Date:08/01/2021

To,

The Dean Academics

R.I.T. Rajaramnagar.

Sub:- M.Tech Civil Structural Engineering Curriculum for 20-22 batch for Approval

Respected Sir,

We are Submitting herewith the M Tech Structural Engineering Curriculum for 20-22 batch for Approval, which is to be implemented from Year 2020- 21.

Kindly acknowledge the same.

Thanking You,

Your faithfully,

H.O.P
Sructural Engg

Member Secretary
BOS,Civil Engg

Chairman
BOS,Civil Engineering

RAJARAMBAPU INSTT. OF TECHNOLOGY
RAJARAMNAGAR CIVIL ENGG. DEPT.

Encl:

PG Civil Structural Engineering Syllabus

Approved

K.E. Society's
Rajarambapu Institute of Technology, Sakharale
(An Autonomous Institute, Affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation
To be implemented for 2020-22 batch
Rev: CES Course Structure/RIT/04/2020-22

Department : Civil Engineering
Class : F.Y. M. Tech. Structural Engineering **Semester:** I

Course Code	Course	Teaching Scheme				Evaluation Scheme					
							Theory (Marks)			Practical (Marks)	
		L	T	P	Credits	Scheme	Max	Min % for Passing		Max	Min % for Passing
SHP 517	Numerical Methods for Structural Engineers	3	-	-	3	ISE	20	40	40	-	-
						UT1	15			-	-
						UT2	15			-	-
						ESE	50	40		-	-
CES 1014	Advanced Structural Analysis	3	-	-	3	ISE	20	40	40	-	-
						UT1	15			-	-
						UT2	15			-	-
						ESE	50	40		-	-
CES 1024	Structural Dynamics and Earthquake Engineering	4	-	-	4	ISE	20	40	40	-	-
						UT1	15			-	-
						UT2	15			-	-
						ESE	50	40		-	-
	Program Elective - I	3	-	-	3	ISE	20	40	40	-	-
						UT1	15			-	-
						UT2	15			-	-
						ESE	50	40		-	-
	Program Elective - II	3	-	-	3	ISE	20	40	40	-	-
						UT1	15				
						UT2	15				
						ESE	50	40			
SHP 551	Technical Communication	2	-	-	Audit Course	P/NP					-
CES 1084	Structural Design lab I	-	-	4	2	ISE	-	-	-	50	50
						ESE	-	-	-	50	50
CES 1094	Advanced Concrete Technology Lab.	-	-	2	1	ISE	-	-	-	100	50
CES 1104	Mini Project I	-	-	2	1	ISE	-	-	-	100	50
Total		18	0	8	20						

Total Contact Hours/week : 26
Total Credits : 20

ISE = In Semester Evaluation, (UT1+UT2) UT-I = Unit Test-I, UT-II = Unit Test-II ESE = End Semester Exam

List of Program Elective -1

Sr No.	Course Code	Course
1	CES 1034	Advanced Design of Steel Structures
2	CES 115	Maintenance and Rehabilitation of Structures
3	CES 1044	Advanced Concrete Technology

List of Program Elective -II

Sr No.	Course Code	Course
1	CES 1054	Design of Advanced Concrete Structures
2	CES 1064	Design of Industrial Structures
3	CES 1074	Design of Formwork

Department : Civil Engineering
Class : F.Y. M. Tech. Structural Engineering **Semester:** II

Course Code	Course	Teaching Scheme				Evaluation Scheme					
							Theory (Marks)			Practical (Marks)	
		L	T	P	Credits	Scheme	Max	Min % for Passing		Max	Min % for Passing
CES 1114	Finite Element Analysis	3	-	-	3	ISE	20	40	40	-	-
						UT1	15			-	-
						UT2	15			-	-
						ESE	50	40		-	-
CES 1124	Advanced Solid Mechanics	3	-	-	3	ISE	20	40	40	-	-
						UT1	15			-	-
						UT2	15			-	-
						ESE	50	40		-	-
	Program Elective - III	3	-	-	3	ISE	20	40	40	-	-
						UT1	15			-	-
						UT2	15			-	-
						ESE	50	40		-	-
	Program Elective - IV	3	-	-	3	ISE	20	40	40	-	-
						UT1	15			-	-
						UT2	15			-	-
						ESE	50	40		-	-
CES 1184	Research Methodology & Intellectual Property Rights (IPR)	1	1	-	2	ISE	50	40		40	-
						ESE	50	40			-
CES 1194	Structural Design Lab II	-	-	4	2	ISE	-	-	-	50	50
						ESE	-	-	-	50	50
CES 1204	Structural Dynamics and Earthquake Engineering Lab	-	-	2	1	ISE	-	-	-	50	50
						ESE	-	-	-	50	50
CES 1214	Mini project II	-	-	4	2	ISE	-	-	-	100	50
	Industry Internship	-	-	-	-	-	-	-	-	-	-
Total		13	1	10	19						

Total Contact Hours/week : 24
Total Credits : 19

***Student has to complete internship of 2weeks duration after 2nd semester. However, its Evaluation will be carried out in the 3rd semester.**

ISE: In Semester Exam, UT1 & UT2: Unit Test-I, Unit Test-II; ESE: End Semester Exam, P: Pass, NP: Not Pass

List of Program Elective -III

Sr No.	Course Code	Course
1	CES 1134	Advanced Earthquake Engineering
2	CES 114	Composite Structures
3	CES 1144	Structural Optimization

List of Program Elective -IV

Sr No.	Course Code	Course
1	CES 1154	Design of Bridges and Flyovers
2	CES 1164	Design of Pre-stress Concrete Structures.
4	CES 1174	Theory of Thin Plates and Shells

K.E. Society's

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Curriculum Structure and Evaluation

