5012	DESIGN OF BRIDGES	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the basic concept of design of bridges
2. To analysebox culvert
3. To design T and I girders
4. To analyse and design cable stayed and suspension bridges
5. To design piers and abutments
6. To design pile foundation and bearings

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Classify the different types of bridges.
2. Analyse box culvert and girder bridges by using different method.
3. Design T girders, I girders and Box girder bridges by IRC method.
4. Analyse and design cable stayed and suspension bridges
5. Design piers and abutments
6. Design pile foundation
7. Design bearings and expansion joints.

Module:1	**General**	**3 hours**
Definition, History, Different types (Permanent/Temporary), Classification based on material, span, structural form etc.,.Field Surveys and selection of site		
Module:2	**Bridge Deck Analysis**	**4 hours**
IRC loadings and introduction to bridge loading worldwide- Analysis of box culverts, solid slab bridges by IRC/Effective width method- Pigeaud's method etc.,- Analysis of girder bridges by Courbon's method and Grillage method.- Introduction to other methods of analysis like Finite element, Finite strip method etc.,.		
Module:3	**Design of Small Bridges & Culverts**	**5 hours**
Design of box culverts, short span slab decks in square & skew - Design of T & I girder and Introduction to Box girder bridges by IRC method.		
Module:4	**Long span & Special type bridges**	**4 hours**
Analysis & design principles of continuous bridges, arch bridges, integral bridges, cable stayed bridges and suspension bridges.		
Module:5	**Design of Substructure**	**4 hours**
Design of piers & abutments -Introduction to wing walls & returns and Reinforced Earth in flyover approaches.		
Module:6	**Design Foundations**	**4 hours**
Pile, Pile cap and well foundation		
Module 7	**Bridge Appurtenances**	**4 hours**
Design of Bearings, Expansion joints, Deck drainage, Crash barriers & handrails.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**
	Sample list of projects for J components	**60 hours**

1. Detailed design of any one type of bridge (RCC, prestressed, composite and steel) with detailed drawings.
2. Working model of bridge including all the structural elements.

3. Detailed report of bridge construction activities (minimum 10 days in site training) 4. Industrial visit - visit to existing bridge location to understand various components of bridge, occurrence of scour etc., and new bridge construction sites. 5. Use of software like STAAD Pro and/or equivalent general purpose software for bridge deck analysis, Development of spread sheets for design of pier, abutment, bearing etc			
Text Book(s)			
1.	Johnson Victor. D., (2012), Essentials of Bridge Engineering, Oxford Publishing Company, New Delhi		
Reference Books			
1.	Jain and Jai Krishna.,(2007), Plain and reinforced concrete, Vol.2.,Nem Chand Brothers, New Delhi.		
2.	Krishna Raju. N., (2014), Design of Bridges, Oxford and IBH Publishing Co., New Delhi		
3.	Rakshit. K. S., (2010), Design and Construction of Highway Bridges, New central Book Agency, New Delhi.		
3	Standard specifications and code of practice for road bridges, (2005) – IRC section I, II, III and IV.		
4	Ponnuswamy (2008), Bridge Engineering, McGraw-Hill Education (India) Pvt Limited		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04-03-2016		
Approved by Academic Council	No. 40	Date	18.03.2016

CLE5013	EXPERIMENTAL STRESS ANALYSIS	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	Design of Concrete Structural systems	Syllabus version				
		1.1				

Course Objectives:

1. To interpret the relation between the mechanics theory and experimental stress analysis
2. To identify various techniques available to measure the stress and strains using different sources.
3. To understand the working of recording instruments and data logging methods
4. To acquire the knowledge in model analysis

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand overall concepts of stress/strain analysis by experimental methods and working of strain gauges
2. Illustrate the measurement of strains
3. Demonstrate the ability to do model analysis using different theorems.
4. Understand the theory and practice of common experimental stress analysis.
5. Have an appreciation of the necessity of photo elasticity and its applications
6. Describe the different methods of 3D photo elasticity for strain measurement
7. Define the brittle and biref ring entcoatings.

Module:1	Strain Gauges	6 hours

Strain Gauges - Mechanical and optical strain gauges – Description and operation – Electrical resistance- Inductance and capacitance gauges – Detailed treatment on resistant gauges.

Module:2	Static and Dynamic Strains	7 hours

Measurement of static and dynamic strains – Strain rosettes – Effect of transverse strains – Use of strain recorders and load cells.

Module:3	Model Analysis	6 hours

Model Analysis - Structural similitude – Use of models – Structural and dimensional analysis – Buckingham Pi Theorem – Muller Breslau's principle for indirect model analysis- Introduction to centrifuge modelling

Module:4	Deformeters	6 hours

Use of Begg's and Eney'sdeformeters – Moment indicators – Design of models for direct and indirect analysis.

Module:5	Two dimensional photo elasticity	6 hours

Two dimensional photo elasticity - Stress optic law – Introduction to polariscope – Plane and circular polariscope – Compensators and model materials – Material and model fringe value

Module:6	Calibration of photo elastic materials	7 hours

Calibration of photo elastic materials – Isochromatic and isoclinic fringes – Time edge effects - Three dimensional photo elasticity - Introduction – Stress freezing techniques – Stress separation techniques – Scattered light photo elasticity – Reflection polariscope.

Module:7	Miscellaneous Methods	5 hours

Brittle coating method – Birefringence techniques – Moire fringe method			
Module:8	**Contemporary issues**		**2 hours**
		Total Lecture hours	**45 hours**
Text Book(s)			
1.	Jindal U.C., (2013), Experimental Stress Analysis, Pearson, New Delhi.		
Reference Books			
1.	Dally J.W., Riley W.F., (2007), Experimental Stress Analysis, McGraw Hill Book Company, New York.		
2.	Heteny. M.,(2008), Handbook of Experimental Stress Analysis, John Wiley and Sons, New York.		
3.	Frocht. M.M., (2010), Photo-elasticity Vol. I and II, John Wiley and Sons, New York.		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE5014	MACHINE FOUNDATION	L	T	P	J	C
		2	2	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the behaviour of soil under dynamic loadings.
2. To study the various methods of vibration isolation.
3. To study the various types of testing methods to obtain dynamic soil properties.
4. To understand the principles of design for various types of foundations
5. To study the dynamic analysis and design for various types of machine foundations.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Explain the basic principles of soil dynamics.
2. Understand the various types of active and passive vibration isolation systems.
3. Describe the various testing methods and dynamic soil properties.
4. Apply the concepts of stiffness, damping, inertia, guide lines for design.
5. Carry out dynamic analysis and design of machine foundation