To be implemented for 2020-22 batch

Rev: CES Course Structure/RIT/04/2020-22

Department : Civil Engineering

Class : S.Y. M. Tech. Structural Engineering **Semester:** III

Course Code	Course	Teaching Scheme				Evaluation Scheme				
		L	T	P	Credits	Scheme	Theory (Marks)		Practical (Marks)	
							Max	Min % for Passing	Max	Min % for Passing
CES 2014	Industry Internship	-	-	2	Audit	ISE	-	-	P/NP	
	Open Elective:	-	-	-	3	ESE	-	-	100	50
CES 2024	Dissertation Phase-I	-	-	08	4	ISE	-	-	100	50
CES 2034	Dissertation Phase-II	-	-	12	6	ISE	-	-	100	50
						ESE			100	50
Total		-	-	**22**	**13**					

Total Contact Hours/week : **22**

Total Credits : **13**

List of Open Elective

Sr No.	Course Code	Course
1	MOE2010	Artificial Intelligence - Machine Learning
2	MOE2020	Creative Thinking: Tools & Techniques
3	MOE2030	MOOC Course
4	MOE2040	Condition Monitoring and Signal Processing
5	MOE2050	Aircraft Conceptual Design

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Curriculum Structure and Evaluation
To be implemented for 2020-22 batch
Rev: CES Course Structure/RIT/04/2020-22

Department : Civil Engineering
Class : S.Y. M. Tech. Structural Engineering **Semester:** IV

Course Code	Course	Teaching Scheme				Evaluation Scheme				
		L	T	P	Credits	Scheme	Theory (Marks) %		Practical (Marks) %	
							Max	Min % for Passing	Max	Min % for Passing
CES 2064	Dissertation Phase-III	-	-	10	06	ISE	-	-	100	50
CES 2074	Dissertation Phase - IV	-	-	18	10	ISE	-	-	100	50
						ESE			100	50
Total		-	-	**28**	**16**					

Total Contact Hours/week : **28**
Total Credits : **16**

ISE = In Semester Evaluation, (UT1+UT2) UT-I = Unit Test-I, UT-II = Unit Test-II ESE = End Semester Exam

TOTAL CREDITS: 20+19+13+16= 68

TOTAL CONTACT HOURS: 26+24+22+28= 100

SEMSTER - I

Class: **First Year M. Tech Structural Engineering**	Semester-I
Course Code: **SHP 517**	Course Name: **Numerical Methods for Structural Engineers**

L	T	P	Credits
3	-	--	3

Course Description:
This course is offered to first year M. Tech. Civil Structural Engineering students. The course introduces students to the formulation, methodology and techniques for numerical solution of engineering problems. The course intends to build the competency in the students to apply the knowledge of mathematics to the solution of engineering problems and to analyze it. The course covers the topics: Error Analysis and Estimation, Interpolations, Curve Fitting, Solution of Nonlinear Algebraic and Transcendental Equations, Elements of Matrix Algebra, Fuzzy Logic Theory and Applications.

Course Learning Outcomes:
1. Estimate the error.
2. Apply the relevant numerical method for interpolating the polynomial
3. Develop the equation to be fitted and fit the curve for given data
4. Estimate numerically the solution of given algebraic equation.
5. Use the relevant method for solving the simultaneous linear equations and compute the Eigen values.
6. Construct the fuzzy set for given linguistic variable and apply fuzzy logic.

Prerequisite:
Undergraduate Engineering Mathematics

Unit No.	Details of Content	Hrs.
1.	**Error Analysis and Estimation:** Error and their analysis, A general error formula, Error in numerical computations, Error in series approximation.	6
2.	**Interpolations:** Introduction, Finite differences, Relation between operators, Differences of a polynomial, Factorial notation, Missing term technique, Lagrange's interpolation formula, Newton's Divided difference formula.	6
3.	**Curve Fitting:** Method of least squares, Fitting a straight line, Fitting of an exponential curve $y = ae^{bx}$, Fitting of the curve $y = ax^b$, Fitting of the curve $y = ab^x$, Fitting of the	6

	curve of the type $xy = b + ax$, Fitting of the curve $y = ax + bx^2$.	
4.	**Solution of Nonlinear Algebraic and Transcendental Equations** Muller's Method, Horner's Method, Multiple roots, Lin Bairtow's Method, Graeffe's Squaring Method.	6
5.	**Elements of Matrix Algebra:** Gaussian Elimination method, Gauss Jordan method, LU- decomposition from Gaussian Elimination method, Solution of Tridiagonal Systems, Eigen Value problems.	6
6	**Fuzzy Logic Theory and Applications:** Classical logic theory, Logical functions of the Two Valued logic, Boolean algebra. Multi valued logic, Fuzzy logic and approximate reasoning, Fuzzy relations, Applications of fuzzy logic for product quality evaluation, Decision making for investment.	6

Reference Books:

1. Atkinson K. E., J. Wiley and Sons,An Introduction to Numerical Analysis.
2. Scheid F, McGraw Hill Book Company, (Shaum Series), Theory and Problems of Numerical Analysis.
3. Sastry S. S, Introductory Methods of Numerical Analysis, Prentice Hall of India.
4. M. S Bapat, Fuzzy Mathematics, ShivajiUniversity, Kolhapur, 2015.
5. Introduction to Fuzzy Systems, Guanrong Chen, Trung Tat Pham, Chapman and Hall/ CRC Taylor and Francis Group.

Class:- **First Year M. Tech**	Semester-**I**
Course Code : **CES 1014**	**Advanced Structural Analysis**

L	T	P	Credits
3	---	--	3

Course Description:
This course is focuses on basic concept and different analytical tools for understanding the behaviour of especially of statically indeterminate structures. This course divided into four modules. The first module contains influence line diagram for cantilever, fixed, continuous beams, portal frames and arches. The Second module focuses on analysis beams curved in plan and Beam-Columns. The module three includes member oriented and structure-oriented stiffness and flexibility matrix methods. Module four contains Boundary value problems.
This course intends to build the competency in the students to identify indeterminate structures, and to analyse the structures like fixed beam, continuous beam, arches and portal frames. Also advanced topic such as beams curved in plan, beam-column analysis, matrix methods of analysis of structures and solution of boundary value problems.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Construct of ILD for reactions, S.F. and B.M. for indeterminate structures.
2. Draw SFD, BMD and TMD for beams curved in plan for various loading and support condition.
3. Analyse the beam-columns.
4. Analyse the skeleton structures by using matrix method.
5. Solve civil engineering boundary value problems.