Module:1	**Theory of Vibrations**	**5 hours**
Introduction – Soil behavior under dynamic loads, Vibration of single and two degree freedom system, Vibration of multi degree freedom system, Mass spring analogy - Barkan's Theory		
Module:2	**Vibration Isolation**	**3 hours**
Introduction, Active and passive isolation, Methods of vibration isolation		
Module:3	**Dynamic Soil Properties**	**3 hours**
General factors affecting shear modulus, elastic modulus and elastic constants, Field Techniques – Cyclic plate load test, block vibration test, Standard Penetration Test, Seismic bore hole surveys, Laboratory techniques – Resonant column test, Cyclic simple shear and Triaxial compression test Problems		
Module:4	**Machine Foundations**	**5 hours**
General principles of machine foundation design, Types of machines and foundations, General requirements of machine foundations, Permissible amplitudes and stresses. Dynamic stiffness of single pile and pile group		
Module:5	**Foundations of Reciprocating Machines**	**4 hours**
Dynamic analysis and Design procedures		
Module:6	**Foundations of Impact Type Machines**	**5 hours**
Dynamic analysis and Design procedures		
Module:7	**Foundations of Rotary Machines**	**3 hours**
Dynamic analysis and Design procedures		
Module:8	**Contemporary issues**	**2 hours**

Total Lecture hours	**30hours**
Tutorial Minimum of 2 Problems to be worked out by Students in Every Tutorial Class Another 2 Problems to be given as Home Work. Tutorial Class Module 1: 2 hrs Tutorial Class Module 2 : 4 hrs Tutorial Class Module 3 : 5 hrs Tutorial Class Module 4 : 5 hrs Tutorial Class Module 5 : 4 hrs Tutorial Class Module 6 : 5 hrs Tutorial Class Module 7 : 5 hrs	**30 hours**

Text Book(s)	
1.	Swami Saran, (2016) Soil Dynamics and Machine Foundations, Galgotia Publications Pvt. Ltd., New Delhi.
Reference Books	
1.	Srinivasulu.P. and Vaidyanathan.C. (1998), Hand book on Machine Foundations, McGraw Hill Publications, New York.
2.	Prakash. S. and Puri. V. K. (1997), Soil Dynamics and Design Foundation, McGraw Hill Publications, New York.
3.	Das B.M and Ramanna G.V. (2011). Principles of soil dynamics 2nd Edition, Cengage learning, Stanford, USA.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE5015	PREFABRICATED STRUCTURES	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.0				

Course Objectives:

1. To study the design principles related to prefabrication.
2. To understand the concepts of precast floors, beams etc.,

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the principles behind prefabricated structure
2. Design the precast concrete floor
3. Understand the composite and non- composite precast beam
4. Design the precast column and walls
5. Understand the principles of joint mechanism
6. Understand the various connection between the precast structural elements
7. Identify the machinery and equipment for precast manufacturing

Module:1	**Design Principles**	**3 hours**

General Civil Engineering requirements, specific requirements for planning and layout of prefabrication plant. IS Code specifications.Types of foundation - Modular co-ordination – Components - Prefabrication systems and structural schemes - Design considerations - Economy of prefabrication- assessment of handling and erection spaces

Module:2	**Precast Concrete Floors**	**3 hours**

Precast flooring options-flooring arrangements-design of individual units-design of composite floors- Beams and roof elements

Module:3	**Precast Concrete Beams**	**4 hours**

Types of composites -non composite-reinforced beam -pre stressed beam

Module:4	**Columns and Shear Wall**	**6 hours**

Precast column design -precast shear walls- infill walls-cantilever walls -distribution of horizontal forces

Module:5	**Joints**	**5 hours**

Basic mechanism-compression joint-shear joint - tension joint

Module:6	**Connections**	**5 hours**

Pin jointed connection-moment resisting connections- beam to column- column foundation connections

Module:7	**Machinery and Equipment**	**2 hours**

Plant machinery, casting yard- casting and stacking

Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**

Sample List of Projects for J Component	
1. Design of precast buildings, bridge, industrial structure, framed structure, etc (Detailed design with drawings including joints, connection, foundation details) 2. Analysis of Precast dry connections 3. Seismic analysis of precast wet connections 4. Detailed review on precast beam to column connections 5. Detailed review and report on precast wall connections	**60 hours**

Text Book(s)	
1.	Kims S. Elliot (2017), Precast Concrete Structures, CRC Press, Taylor & Francis
Reference Books	
1.	Handbook of Precast Concrete Buildings (2016) ICI publications
2.	Ryan E. Smith, (2010), Prefab Architecture: A Guide to Modular Design and Construction, John Wiley and Sons. Inc. London
3.	Hubert Bachmann, Alfred Steinle, (2011), Precast Concrete Structures, Ernst &Sohn, Wiley Publication

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04-03-2016		
Approved by Academic Council	No.40	Date	18-03-2016

CLE5016	STABILITY OF STRUCTURES	L	T	P	J	C
		2	2	0	0	3
Pre-requisite		**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the difference between stability and instability.
2. To evaluate the structural stability of columns
3. To analyse the stability of beam column
4. To analyse stability of frames
5. To understand deformation characteristics of torsional buckling
6. To identify the differential equation of buckling of plates and shells

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the difference between stability and instability.
2. Evaluate the structural stability of columns
3. Analyse the stability of beam column
4. Analyse stability of frames
5. Understand deformation characteristics of torsional buckling
6. Identify the differential equation of buckling of plates and shells

Module:1	**Introduction**	**3 hours**
Static equilibrium – Governing equation for columns – Analysis for various boundary conditions.		
Module:2	**Analysis of Column**	**4 hours**
Eccentrically loaded column and Initial Imperfect column -Numerical Problems		
Module:3	**Beam column**	**5 hours**
Theory of Beam column – Stability analysis of beam column with different types of loads – Failure of beam columns.		
Module:4	**Analysis and Stability of Frames**	**5 hours**
Various Boundary Conditions – Differential equations – Slope Deflection method		
Module:5	**Torsional Buckling**	**5 hours**
Torsional load-Deformation characteristics of structural members- strain energy of torsion – Torsional and flexural torsional buckling of columns		
Module:6	**Buckling of Plates**	**3 hours**
Differential Equation of plate buckling –linear theory – critical load of a plate uniformly compressed in one direction.		
Module:7	**Buckling of Shells**	**3 hours**
Differential equation – Analysis – Application		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**
	Tutorial ➢ Minimum of 2 Problems to be worked out by Students in Every Tutorial Class	**30 hours**

	➢ Another 2 Problems to be given as Home Work. Tutorial Class Module 1: 2 hrs Tutorial Class Module 2 : 4 hrs Tutorial Class Module 3 : 5 hrs Tutorial Class Module 4 : 5 hrs Tutorial Class Module 5 : 4 hrs Tutorial Class Module 6 : 5 hrs Tutorial Class Module 7 : 5 hrs	