Prerequisite:
The course learns through prerequisite courses of Engineering Mathematics, Engineering Mechanics, Solid Mechanics and Theory of Structures should have a clear understanding of methods of analysis of structures.

Course Content

Unit No.	Description	Hrs
1	**Influence Lines:** Physical Significance, Muller Breslau's Principle, Moment distribution method, ILD for propped cantilever, fixed beams, continuous beam, portal frames and two hinged arches.	06
2	**Beams Curved in Plan:** Analysis of determinate and indeterminate beams curved in plan such as cantilever circular arch, semi-circular beams fixed at two ends subjected to point load and udlsimply supported semi-circular beams, circular ring beam.	06

3	**Beam Columns:** Governing differential equation, geometric and material nonlinearity, analysis of beam-columns simply and fixed supported at ends with concentrated load, moment and uniformly distributed load, magnification factor.	**06**
4	**Member Oriented Stiffness Matrix:** Stiffness matrices for beam, truss, plane frame, pin and rigid jointed space frame element on member axis, transformation of matrices on structure axes, overall joint stiffness matrix and nodal vector, assembly rules, calculation of member end forces.	**06**
5	**Structure Oriented Stiffness Method:** Flexibility and stiffness matrices, analysis of continuous beams, trusses and plane frames by structure-oriented approach.	
6	**Boundary Value Problems:** Approximate solution of boundary value problems, Modified Galerkin Method for one-dimensional BVP, Matrix formulation of the Modified Galerkin Method.	**06**

References -

Text Books:

1. Vazirani and Ratwani, Advanced Theory of Structures & Matrix method, Khanna Publisher, Delhi.
2. C.S. Reddy, Basic structural Analysis, Tata McGraw Hill, Delhi.

Reference Books:

1. Timoshenko and Gere, Strength of Materials Vol II, East West Press Ltd.
2. Gere and Weaver, Matrix Analysis of Framed Structures, CBS Publishing, Delhi.
3. Pandit & Gupta, Structural Analysis - A matrix approach, Tata McGraw Hill, Delhi.
4. Negi and Jangid, Structural Analysis, Tata McGraw Hill Pub.Co.Delhi
5. Timoshenko, Strength of Materials Vol. II, East-West Press ltd.
6. N. Krishnaraju and D.R. Gururaja, Advanced Mechanics of Solids & Structures, Narosa Pub. House Delhi.
7. Lewis P. E. and Ward J. P., The Finite Element Method, Addison-Wesley Pub.Co.
8. Meek J. L., E and FN, Computer Methods in Structural Analysis, Span Pub.
9. Desai and Able, The Finite Element Method, CBS Publication.

Class: -**First Year M. Tech Structural Engineering**	Semester-**I**
Course Code: **CES 1024**	Course Name: **Structural Dynamics & Earthquake Engineering**

L	T	P	Credits
4	---	--	4

Course Description:
This course focuses on vibrations types and their causes. Response for single and multiple degree of freedom system by fundamental theory. This course also throws light on response by numerical methods. This course also focuses on elements of seismology and static method for lateral load evaluation.
This course intends to build the competency in the students to evaluate responses developed due to vibrations caused by various means. This theoretical knowledge will help to student for studying behaviour of structures under earthquake loading.

Course Learning Outcomes:
1. Analyse the response of single and multi-degree freedom systems by fundamental theory and equations of motion.
2. Analyse the response of single and multi-degree freedom systems by numerical methods. Discuss elements of seismology.
3. Evaluate lateral loads developed on multi-storeyed RCC structures by the Response Spectrum Analysis Method and Static Equivalent Method.

Prerequisite:
As a prerequisite to study this course, the students must possess the knowledge of D'Alembert's principle, differential equations and Integration by parts.

Course Content

Unit No	Description	Hrs
1	**Introduction** Introduction to dynamic problems of Civil Engineering, Concept of degrees of freedom, D'Alembert's principle, Types of vibrations, Principle of virtual displacement and energy, Single degree of freedom systems, Examples of Single degree of freedom systems in Engineering, Free vibration of damped and undamped systems. Mathematical modelling of dynamic system. Equivalent stiffness.	08
2	**Single Degree of Freedom Systems** Free and force vibration with and without damping, Response to harmonic loading, Response to general dynamic loading, Duhamel integral solution, Response to suddenly applied load and triangular pulse loading, Vibration isolation,	08

	transmissibility, Methods of damping measurements, Response of Single degree of freedom systems to arbitrary excitation, Principles of vibration measuring instruments.	
3	**Numerical Methods:** Numerical methods of frequency analysis, Rayleigh's method and matrix iteration methods, Stadola method, Newmarks method, Direct integration method.	**08**
4	**Multiple Degree of Freedom System** Two and multiple degrees of freedom system, Determination of Natural Frequency and normal modes, Orthogonality of modal vectors, Shear building model without damping and with proportional damping,	**08**
5	**Introduction Engineering seismology:** Earthquake phenomenon, cause of earthquakes-Faults- plate seismic tectonics-waves- Terms associated with earthquakes-Magnitude/Intensity of an earthquake-scales-Energy Released –Earthquake measuring instruments-seismograph accelerograph, Characteristics of strong ground motions - Seismic zones of India, Earthquake prediction. Some Case studies important earthquakes.	**08**
6	**Conceptual design** Introduction-Functional planning, continuous load path, overall form, simplicity and symmetry, elongated shapes, stiffness and strength, Horizontal and Vertical members, Twisting of buildings, Ductility, definition, ductility relationships, flexible buildings, framing systems, choice of construction materials, Introduction to earthquake resistant design: seismic design requirements, regular and irregular configurations, basic assumptions, design earthquake loads, basic load combinations, permissible stresses, seismic methods of analysis, factors in seismic analysis, Evaluation of equivalent lateral forces, response spectrum method..	**08**