Text Book(s)	
1.	Iyengar. N.G.R., (2007), Elastic Stability of Structural Elements, McMillan, New Delhi
Reference Books	
1.	Galambos. T.V., Surovek A. E(2008), Structural Stability of Steel: Concepts and Applications for Structural Engineers, Wiley, London

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE6001	ADVANCED CONCRETE MATERIALS AND TECHNOLOGY	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objective:

1. To study the roles of concrete constituent materials, the requirements and properties of the materials and their effects on concrete.
2. To understand the behaviour of fresh and hardened of concrete with and without admixtures.
3. To study the concrete mix design using different methods.
4. To study the mechanical properties and durability of concrete.
5. To study the testing procedure of different non-destructive testing methods.
6. To study the different types of special concrete and concreting methods.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify and explain the role of ingredients of concrete and their effect on concrete properties.
2. Explain the behaviour of fresh and hardened properties of concrete.
3. Design of concrete mix using different methods.
4. Apply the destructive and non-destructive testing methods to assess the hardened properties of concrete.
5. Describe testing procedures for durability properties of concrete.
6. Explain the different types of special concretes

Module:1	Concrete Materials and Admixtures	4 hours

Cement, Fine and Coarse aggregates –Mineral and Chemical Admixtures – Properties and applications.

Module:2	Behaviour of Fresh Concrete and Hardened Concrete	4 hours

Behaviour of Concrete with and without admixtures - Modern trends in concrete manufacture and placement techniques - Ready mix concrete - Rheological behaviour of fresh concrete and hardened concrete.

Module:3	Concrete Mix Design	4 hours

Methods of mix design-Design of concrete mixes by using IS code method and ACI method

Module:4	Mechanical Properties of Concrete	4 hours

Compressive strength test- Split tensile strength test-Flexural test- Modulus of elasticity of concrete-Static modulus -Stress-strain characteristics- Dynamic modulus- Factors affecting strength of concrete.

Module:5	Non-destructive Testing of Concrete	3 hours

Rebound hammer test – UPV test – Half cell Potential test – Thermography – Pull out test.

Module:6	Durability Properties of Concrete	4 hours

Rapid chloride permeability test- Water absorption test – Resistance against sulphate attack, acid attack, alkaline attack- Effect of elevated temperature.

Module:7	Special Concrete and Concreting Methods	5 hours

High performance concrete- Lightweight concrete – High density concrete - Polymer concrete -

Fibre reinforced concrete – Self compacting concrete - Cold weather concreting - Hot weather concreting -Pre-packed concrete - Vacuum concrete		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**
	Sample List of Projects for J Component	
	1. Determination of compressive strength of cement mortar cube with cement replacement by 50 %FLY ASH 2. Study of the influence of chemical and mineral admixture on mechanical properties of concrete 3. Effect of fly ash on self-compacting concrete 4. An experimental investigation on the strength and workability characteristics of fiber reinforced concrete 5. Effect of fly ash on high strength concrete	**60 hours**

Text Book(s)	
1.	Metha.P.K, (2005), Concrete: Microstructure, Properties and Materials, McGraw-Hill, New Delhi.
Reference Books	
1.	Neville.A.M.,Brooks.J.J., (2008), Concrete Technology, Pearson Education, New Delhi.
2.	Gambir.M.L., (2009), Concrete Technology, Tata Mc-Graw Hill-Education, New Delhi.
3.	Shetty.M.S.,(2017), Concrete Technology, S. Chand and Company Ltd, New Delhi.
4.	IS : 12269, Specification for 53 grade ordinary Portland Cement, BIS, New Delhi
5.	IS : 383, Specification for Coarse and fine natural sources for Concrete, BIS, New Delhi
6.	IS:10262, Concrete Mix Proportioning -Guidelines
7.	ACI 211.1-91 Reapproved 2009, Standard Practice for selecting Proportions for Normal, Heavyweight, and Mass Concrete.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04-03-2016		
Approved by Academic Council	No. 40	Date	18-03-2016

CLE6002	ADVANCED FOUNDATION DESIGN	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
		1.1				

Course Objectives:

To impart the knowledge in the area of analysis and design of foundations and earth retaining structures.

Expected Course Outcome:

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

1. Estimate bearing capacity of raft foundation
2. Determine safe load carrying capacity of pile for a given site condition
3. Design a reinforced earth wall and analyse its stability
4. Analyse sheet pile and find embedment depth
5. Distinguish f piled-raft and load sharing between raft and pile
6. Evaluate stability of well foundation
7. Identify suitable type of cofferdam for a given construction problem

Module:1	**Raft Foundations**	**6 hours**

Bearing capacity of rafts; Rafts on clays and sands; Compensated raft; Flexible and rigid rafts (IS: 2950); Settlement analysis of rafts (under embankment loading).

Module:2	**Pile Foundations**	**7 hours**

Load capacity of piles in sands and clays; α - method; Brom's analysis; Laterally loaded piles; Uplift capacity of piles; Pile group capacity; Pile load test. Analysis of stress waves in pile driving.

Module:3	**Piled Rafts**	**7 hours**

Concept of a piled raft - Examples, definitions and terminology; Piled raft as a composite construction; Advantages of piled rafts; Performance and design of a piled raft; Steps involved in piled raft design.

Module:4	**Well Foundations**	**6 hours**

Well Foundations - Types of wells or caissons – Drilled shafts and caissons - Design and construction

Module:5	**Deep Excavation Protection Systems**	**6 hours**

Sheeting and bracing systems in shallow and deep open cuts in different soil types - Cantilever sheet piles, Anchored sheet piles; Stability and design of braced supports. Diaphragm walls

Module:6	**Coffer Dams**	**5 hours**

Types of Coffer dams, merits and demerits; Design of single wall coffer dams; Stability aspects, TVA method and Cumming's method.

Module:7	**Reinforced Earth Walls**	**5 hours**

Advantages of RE walls, Behaviour of RE walls, Soil-reinforcement interaction; Internal and external stability conditions; Field applications of RE walls.