References -

Text Books:

1. Grover, Mechanical Vibrations.
2. Chopra A. K.Structural Dynamics and Introduction of Earthquake Engineering.
3. Mario Paz, Structural Dynamics, Theory and Computation, CBS Publisher.
4. P. Agarwal & M. Shrikhande, Earthquake Resistant Design of Structures, Prentice Hall Publications.
5. Jai Krisna, A. R. Chandrashekharan & B. Chandra, Elements of earthquake Engineering, South Asian Publishers Private Limited.

Reference Books:

1. Madhujit Mukophadhyay,Structural Dynamics Vibrations and Systems, Publisher: ANE Books.
2. R.W. Clough and J.Penzien, McGraw, Dynamics of Structures,Hill Education.
3. Willaim Thomson, CRC Press, Theory of Vibration with applications.
4. David Dowrick Earthquake Resistant Design and Risk Reduction, Willey Publication.

IS Codes:-

1. I. S. 1893 2016, Criteria for Earthquake Resistant Design of Structures.

Class: **-First Year M. Tech. Structural Engineering**	Semester-**I**
Course Code: **SHP 551**	Course Name: **Technical Communication**

L	T	P	Credits
2	---	--	**Audit Course**

Course Description:

This course is designed to help students in improving skills that will enable them to produce well designed technical documents and to deliver impressive oral presentations. The course focuses on principles of effective writing and on types of documents common in technical fields. While the emphasis will be on writing, oral communication of technical information will form an important component of the course, as well. The course assists students in preparing them for oral presentations in various professional contexts.

Course Learning Outcomes:

1. Acquire skills required for good oral and written communication.
2. Demonstrate improved writing and reading skills.
3. Ensure the good quality of oral and written communication.

Course Content

Unit No.	Description	Hrs
1.	Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.	**06**
2.	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism.	**06**
3.	Sections of a Paper, Abstracts, Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	**06**
4.	4 key skills needed when writing a Title, key skills needed when writing an Abstract, key skills needed when writing an Introduction, skills needed when writing a Review of the Literature.	**06**
5.	Key skills needed when writing the Methods, skills needed when writing the Results, skills needed when writing the Discussion, skills needed when writing the Conclusions, useful phrases, how to ensure good quality of the paper at the time of submission.	**06**
6.	Resume Writing, e-Mails, Interview skills, Dos and Don'ts while Answering, FAQs, GROUP DISCUSSION: Structured and Unstructured GD, Opening and Closure, Showing Agreement and Disagreement	**06**

References -

Text Books:

1. Goldbort R. Writing for Science, Yale University Press (available on Google Books).
2. Day R. How to Write and Publish a Scientific Paper, Cambridge University Press.
3. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London.
5. John Seely, Oxford Guide to Effective Writing and Speaking; Oxford University Press.
6. Thomas N. Huckin and Leslie A. Olsen, Technical Writing and Professional Communication for Nonnative Speakers of English; Tata McGraw Hills, International Edition.
7. Jeff Butterfield, Soft Skills for Everyone, Cengage Learning India Private Limited.

Class: -**First Year M.Tech. Structural Engineering**	Semester-**I**		**L**	**T**	**P**	**Credits**
Course Code: **CES 1084**	Course Name: **Structural Design Lab – I**		-	-	4	2

Course Description:
Structural Engineering program. This laboratory course is mainly focused on analysis and design of steel structures using standard software packages like STAAD- Pro, ETABS and SAP etc. Students are expected to design various steel structures and prepare drawing of the same.

Course Learning Outcomes:
1. Analyze and design of the steel structures such as truss, Towers, Steel Building Frame and Hoarding Board etc. using standard software packages.
2. Interpret the results of analysis and design obtained from the software.
3. Prepare drawings of detailing of structural elements.

Prerequisite:
As a prerequisite to this course student must know limit state design of steel structures

Course Content		
Experiment No.	**Description**	**Lab Hrs**
1.	Analysis and design of truss	5
2.	Structural drawing of truss	4
3.	Analysis and design of transmission tower	5
4.	Analysis and design of steel building (Frame)	5
5.	Analysis and design of hoarding boards	5

References -
1. M. R. Shiyekar, Limit State Design in Structural Steel, PHI Learning.
2. K. S. Sai Ram, Design of Steel Structures, Pearson.
3. S. K. Duggal, Design of Steel Structures, Tata Mc-Graw Hill publishing company Ltd., New Delhi.
4.Dr. N. Subramanian, Design of Steel Structures, Oxford University Press, New Delhi.
5. J.E.Lothers, Design in Structural Steel Structures, Prentice Hall New Jersy.

Class: **F.Y. B. Tech**	Semester- **I**
Course Code: **CES1094**	Course Name: **Advanced Concrete Technology Lab**

L	T	P	Credits
-	-	2	01

Course Description:
The Advanced Concrete Lab course focuses on the experimental study of properties of various concrete ingredients and concrete elements / structure in order to analyse the quality and durability aspects. The course deals mix design methods of some special concretes and study of their properties in fresh and hardened state. The course aims to carry out condition survey of any structure for assessing its quality status using various standard and advanced NDT tools / equipment.

Course Learning Outcomes:
1. After successful completion of the course, students will be able to,
2. Perform quality control tests on various ingredient of concrete and special concrete.
3. Design ordinary and special concretes using existing and new methods of mix design.
4. Evaluate quality of concrete using NDT.
5. Recommend appropriate methods / techniques for repair and strengthening works.

Prerequisite:
Fundamental knowledge of basic ingredients of concrete and properties of ordinary concrete.

Course Content

Unit No.	Description	Hrs
1	Determination of properties of ingredients of ordinary concrete.	4
2	Determine properties of special concrete in fresh and hardened state- Workability tests. Compressive Strength.	4
3	Design of Special Concretes Mixes (Light Weight or High Strength Concrete).	4
4	Study of flexural behaviour of concrete member under static loading.	2
5	Non-destructive Testing of concrete elements/structure using standard and advanced NDT equipment.	2
6	Durability Tests on Concrete (any two) Carbonation Test. Water Permeability Test. Effect of elevated temperatures. Effect of acids, sulphates and chlorides. Rapid Chloride Penetration Test.	4

7	Preparation of structural audit and condition survey report of any one structure.	4

References -

Text Books:

1. M.S. Shetty, Concrete Technology, S. Chand & Company Pvt. Ltd., New Delhi.
2. M. L. Gambhir, Concrete Technology, Tata McGraw-Hill.

Reference Books:

1. P. Kumar Mehta &Paulo J. M. Monteiro, Concrete Microstructure, Properties and Material, McGraw-Hill New York.
2. A. M. Neville, Properties of Concrete, Prentice Hall India Learning Private Limited.
3. Krishna Raju, Design of Concrete Mixes, Prentice Hall India Learning Private Limited.
4. A.R. Santhakumar, Concrete Technology, S. Chand & Company Pvt. Ltd., New Delhi.

Class: **First Year M. Tech. Structural Engineering**	Semester- **I**
Course Code: **CES1104**	Course Name: **Mini Project I**

L	T	P	Credits
-	-	2	01

Laboratory Work (Mini Project):
Mini project shall be delivered on one of the advanced topics chosen in consultation with the supervisor, based on dissertation work/societal problem/special structure. Here parametric study is not expected. Some lifelong learning abilities should be developed. A hard copy of the report (25 to 30 pages A4 size, 12 fonts, Times New Roman, single spacing single side printed, preferably in TRM format) should be submitted to the Department Post Graduate Committee (DPGC) before delivering the seminar. A copy of the report in soft form must be submitted to the supervisor, along with other details, if any. Minimum 03 presentations should be delivered by the students.

Course Outcomes:
1. Identify research problem.
2. Prepare and present statement of Purpose.
3. Perform analysis work.
4. Communicate with outside agencies.
5. Write report and Present the work carried out.
6. Develop self-learning ability.

Class: **First Year M. Tech. Structural Engineering**	Semester-**I**
Course Code: **CES1034**	Course Name: **Advanced Design of Steel Structures (PE I)**

L	T	P	Credits
3	---	--	3

Course Description:
It consists of design of steel structures, components, design of plate girders, beam-columns, portal frames, cold formed light gauge steel sections, composite sections and bolted and welded connections. This course intends to build confidence in students to design elements steel structures and their connections.

Course Learning Outcomes: Course Outcomes:
1. Design steel structures and frames by varying methods.
2. Design various connectivity of structure as per code provisions.

Prerequisite: This course requires the knowledge of structural analysis and design of basic structural elements of steel structures.

Course Content

Unit No.	Description	Hrs
1.	**Plate girder** Introduction, plate buckling, web buckling in shear, tension field action, design of plate girder.	06
2.	**Design of beam-columns** Introduction, general behaviour of beam-columns, P-Δ effects, elastic lateral-torsional buckling of beam columns, interaction between beam-column and structure, design of beam columns, beam-columns subjected to tension and bending, crane columns.	06
3.	**Design of portal frames** Introduction, plastic analysis of rectangular portal frames, plastic analysis of gable portal frames, design of portal frames.	06
4.	**Cold formed light gauge steel sections** Introduction, behaviour of light gauge sections, design of axially loaded compression members, design of beams. deflection calculation.	06
5.	**Composite beams:** Introduction, elastic behaviour, shear connectors, ultimate load behaviour of composite beam, serviceability limit state.	06
6.	**Connections**	06

	Bolted connections, behaviour of bolted connections, design strength, block shear failure, truss joint connections, design of seat connection, web angle connection, eccentrically loaded connections, beam splices, column splices, welded connections, design of welds for truss members, angle seat connections, web angles and end plate connections, moment resistant connections, beam and column splices, tubular connections.	

Reference Books:

1. N. Subramanian, Design of Steel Structures, Oxford University Press.
2. K. S. Sai Ram, Design of Steel Structures, Pearson.
3. M. R. Shiyekar, Limit State Design in Structural Steel, PHI Learning Private Limited.
4. S. K. Duggal, Design of Steel Structures, Mc-Graw Hill Education (India) Private Limited.
5. Dayaratnam, Design of Steel Structures, Wheeler Publishing, New Delhi.

IS Codes:-

1. IS:800-2007, General Construction in Steel- Code of Practice.
2. IS:811-1987.
3. IS:4923-1997.
4. IS:11384-1985.

Class: **First Year M. Tech Structural Engineering**	Semester-I
Course Code: **CES 115**	Course Name: **Maintenance and Rehabilitation of Structures (PEI)**

L	T	P	Credits
3	---	--	3

Course Description:
Concrete structures are subjected to constant deterioration due to effects of ageing, inadequate maintenance, severe environmental exposure, penetration of catalytic agencies such as moisture, gases like CO2 & oxygen, chloride ions, industrial pollutants etc. This deterioration needs to be timely arrested before it leads to irreparable damage making it very important to repair and upgrade (retrofit/strengthening) the current stock of deteriorated and deficient structures. This course has been designed with an aim to give the students an insight into the subject of concrete repair, its protection and strengthening. This course focuses on various facets of maintenance and repairs of existing damaged structures. Various materials used in carrying out repair works forms the important aspect of this course. It also includes preventive measures on various aspects and provides the information on inspection, assessment procedure for evaluating a damaged structure, causes of deterioration and testing techniques. The course covers the basic principles and methods for strengthening the existing structures.