Module:8	**Contemporary issues**	**3 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1.	Bowles, J. E., (2011), Foundation Analysis and Design, 7th Edition, McGraw Hill Book Co., New York.
2.	Das. B. M., (2010), Principles of Foundation Engineering, CL Engineering.
Reference Books	
1.	Fang. H.Y.,(2012), Foundation Engineering Handbook, Springer Science and Business Media.
2.	Varghese. P. C., (2009), Design of Reinforced Concrete Foundations, Prentice Hall of India, New Delhi.
3.	Murthy. V. N. S., (2009), Soil Mechanics and Foundation Engineering - CBS Publications, Delhi.
4.	Swami Saran ., (2010), Reinforced Soil and Its Engineering Applications., I. K. International Pvt Ltd.
5.	Swami Saran., (2006), Analysis and Design of Substructures: Limit State Design, Oxford & IBH Publishing Company Pvt. Limited.
6.	Tomlinson M and Woodward J. (2008). Pile Design and Construction Practice" 5th Edition. Taylor and Francis.
7.	Fleming K, Weltman A, Randolph M and Elson K (2009). Piling Engineering. 3rd Edition. Taylor and Francis.
8.	K. R. Arora., (2011) Soil Mechanics and Foundation Engineering, Standard publishers

Mode of Evaluation: Continuous Assessment Test, Final Assessment Test, Quiz, Assignments			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE6004	REPAIR AND REHABILITATION OF STRUCTURES	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		1.1				

Course Objectives:

1. To impart broad knowledge in the area of repair and rehabilitation of structures
2. To understand about various causes of deterioration of structures
3. To obtain the knowledge about corrosion of structures
4. To understand the properties of repair materials
5. To know various repair techniques and strengthening methods

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify the role of the maintenance engineer
2. Understand the causes of deterioration of structures
3. Identify the effect of corrosion on structures
4. Apply the NDT techniques to assess the condition of the structures
5. Evaluate various properties and applications of repair materials
6. Assessing the techniques for repairing
7. Apply the strengthening techniques for distressed buildings

Module:1	Introduction	5 hours
Importance of maintenance - Types of maintenance - Decay of structures- Role of the Maintenance Engineer - Quality Assurance for concrete construction - Design and construction errors.		
Module:2	**Deterioration of Structures**	**6 hours**
Causes of deterioration of concrete, steel, masonry and timber structures - surface deterioration - efflorescence - Causes and preventive measures.		
Module:3	**Corrosion of Structures**	**6 hours**
Corrosion mechanism - Effects of cover thickness and cracking - Methods of corrosion protection – Inhibitors - Coatings - Cathodic protection for reinforcements.		
Module:4	**Inspection and Assessment of Distressed structures**	**6 hours**
Visual inspection – Non-destructive tests –Ultrasonic pulse velocity method – Rebound hammer technique– Pullout tests – Core test.		
Module:5	**Materials for Repair**	**6 hours**
Special concretes and mortar - Concrete chemicals - Special elements for accelerated strength gain - Expansive cement- Polymer concrete – Ferro cement, Fibre reinforced concrete - Fibre reinforced plastics.		
Module:6	**Techniques for Repair**	**6 hours**
Techniques for repairing of spalling and disintegration of structures - Grouting –Autogenous healing- Pre-packed concrete- Protective surface coating.		
Module:7	**Strengthening of distressed buildings**	**6 hours**
Repairs to overcome low member strength – Deflection - Chemical disruption - Weathering wear - Fire leakage - Marine exposure- Use of FRP- NDT tests		
Module:8	**Contemporary issues**	**4 hours**
	Total Lecture hours	**45 hours**

Text Book(s)

1.	Modi, P.I., Patel, C.N. (2016). Repair and Rehabilitation of Concrete Structures, PHI India, New Delhi.		
Reference Books			
1.	IABSE, (2010). Case Studies of Rehabilitation, Repair, Retrofitting, and Strengthening of Structures, Volume 12, Structural Engineering Documents (SED), Switzerland.		
2.	Varghese, P.C. (2014), Maintenance, Repair & Rehabilitation and Minor Works of Buildings, PHI India, New Delhi.		
3.	Bhattacharjee, J. (2017), Concrete Structures Repair Rehabilitation And Retrofitting, CBS Publishers & Distributors, New Delhi.		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE6016	PRESTRESSED CONCRETE STRUCTURES	L	T	P	J	C
		2	2	0	0	3
Pre-requisite	CLE5002 Design of Concrete Structural systems	Syllabus version				
		1.1				

Course Objectives:

1. To learn the principles, materials, methods and systems of prestressing
2. To know the different types of losses and deflection of prestressed members
3. To learn the design of prestressed concrete beams for flexural members

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the concepts of pre-tensioning and post-tensioning members
2. Design a prestressed concrete beam accounting for losses
3. Evaluate the deflection and crack width of prestressed members
4. Design the member subjected to flexure and shear.
5. Design the member subjected to torsion.
6. Design the anchorage zone reinforcement
7. Analyse and design the indeterminate structures.

Module:1	Introduction	3 hours
Introduction – Development of Pre-stressed Concrete, General Principles of Pre-stressed Concrete, Classification and types of pre-stressing, Stages of loading, Materials – Concrete and Steel - stress, strain characteristics.		
Module:2	**Losses in Pre-stress**	**3 hours**
Significance of loss of Pre-stress, Immediate losses and time dependent losses		
Module:3	**Deflections**	**7 hours**
Deflections- calculation for short term/immediate and long term deflection		
Module:4	**Design for Flexure and Shear**	**4 hours**
Design For Flexure and shear– Flexural analysis of beams for limit state of serviceability, design for simply supported beams for limit state of collapse – Shear and Diagonal tension in Un-cracked beams, Diagonal cracking in shear, shear design for Limit state of collapse		
Module:5	**Design for Torsion**	**4 hours**
Torsion in concrete structures – Torsional design for pre-stressed concrete structures – Limit State of Collapse		
Module:6	**Design of End Anchorages**	**3 hours**
Stress distribution in end block – design of anchorage zone reinforcement		
Module:7	**Indeterminate Structures**	**4 hours**
Concept of concordant cable and profile – sketching of pressure lines for continuous beams.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**
	Tutorial Minimum of 2 Problems to be worked out by Students in Every	**30 hours**

	Tutorial Class Another 2 Problems to be given as Home Work. Tutorial Class Module 1: 2 hrs Tutorial Class Module 2 : 4 hrs Tutorial Class Module 3 : 5 hrs Tutorial Class Module 4 : 5 hrs Tutorial Class Module 5 : 4 hrs Tutorial Class Module 6 : 5 hrs Tutorial Class Module 7 : 5 hrs	

Text Book(s)	
1.	Krishna Raju. N., (2014), Pre-stressed Concrete - Problems and Solutions, CBS Publishers and Distributors, Pvt. Ltd., New Delhi.
Reference Books	
1.	Praveen Nagarajan, Advanced Concrete Design, Person, 2013
2.	N. Rajagopalan., (2013), Prestressed Concrete – Second Edition, Narosa Publishers, New Delhi
3.	IS: 1343: Indian Standard code of practice for Prestressed concrete, BIS, New Delhi.
4.	IS: 3370-Indian Standard code of practice for concrete structures for storage of liquids, BIS, New Delhi.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE6017	EARTHQUAKE RESISTANT DESIGN	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	CLE5003 Structural Dynamics	Syllabus version				
		1.1				

Course Objectives:

1. To study the basic concepts of engineering seismology and ground motion characteristics.
2. To understand the strength and capacity design principles of earthquake resistant design.
3. To study the behavior of various types of buildings under static and dynamic forces.
4. To study the elastic and inelastic deformations and significance of ductility in beam-column joints.
5. To study the seismic behavior of masonry and concrete shear wall systems.
6. To study the significance of energy dissipating devices in seismic resistant design.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify the characteristics of seismic waves and its measures.
2. Understand the principles of earthquake resistant design and response spectrum.
3. Analyze and design the various types of structures under static and dynamic loading conditions.
4. Design various beam-column joints as per ductility requirements.
5. Analyze and design unreinforced and reinforced masonry and concrete shear wall structures.
6. Explain the types of dampers and base isolation systems and its importance in seismic resistant design.

Module:1	Seismology and Earthquake	6 hours

Internal structure of the earth, continental drift and plate tectonics, Faults, Elastic rebound theory, seismic waves and characteristics, earthquake size, strong ground motion, seismic zoning map of India, Seismic hazard assessment.

Module:2	Principles of Earthquake Resistant Design	3 hours

Seismic design philosophy - Principles of earthquake resistant design - Response spectrum theory - Application of response spectrum theory to seismic design of structures -Capacity - Design Principles - Design criteria for strength - Stiffness and ductility.

Module:3	Seismic Analysis of Moment Resisting Frames	5 hours

Determination of design lateral forces as per IS: 1893-2016 – equivalent static force and dynamic analysis procedure. Effect of infill stiffness on analysis of frames – Equivalent diagonal strut.

Module:4	Modelling, Analysis and Design of Structures	3 hours

Seismic analysis and design of RC structures using software - static and dynamic methods – equivalent static, response spectrum and time history methods.

Module:5	Design of Beam Column Junctions	5 hours

Elastic and Inelastic deformations of structures – ductility of the composite system - design of axial and flexural members – beam column junction detailing – strong column - weak beam effects as per IS: 13920: 2016.

Module:6	**Design of Shear Walls**	**3 hours**
Unreinforced and reinforced masonry shear walls – analysis and design of reinforced concrete shear walls.		
Module:7	**Vibration Control Techniques**	**3 hours**
Vibration control – energy dissipating devices – principles and application, basic concept of base isolation – various systems - case studies.		
Module:8	**Contemporary issues**	**2 hours**
Total Lecture hours		**30 hours**
Sample List of Projects for J Component		
1. Comparison of inter storey drift of multi-storied building using linear static and dynamic methods		**60 hours**
2. Determine the effect of infill stiffness on reduction of inter storey drift		
3. Analysis and design of regular/irregular buildings considering strong column-weak beam criteria (linear static / dynamic)		
4. Determine the optimum position of shear wall / design of ductile shear wall systems / evaluation of response modification factor for shear wall – using different methods of modeling of shear wall		
5. Modeling and analysis of buildings considering vibration control techniques		

Text Book(s)

1.	Pankaj Agarwal and Manish Shrikhande., (2010), Earthquake resistant design of structures, Prentice-Hall India Pvt. Ltd., New Delhi.

Reference Books

1.	Pauley and Priestly. (1992), Seismic design of reinforced concrete and masonry buildings, John Wiley and Sons, London.
2.	Jack Moehle (2015), Seismic Design of Reinforced Concrete Buildings, McGraw-Hill Education, New Delhi.
3.	IS: 1893:2016 (Part 1), Criteria for earthquake resistant design of structures.
4.	IS:13920: 2016, Ductile detailing of reinforced concrete structures subjected to seismic forces.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04-03-2016		
Approved by Academic Council	No.40	Date	18-03-2016

CLE6018	APPLICATION OF NUMERICAL METHODS IN STRUCTURAL ENGINEERING	L	T	P	J	C
		2	2	0	0	3
Pre-requisite	MAT5005 **Advanced Mathematical Methods**	**Syllabus version**				
		1.1				

Course Objectives:

1. To apply the numerical techniques for different structural elements
2. To study the different numerical procedures for calculating the response of structures
3. To learn the analysis of frames, slabs for deflection
4. To study the finite element and Trapezoidal and Simpson's rule.
5. To apply the concepts of numerical methods.
6. To evaluate stability and analysis of plate.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the concepts of numerical techniques to structural elements.
2. Analyze the frame member.
3. Understand the concepts of finite difference and finite strip method
4. Evaluate the slope and deflection of the members
5. Analyze the bending moment, shear and deflection of beam.
6. Apply numerical method in structural members

Module:1	**Solutions of Simultaneous Equations**	**5 hours**
Solution of simultaneous equations – Bending moment - Slope and deflection in beams.		
Module:2	**Finite Difference Method-Slabs**	**4 hours**
Membrane analogy using finite difference method for slabs-slope and deflection of slabs		
Module:3	**Numerical Methods – I**	**4 hours**
Numerical integration (Trapezoidal and Simpson's rule) for determining shear, moment and deflection in beams– Gauss Quadrature formula.		
Module:4	**Numerical Methods - II**	**4 hours**
Newmark's method – Determination of shear force - Bending moment - Slope and deflection in beams.		
Module:5	**Eigen Values Problems**	**5 hours**
Evaluation of Eigen values for stability problems- Evaluation of Eigen vectors for stability problems.		
Module:6	**Boundary Elements and Discrete Element Methods**	**3 hours**
Boundary Elements for plates		
Module:7	**Finite Strip Method**	**3 hours**
Finite Strip method for analysis of plates.		
Module:8	**Contemporary issues**	**2 hours**
Total Lecture hours		**30 hours**
	Tutorial ➢ Minimum of 2 Problems to be worked out by Students in Every Tutorial Class ➢ Another 2 Problems to be given as Home Work. Tutorial Class Module 1: 2 hrs	**30 hours**

	Tutorial Class Module 2 : 4 hrs Tutorial Class Module 3 : 5 hrs Tutorial Class Module 4 : 5 hrs Tutorial Class Module 5 : 4 hrs Tutorial Class Module 6 : 5 hrs Tutorial Class Module 7 : 5 hrs	

Text Book

1.	Steven O'Hara, Carisa H Ramming, (2014), Numerical Structural Analysis (Sustainable Structural Systems Collection), Momentum Press.