Course Learning Outcomes:
1. Diagnose various distress mechanisms of damaged or deteriorated concrete or elements concrete structure based on the symptoms indicated.
2. Carry out systematic condition assessment of RCC buildings/structures.
3. Recommend appropriate repair materials and techniques for repairing and strengthening of deteriorated or damaged elements of RCC structures.
4. Evaluate the quality of concrete or elements of concrete structure based on the results obtain through condition survey.

Prerequisite:
Concrete technology, Structural Analysis, Design of Reinforced Concrete structure, Earthquake Engineering

Course Content

Unit No.	Description	Hrs
1.	**Deterioration of Concrete Structures:** Distresses in concrete structures, Deterioration of Concrete Structures – signs,	06

	causes and symptoms, mechanism of deterioration; Physical deterioration due to moisture, temperature, shrinkage, exposure to severe environment; Chemical deterioration due to corrosion of reinforcement (chloride & carbonation induced), alkali-silica reaction, sulphate attack, acid attack. Deterioration due to fire - aspects of fire and fire prevention on buildings.	
2.	**Building Cracks:** Cracks: types, causes, diagnosis, characteristics of cracking in various structural components like beam, column, slab, masonry walls; Measurement of cracks. Moisture penetration: causes of dampness, ill effects of dampness, and methods of preventing dampness, damp-proofing materials, damp-proofing and waterproofing, components of a waterproofing system, requirements, water proofing types and applications.	**06**
3.	**Maintenance and Diagnosis of Failure:** Maintenance, phases of maintenance, maintenance jobs in buildings, Repair and rehabilitation, Facets of maintenance, importance of maintenance, various aspects of inspection – assessment procedure for evaluating a damaged structure, diagnosis of construction failures; condition survey and non-destructive evaluation of structures.	**06**
4.	**Materials of Repair:** Factors considered in the selection of repair method, repair stages. Materials for repair: desirable properties of materials, special mortar and concretes, concrete chemicals, special cements and high grade concrete – expansive cement, polymer concrete, sulphur infiltrated concrete, ferrocement, fiber reinforced concrete, admixtures of latest origin.	**06**
5.	**Techniques of Repair and Protection Methods:** Rust eliminators and polymers coating for rebars during repair; foamed concrete, mortar and dry pack, Gunite and shotcrete, Repair of cracks in concrete and masonry: methods of repair- epoxy injection, mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings and cathodic protection.	
6.	**Repairs, Rehabilitation and Retrofitting of Structures:** Strengthening measures- flexural strengthening, beam shear capacity strengthening, column strengthening – jacketing, slab strengthening, Seismic retrofit of concrete structures-deficiencies in structure requiring seismic retrofit, techniques to enhance seismic resistance of structures, advanced techniques for making seismic resistant structures.	**06**

References –

Books:

1. Santhakumar, A.R., Concrete Technology, Oxford University Press.

2. Shetty M.S., Concrete Technology, Theory and Practice, S.Chand and Company, New Delhi.
3. Gambhir, M.L., Concrete Technology, Tata McGraw-Hill Publishing Company Limited, New Delhi.
4. Raiker R.N., Learning from Failures, Deficiencies in Design, Construction and Service, - R&D Centre (SDCPL), RaikarBhavan, Bombay.
5. Repair & Rehabilitation, Compilation from The Indian Concrete Journal, - ACC - RCD Publication.
6. Health Monitoring of Structures- A Proactive strategy - proceedings of the ISTE sponsored short course, organized by the Department of Civil Engineering, S.R.M. Engineering College, S.R.M. Nagar.
7. Revision Compbell, Allen and Itarold Roper, Concrete Structures Materials Maintenance and Repair,Longman Scientific and Technical UK.

Allen .R.T and Edwards .S.C, Repair of Concrete Structures, Blakie and Sons, UK.

Class:- F.Y. B. Tech	Semester-I
Course Code : CES 1044	Course Name : Advanced Concrete Technology (PEI)

L	T	P	Credits
3	-	--	3

Course Description:
The Advanced Concrete Technology course focuses on properties of newly developed concrete ingredients such as supplementary cementitious materials, artificial sand, chemical and mineral admixtures etc. The quality control and durability aspects of the concrete are also considered in the course content. The course throws light on various types of special concretes, mix design methods, manufacturing processes, properties in fresh and hardened state. The course aims to give updated information in the field of concrete technology involving modern trends and techniques.

Course Learning Outcomes:
1. Illustrate the micro-structural aspects associated with concrete/concrete ingredients and their effect on concrete quality, strength and durability properties.
2. Design special concretes using existing and new methods of mix design.
3. Explain various types of special concretes, their properties and methods of manufacturing and placing.
4. Describe various special processes and new techniques involved in various concreting jobs.
5. Analyse qualities of fresh and hardened concrete / concrete elements using appropriate destructive or non-destructive testing methods for evaluating quality.
6. Identify and discuss various mechanisms affecting durability of concrete / concrete structures /elements.

Prerequisite:
Fundamental knowledge of basic properties of concrete ingredients is required.

Course Content

Unit No	Description	Hrs
1	**Micro-structural aspects of cement and concrete** Ingredients of concrete, phases in concrete, microstructure of cement paste, microstructure of concrete, microstructure investigation methods, basic properties of concrete, mineral and chemical admixtures, effect of admixtures on concrete properties.	06
2	**Methods of Concrete mix design** Mix design: Review of methods and philosophies of IS, BS and ACI methods, mix design for special purposes, acceptance criteria for compressive strength of concrete. Design of high strength and high-performance concrete, design of self-compacting	06

	concrete. Rheological behaviour of fresh concrete, properties of fresh and hardened concrete.	
3	**Special Concretes** Lightweight concrete, foamed concrete, sulphur concrete and sulphur infiltrated concrete, high strength concrete, high performance concrete, self-compacting concrete, pervious concrete, polymer concrete, fibre-reinforced concrete, refractory concrete, high density and radiation-shielding concrete, geopolymer concrete.	05
4	**Special processes and technology for particular types of structure** Sprayed concrete, underwater concrete, grouts, grouting and grouted concrete, mass concrete, slip form construction, pumped concrete, concrete for liquid retaining structures, vacuum process, concrete coatings and surface treatments.	07
5	**Test methods** Analysis of fresh concrete, accelerated testing methods, tests on hardened concrete, Core cutting and testing, partially destructive testing, and advanced non-destructive testing methods of concrete structures: ground penetration radar, probe penetration, break off maturity method, stress wave propagation method, electrical/magnetic methods, nuclear methods and infrared thermographs.	06
6	**Durability of concrete and concrete construction** Durability concept, permeability of concrete, reinforcement corrosion, fire resistance, frost damage, sulphate attack, alkali silica reaction, delayed ettringite formation, methods of providing durable concrete, short-term tests to assess long-term behaviour.	06

References -

Text Books:

1. M.S. Shetty, Concrete Technology, S. Chand & Company Pvt. Ltd., New Delhi.
2. M. L. Gambhir, Concrete Technology, Tata McGraw-Hill.

Reference Books:

1. P. Kumar Mehta &Paulo J. M. Monteiro, Concrete Microstructure, Properties and Material,McGraw-Hill New York.
2. A. M. Neville, Properties of Concrete, Prentice Hall India Learning Private Limited.
3. Krishna Raju, Design of Concrete Mixes, Prentice Hall India Learning Private Limited.
4. A.R. Santhakumar, Concrete Technology, S. Chand & Company Pvt. Ltd., New Delhi.

Class: **-First Year M. Tech Structural Engineering**	Semester-I
Course Code: **CES 1054**	Course Name: **Design of Advanced Concrete Structures (PE-II)**

L	T	P	Credits
3	**-**	**--**	**3**

Course Description:
The course 'advanced design of concrete structures' mainly focuses on analysis and design of various concrete elements and structures subjected to different types of loads using latest methods of analysis and design. The analysis and design of concrete structures namely bunkers, silos, water tanks, flat slabs, grid floor slabs deep beam etc. forms the core content of the course. The RCC structures exposed to higher temperatures or fire are also considered for analysis and determining their capacity in the event of fire.

Course Outcomes:
1. Analyse the special R.C.C. structures.
2. Design and prepare detail structural drawings.

Prerequisite: The student should possess fundamental knowledge of concrete technology, RCC, earthquake engineering and basic methods of analysis and design of RCC elements and structure.

Course Content

Unit No	Description	Hrs
1.	**Analysis and design of slabs– Yield line theory** Various patterns of yield lines, Assumptions in yield line theory, Equilibrium and virtual work method of analysis, Design of various slabs such as rectangular, circular using yield line theory.	**06**
2.	**Design of Reinforced Concrete Members for Fire Resistance:** Introduction, ISO 834 standard heating conditions, Grading or classifications, Effect of high temperature on steel and concrete, Effect of high temperatures on different types of structural members, Analytical determination of the ultimate bending moment, Capacity of reinforced concrete beams under fire.	**06**
3.	**Analysis and design of deep beam:** Introduction, Assumptions and analysis of deep beam, Design of rectangular beams	**06**
4.	**Analysis and design of flat and grid slabs:** Introduction, Proportioning of flat slabs, Design by direct design method, Analysis and design of rectangular grid floors by Timoshenko's plate theory.	**06**

5.	**Elevated service reservoir** Rectangular and Circular type and flat bottom only, Design of staging for wind and earthquake forces, Effect of joint reactions and continuity.	**06**
6.	**Design of Special structures** Introduction, Design of rectangular and circular bunkers and silos Design of Shear wall.	**06**

Reference Books:

Books:-

1. S.S.Bhavikatti, Advance R.C.C. Design, New Age International Publishers.
2. B.C. Punmia, Ashok K. Jain, Arun K. Jain,Reinforced Concrete Structures–Vol. II,Laxmi Publications.
3. N.C. Sinha and S.K. Roy. S. Chand, Fundamentals of Reinforced Concrete, Co. Ltd, New Delhi.
4. P.C. Varghese,Advanced Reinforced Concrete Design, Prentice Hall of India.
5. Dr. H. J. Shah, Reinforced Concrete design, Charotar Publishing House.
6. Purushothaman P.,Reinforced Concrete Structural Elements, (3rd Edition), Tata McGraw-Hill Publishing.

IS Code:-

1. IS: 456-2000, IS 3370, Indian Standard code of practice, Bureau of Indian Standards, New Delhi.

Class: **First Year M. Tech Structural Engineering**	Semester-**I**
Course Code: **CES 1064**	Course Name: **Design of Industrial Structures (PE-II)**

L	T	P	Credits
3	---	--	3

Course Description:
This covers the design of various industrial structures- gantry girders, portal frames, steel bunkers & silos, chimneys, water tanks and connections.

Course Learning Outcomes:
1. Design the Steel Gantry Girders.
2. Design the Steel Portal, Gable Frames.
3. Design Steel Bunkers and Silos.
4. Design Chimneys and Water Tanks.

Prerequisite:
This course requires the knowledge of structural analysis and design of basic structural elements of steel structures.