Reference Books

1.	Joe G. Eisley, Antony M. Waas, (2011), Analysis of Structures: An Introduction Including Numerical Methods, Wiley.
2.	Mahinder Kumar Jain, (2012), Numerical Methods: For Scientific and Engineering Computation, New Age International Publishers
3.	Rajesh Srivastava, Saumyen Guha, (2010), Numerical Methods: For Engineering and Science, OUP India.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE6019	THEORY AND DESIGN OF PLATES AND SHELLS	L	T	P	J	C
		2	2	0	0	3
Pre-requisite	CLE5001 Theory of Elasticity and Plasticity	Syllabus version				
		1.1				

Course Objectives:

1. To understand the behaviour of thin plates under bending
2. To study the different solution techniques of rectangular thin plates
3. To understand the numerical techniques for the analysis of plates
4. To know the structural behaviour of folded plates
5. To obtain knowledge on the behaviour of shells
6. To understand the analysis techniques of different types of shells

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Develop and solve differential equation of thin plates subjected to flexure
2. Analyze rectangular plates using Navier's and Levy's method
3. Analyse plates by using finite difference method
4. Identify the structural behaviour of folded plates
5. Differentiate various types of shells based on structural behaviour
6. Analyse and design different types of shells
7. Determine membrane behaviour of shells

Module:1	Introduction	4 hours
Laterally loaded thin plates – Differential equation – Boundary conditions. Bending of plates		
Module:2	**Analysis of Plates - I**	**4 hours**
Simply supported rectangular plates – Navier's solution and Levy's method – Rectangular plates with various edge conditions.		
Module:3	**Analysis of Plates - II**	**4 hours**
Symmetrical bending of circular plates – Finite difference method for analysis of square and rectangular plates.		
Module:4	**Folded Plates**	**4 hours**
Introduction of folded plate structures – Structural behavior – Various types		
Module:5	**Shells**	**4 hours**
Introduction - Types of shells – Structural action – Membrane theory – Limitations		
Module:6	**Analysis and Design of Shells - I**	**5 hours**
Beam method of analysis. Analysis and design of doubly curved shells – Elliptic paraboloid		
Module:7	**Analysis of Shells - II**	**3 hours**
Conoid and hyperbolic paraboloid roofs.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**

Tutorial ➢ Minimum of 2 Problems to be worked out by Students in Every Tutorial Class ➢ Another 2 Problems to be given as Home Work. Tutorial Class Module 1: 2 hrs Tutorial Class Module 2 : 4 hrs Tutorial Class Module 3 : 5 hrs Tutorial Class Module 4 : 5 hrs Tutorial Class Module 5 : 4 hrs Tutorial Class Module 6 : 5 hrs Tutorial Class Module 7 : 5 hrs	**30 hours**

Text Book(s)

1.	Timoshenko. S., (2010), Theory of Plates and Shells, McGraw Hill Education (India) Private Limited, 2 edition, New York.

Reference Books

1.	Chandrashekhara, K., (2001), Theory of Plates, University Press (India) Ltd., Hyderabad.
2.	Szilard. R., (2007), Theories and Applications of Plate Analysis: Classical Numerical and Engineering Methods, John Wiley & Sons, New Jersey.
3.	Bhavikatti. S.S., (2012), Theory of Plates and Shells, New Age International Publisher, First edition, New Delhi.
4.	Reddy. J.N., (2006), Theory and Analysis of Elastic Plates and Shells: Solutions Manual, CRC Press Inc, 2nd Revised edition, London.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE6020	ANALYSIS AND DESIGN OF TALL STRUCTURES	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	CLE6015 Advanced Design of Steel Structures	Syllabus version				
		1.0				

Course Objectives:

1. To understand the behaviour of tall structures subjected to dynamic loads
2. To study the behaviour of different types of tall structural systems

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Analyse the tall structure for gravity and lateral loads
2. Evaluate the structural systems in tall buildings
3. Understand the behaviour of various structural systems under gravity and lateral loading
4. Examine different types of outrigger system
5. Understand shear wall systems
6. Identify the importance of infilled frames
7. Examine three dimensional analysis of floors

Module:1	**Types of Buildings and Loads Calculations**	**5 hours**
Classification of buildings according to NBC – Wind load – Seismic load – Quasi static approach- combination of loading		
Module:2	**Rigid frame**	**4 hours**
Rigid frame behaviour- analysis of gravity loading-Substitute frame method for dead load and live loads- analysis of horizontal loading- Portal - Cantilever and factor methods – Kani's method- Equivalent frame method- Diaphragm openings		
Module:3	**Braced Frame**	**4 hours**
Types of bracing- behaviour of bracing- methods of analysis- member force analysis- drift analysis		
Module:4	**Core and Outrigger System**	**4 hours**
Behaviour- optimum location of single outrigger- optimum location of two outrigger- framed tube systems		
Module:5	**Shear Wall System**	**5 hours**
Behaviour and analysis of shear wall- coupled shear wall		
Module:6	**In-filled Frame Systems**	**3 hours**
Importance – Methods of analysis – Equivalent truss and frame method – Force-displacement method – Effect of perforation in the in-filled frame.		
Module:7	**Three Dimensional Analysis**	**3 hours**
Basic principles – Centre of rotation of a rigid floor, Force displacement method		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**

Sample List of Projects for J Component	
1. Comparative study of conventional and core-outrigger structure under wind loading 2. Investigation of efficient bracing system as per IS 800:2007. 3. Effect of concentric and eccentric type of bracings on performance based seismic analysis of RC building 4. Analysis of reinforced concrete tall building with different arrangement of	**60 hours**

concrete and steel bracing system 5. Analysis and design of diagrid structural system for high rise steel buildings			
Text Book(s)			
1.	B.S. Taranath (2011), Structural analysis and design of tall building, CRC Press		
Reference Books			
1.	Ghali.A., Neville.A.M and Brown.T.G, (2003), Structural Analysis – A unified classical and Matrix Approach (Fifth Edition), Span press		
2.	IS 13920 Ductile detailing of reinforced concrete structures, BIS, India		
3.	IS 1893 Criteria for earthquake resistant design BIS, India		
4.	IS 875 Code of practice for design loadsBIS, India		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04-03-2016		
Approved by Academic Council	No. 40	Date	18-03-2016

CLE6021	STRUCTURAL OPTIMIZATION	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	CLE6015 Advanced Design of Steel Structures	Syllabus version				
		1.1				

Course Objectives:

To study the different optimization methodologies applied to structural systems.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand structural optimization problems,
2. Apply various classical techniques for optimization.
3. Identify problem formulation, analytical method and basic feasible solution
4. Apply various unconstrained nonlinear programming for optimization problems.
5. Apply various constrained nonlinear programming for optimization problems.
6. Understand geometric and Dynamic Programming
7. Understand optimization techniques for steel and RC members.

Module:1	Introduction	5 hours

Definition - Variables - Objective Function - Constraints - Design space - Feasible and infeasible - Convex and Concave - Local and global optima - Formulation of structural optimization problems.

Module:2	Classical Technique	6 hours

Differential calculus - Optimality criteria - Single variable optimization - Multivariable optimization - Lagrange Multiplier method - Khun - Tucker Criteria.

Module:3	Linear Programming	6 hours

Problem formulation - Graphical solution - Analytical method - Standard form - Slack, surplus and artificial variables - Canonical form - Basic feasible solution - Simplex method - Two phase method - Penalty method - Duality theory - Primal - Dual algorithm.

Module:4	Unconstrained Nonlinear Programming	6 hours

Unidimensional - Unimodal function - Exhaustive and unrestricted search - Dichotomous search - Fibonacci Method - Golden section method - Interpolation method - Unconstrained multivariable function - Univariate method - Cauchy's steepest descent method - Conjugate gradient method (Fletcher Reeves) - Variable metric methods - (Davidon - Fletcher Powell).

Module:5	Constrained Nonlinear Programming	6 hours

Direct and indirect method- Cutting plane method - Method of feasible direction - Interior penalty function - Exterior penalty function method.

Module:6	Geometric and Dynamic Programming	6 hours

Polynomial - Degree of difficulty - Reducing G.P.P to a set of simultaneous equations - Unconstrained and constrained problems with zero difficulty - Concept of solving problems with one degree of difficulty - Bellman's principle of optimality - Representation of a multistage decision problem - Concept of sub-optimization problems using classical and tabular methods.

Module:7	Structural Engineering Applications	6 hours

Methods for optimal design of structural elements, continuous beams and single storied frames using plastic theory - Minimum weight design for truss members - Fully stressed design - Optimization principles to design R.C. structures such as multi-storey buildings, water tanks and

bridges. Structural optimization for transient (dynamic) problems.		
Module:8	**Contemporary issues**	**4 hours**
	Total Lecture hours	**45 hours**

Text Book	
1.	Rao, S.S. (2014), Engineering Optimization: Theory and Practice, New Age International, New Delhi.
Reference Books	
1.	Raphael T. Haftka, ZaferGürdal, (2012), Elements of Structural Optimization, Series in Solid Mechanics and its Applications, Vol. 11, Springer Science & Business Media, Netherlands.
2.	Osvaldo M. Querin, Mariano Victoria, Cristina Alonso Gordoa, Rubén Ansola, PascualMartí, (2017), Topology Design Methods for Structural Optimization, Butterworth-Heinemann.
3.	Andrej Cherkaev, (2012), Variational Methods for Structural Optimization, Vol.140, Applied Mathematical Sciences, Springer Science & Business Media, Netherlands.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE6022	URBAN PLANNING AND SUSTAINABILITY	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	CLE6015 Advanced Design of Steel Structures	Syllabus version				
		1.1				

Course Objectives:

1. To understand about the project formulation for urban sustainability
2. To be able to know the theories of urban planning
3. To understand the impact of a plan to the environment
4. To find effective methods of infrastructure planning
5. To identify areas where smart infrastructure and smart cities can be incorporated.

Expected Course Outcome:

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

1. Explain the aspects to be considered when planning a city
2. Examine the impact of a plan on the environment
3. Identify the factors of existing theories of planning
4. Understand the requirements of institutional bodies
5. Apply various aspects of sustainable infrastructure and plan development
6. Evaluate the various factors that affect the urban structure
7. Understand requirements of smart city

Module:1	Introduction to City Planning	5 hours

Overview of planning from prehistory to current - Industrialization and the transformation of Urban Space - Detailed case studies of planned cities - Introduction of Remote sensing, GIS and GPS in urban planning. Smart City Planning.

Module:2	Economy and Environment	8 hours

Indian cities and challenges involved in planning -Urban Renewal and Suburbanization - Downtown Redevelopment - Planning for Disaster risk reduction - Energy and Sustainability -Global Sustainability Issues and Climate Change - Concepts of EIA and LCA.

Module:3	Planning Theories	5 hours

Theory of city form: normative models –cosmic, machine, organic; Concentric Zone Theory, Sector Theory, Multiple Nuclei Theory - Modes of planning -Land use and land value -Emerging Concepts and Environmental Planning.

Module:4	Institutional Mechanisms	5 hours

Planning system in India and changes in institutional provisions over time - authorities and mechanisms for planning, implementation and evaluation - levels of hierarchy. Types of plans – master plans, development plans. Digital Data Integration with Sustainable Smart Cities.

Module:5	Infrastructure Planning	8 hours

Critical issues in sustainable infrastructural planning- Concepts of basic needs, formation of objectives and standards - Data requirements for planning of urban networks and service - feasibility planning studies for structure, infrastructure systems. Technology for Sustainable Smart City Infrastructure. Recycling Technologies and Renewable energy.

Module:6	Evaluation of Urban Structure	4 hours

Infrastructure and management -Sustainable Transportation systems and their types - design and operating characteristics - urban road hierarchy planning - criteria for road and junction improvements - arterial improvement techniques. Integrated inter-modal transport systems.

Module:7	Smart Cities and Sustainable Development	8 hours

Human development and sustainability - Rights of future generations -Climate Change and development - Leveraging recent technologies in enhancing urban living: internet of things (IoT) – Concept of smart cities.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book	
1.	Peter Hall, Mark Tewdwr-Jones. (2010), Urban and Regional Planning, Taylor & Francis.
Reference Books	
1.	Peter Hall (2014), Cities of Tomorrow, An Intellectual History of Urban Planning and Design Since 1880. 4th Edition, Wiley-Blackwell.
2.	Randall Crane and Rachel Weber (2012), The Oxford Handbook of Urban Planning, Oxford University Press.
3.	Ian Bracken (2009), Urban Planning Methods, Research and Policy Analysis, Routledge, Taylor & Francis.
4.	Harry T. Dimitriou, Ralph Gakenheimer (2011), Urban Transport in the Developing World, A Handbook of Policy and Practice. Edward Elger, USA.
5.	Joy Sen (2013), Sustainable Urban Planning, The Energy and Resources Institute, New Delhi, India.
6.	Russ Lopez. (2012). The Built Environment and Public Health. John Wiley & Sons.
7.	Eddie N. Laboy-Nieves, Fred C. Schaffner, Ahmed Abdelhadi, Mattheus F.A. Goosen (2008), Environmental Management, Sustainable Development and Human Health, CRC Press, Taylor & Francis.
8.	Carol L. Stimmel. (2015), Building Smart Cities: Analytics, ICT, and Design Thinking, CRC Press, Taylor & Francis.
9.	DurganandBalsavar (2012) Mahindra World City, Public Private Partnerships in Urban Planning, Mapin Publishers.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE6023	OFFSHORE STRUCTURES	L	T	P	J	C
		2	2	0	0	3
Pre-requisite	Nil	Syllabus version				
		1.1				

Course Objectives:

1. To learn the types and functions of offshore structure.
2. To study the behavior of structures subjected to hydrodynamic loads
3. To study different analysis procedures for different offshore structures and also study the wave structure interaction.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the types and functions of offshore structure
2. Evaluate the loads experienced by offshore structure
3. Understand the concept of fixed offshore structures
4. Understand the wave hydrodynamics
5. Evaluate the wave forces on offshore structures
6. Design the framed structure in offshore.
7. Analyse the offshore structures subjected to dynamic loads.

Module:1	**Introduction**	**4 hours**
Types of Offshore Structures-Types of Offshore Platforms -Functions of offshore structures-Components of a Typical Offshore Structure		
Module:2	**Loads on Offshore Structures**	**4 hours**
Gravity Loads-Wind Load- Offshore Loads- Fatigue Load-Seismic Loads.		
Module:3	**Concepts of Fixed Platform Jacket and Deck**	**4 hours**
Jacket concepts-redundant framing arrangement-Launch and Lift jackets-Simple Deck configurations for Lift and float- Over installations- In-service and Pre-service Loads and analysis.		
Module:4	**Wave Theories**	**4 hours**
Wave generation and Propagation - Small and finite amplitude wave theories - Wave energy and pressure distribution		
Module:5	**Wave force on Offshore Structures**	**4 hours**
Slender Vertical Cylindrical Members-Linearization of Nonlinear Wave Drag Force-Wave Forces on Arbitrarily Oriented Cylindrical Members - Wave Forces on Large Diameter Structures		
Module:6	**Fundamental Considerations for Framed Offshore Structural Analysis**	**4 hours**
Site Characteristics and Modelling Procedures for Analysis-Hydrostatic Pressure and Buoyancy-Finite Element Applications for Framed Offshore Structural Analysis		
Module:7	**Considerations for Dynamic Analysis**	**4 hours**
Characterization of Offshore Structure as an SDOF System-SDOF Models in Offshore Structures-MDOF Systems		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**
	Tutorial ➢ Minimum of 2 Problems to be worked out by Students in Every Tutorial Class	

	➢ Another 2 Problems to be given as Home Work. Tutorial Class Module 1: 2 hrs Tutorial Class Module 2 : 4 hrs Tutorial Class Module 3 : 5 hrs Tutorial Class Module 4 : 5 hrs Tutorial Class Module 5 : 4 hrs Tutorial Class Module 6 : 5 hrs Tutorial Class Module 7 : 5 hrs	**30 hours**

Text Book(s)	
1.	D.V. Reddy, A. S. J. Swamidas(2014), Essentials of Offshore Structures, CRC Press, Taylor & Francis Group
Reference Books	
1.	Mohamed A. El-Reedy (2012), Offshore Structure, Design, Construction and Maintenance, Gulf Professional Publishing,
2.	API (2014), Recommended Practice for Planning, designing and Construction, Fixed offshore platform, American Petroleum Institute publication, RP2A, Dallas, Texas.
3.	Günther Clauss, Eike Lehmann, Carsten Östergaard, M.J. Shields (2012), Offshore Structures: Volume I: Conceptual Design and Hydromechanics: 1, Springer- Verlag.
4.	Eugenio Fortaleza (2012), Active Control of Offshore Structures, Lambert Academic Publication.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017

CLE6024	ENERGY EFFICIENT BUILDINGS	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		1.1				

Course Objectives:

1. To understand the concept of reduction in energy consumption through low energy building design
2. To Understand the sources of Renewable Energy
3. To Highlight strategies to integrate daylighting and low energy heating/cooling in buildings
4. To Model air flow and Ventilation
5. To know illumination requirements artificial lighting and factors affecting day lighting
6. To Design for climatic zones

Expected Course Outcome:

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

1. Understand the concept of reduction in energy consumption through low energy building design
2. Understand the sources of renewable Energy
3. Examine strategies to integrate day lighting and low energy heating / cooling in buildings
4. Understand model air flow and Ventilation
5. Know illumination requirements artificial lighting and factors affecting day lighting
6. Design for climatic zones

Module: 1	Green Buildings, Energy and Environment	6 hours

Green Buildings within the Indian Context, Types of Energy, Energy Efficiency and Rebound Effect, Pollution, Better Buildings, Reducing energy consumption, Low energy design.

Module:2	Renewable Energy sources	7 hours

Solar energy, Passive Solar Heating, Passive Solar collection, Wind and other renewables. A passive solar strategy: Direct gain - Trombe wall, convective air loop, Photovoltaics, Climate and Energy, Macro and Microclimate - Indian Examples.

Module:3	Heating and Cooling	8 hours

Building Form Surface area and Fabric Heat Loss, utilizing natural energy, Internal Planning, Grouping of buildings – Robin's Spatial Proportion – Orientation of building –Heat transmission through buildings –Thermal properties of building materials – Thermal Comfort –Psychrometric Chart –Heat transfer – Cosine Effect - Insulation - Cooling buildings, passive cooling, and mechanical cooling – Measurement of heating and cooling loads.

Module:4	Ventilation and Infiltration	8 hours

Natural ventilation and forced ventilation in commercial buildings, passive cooling, modelling air flow and ventilation – stack effect - ventilation calculation – Mass effect

Module:5	Day lighting and Artificial Lighting	8 hours

Illumination requirements - Concepts of daylight factors and day lighting, daylight assessment, sky dome - sun path diagram, sky exposure angle, sun protection, shading coefficient, visualizing day lighting: Source-Path-Target and apparent size, illuminance calculation, penetration and spread of sky component, artificial lighting, efficacy, Radiant barriers - new light sources –luminaries - light shelves - Supplementary artificial lighting design – light distribution – electric lighting control

Module:6	Design for Climatic Zones	3 hours

Energy efficient building strategies for various climatic zones – cold and cloudy – cold and sunny – composite – warm and humid – moderate – hot and dry – case studies.

Module:7	**EnergyAssessment and Compliances Procedures**	**3 hours**
Energy awareness, monitoring energy consumption, Building Environmental Assessment-environmental criteria – embodied energy of building materials - assessment methods - assessment tools (e.g. GRIHA, LEED) - Ecohomes - Sustainable architecture and urban design – principles of environmental architecture.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)

1.	Satyajit Ghosh and Abhinav Dhaka (2015), Green Structures: Energy Efficient Buildings, Ane Books.

Reference Books

1.	Charles Eley (2016), Design Professional's Guide to Zero Net Energy Buildings, Island Press.
2.	Ian M. Shapiro (2016), Energy Audits and Improvements for Commercial Buildings, John Wiley & Sons.
3.	Moncef Krarti (2016), Energy Audit of Building Systems: An Engineering Approach, Second Edition.
4.	EngHwa Yap., (2017), Energy Efficient Building, Published by InTech.,Crotia.
5.	Lal Jayamaha (2006), Energy-Efficient Building Systems: Green Strategies for Operation and Maintenance, McGraw Hill Professional.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	27.09.2017		
Approved by Academic Council	No. 47	Date	05-10-2017