Course Content

Unit No	Description	Hrs
1.	**Steel Gantry Girders** – Introduction, loads acting on gantry girder, permissible stress, types of gantry girders and crane rails, crane data, maximum moments and shears, construction detail, design procedure.	06
2.	**Portal Frames** – Design of portal frame with hinge base, design of portal frame with fixed base -Gable Structures – Lightweight Structures.	06
3.	**Steel Bunkers and Silos** – Design of square bunker – Jansen's and Airy's theories – IS Code provisions – Design of side plates – Stiffeners – Hooper – Longitudinal beams Design of cylindrical silo – Side plates – Ring girder – stiffeners.	06
4.	**Chimneys** – Introduction, dimensions of steel stacks, chimney lining, breech openings and access ladder, loading and load combinations, design considerations, stability consideration, design of base plate, design of foundation bolts, design of foundation.	06
5.	**Water Tanks** – Design of rectangular riveted steel water tank – Tee covers – Plates – Stays –Longitudinal and transverse beams –Design of staging – Base plates – Foundation and anchor bolts.	06
6.	**Design of pressed steel water tank** – Design of stays – Joints – Design of hemispherical bottom water tank – side plates – Bottom plates – joints – Ring girder –Design of staging and foundation	06

Reference Book

Books:-

1. Dr. N. Subramanian, Design of Steel Structures, Oxford University Press, New Delhi.
2. K. S. Sai Ram, Design of Steel Structures, Pearson
3. Dr V. L. Shah and Veena Gore, Limit State Design of Steel Structures, Structures Publications
4. M. R. Shiyekar, Limit State Design in Structural Steel, PHI Learning
5. S. K. Duggal, Design of Steel Structures, Tata Mc-Graw Hill publishing company Ltd., New Delhi.
6. Dayaratnam, Design of Steel Structures, Wheeler Publishing, New Delhi.
7. Ram Chandra, Design of Steel StructuresVol.I&Vol.II - Standard Book House, New Delhi.
8. A.S.Arya and J.L.Ajamani, Design of Steel Structures, Nemchand and Bros., Roorkee
9. Vazirani & Ratwani.Design of Steel Structures.
10. B.C.Punmia, Jain & Jain Design of Steel Structures, Laxmi Publication, New Delhi.
11. E.H.Gaylord and C.N., Design of Steel Structures,Gaylord, Mc-Graw Hill, NewYork.
12. J.E.Lothers, Design in Structural Steel Structures, Prentice Hall New Jersy.

Class: **Final Year M. Tech Structural Engineering**	Semester-I
Course Code: **CES 1074**	Course Name: **Design of Formwork(PE-II)**

L	T	P	Credits
3	--	--	3

Course Description:
This course mainly focusses on types and design of falsework required for concrete structures (i.e. formwork). Although cost of formwork contributes significantly to the total reinforced concrete construction cost and formwork failure will result in a very complicated construction problem, formwork design is often neglected and left to the foreman to design. Therefore, in this course emphasis is given on materials used for form work, design of various formworks for regular structural members, design of formwork for special structures, some special formwork systems and failure of formwork.

Course Learning Outcomes:
1. Design the form work for Beams, Slabs, columns, Walls and Foundations.
2. Design the form work for Special Structures.
3. Explain the working of flying formwork.
4. Judge the formwork failures through case studies.

Prerequisite:
Basic knowledge of concrete technology and construction procedures.

Course Content

Unit No	Description	Hrs
1.	**Introduction:** Introduction to formwork system, Requirements of formwork and Factors affecting Selection of Formwork	04
2.	**Formwork Materials** Timber, Plywood, Steel, Aluminium, Plastic, and Accessories. Horizontal and Vertical Formwork Supports.	04
3.	**Formwork Design:** Concepts, Formwork Systems and Design for Foundations, Walls, Columns, Slab and Beams.	08
4.	**Formwork Design for Special Structures**: Shells, Domes, Folded Plates, Overhead Water Tanks, Natural Draft Cooling Tower, Bridges.	08
5.	**Flying Formwork**: Table Form, Tunnel Form, Slip Form, Formwork for Precast Concrete, Formwork	06

	Management Issues –Pre- and Post-Award.	
6.	**Formwork Failures:** Causes and Case studies in Formwork Failure, Formwork Issues in Multi-Story Building Construction.	**06**

References –

Books:-

1. Purify, Formwork for Concrete Structures, McGraw Hill India.
2. Kumar Neeraj Jha, Formwork for Concrete Structures, Tata McGraw Hill Education.

IS Code:-

3. IS 14687: 1999, False work for Concrete Structures - Guidelines, BIS.

SEMSTER - II

Class:- **First Year M. Tech Structural Engineering**	Semester-**II**
Course Code: **CES 1114**	Course Name: **Finite Element Analysis**

L	T	P	Credits
3	-	--	3

Course Outcomes:
At the end of the course, students will be able to
1. Analyse structure using finite element method.
2. Solve continuum problems using finite element analysis.
3. Execute the Finite Element Program/ Software.

Course Content

Unit No	Description	Hrs
1.	**Introduction:** Principle of minimum potential energy, finite element procedure. discretization, nodes, element incidence, displacement model, application to springs, bars with constant and variable cross sections subjected to axial forces, nodal equilibrium equations, assembly of global stiffness	06
2.	**2D problems:** Development of element stiffness matrix and nodal load vector for truss, beam and plane frame elements, transformation of matrices, relevant structural engineering applications	06
3.	**3D problems:** Pascal's triangle, Convergence requirements and compatibility conditions, element aspect ratio, half band width, development of element stiffness matrix and nodal load vector for tetrahedron, hexahedral elements	06
4.	**Application to Solid Mechanics:** Plane Stress, CST element, plane strain rectangular element, Shape function, Natural coordinate systems, Isoperimetric formulation, 1D & 2D isoperimetric elements, axis-symmetric elements	06
5.	**Plate and Shell Elements:** Formation of stiffness matrix for plate bending elements of triangular and quadrilateral shapes, types of shells elements, formation of stiffness matrix for cylindrical thin shell element	06
6.	**puter Implementation:** FEM procedure, Pre-processing, solution, post-processing, use of commercial FEA software, Result interpretation	06

Reference
Books:

1. O.C. Zienkiewicz & R.L. Taylor, The Finite Element Method Vol. I & II, Tata McGraw Hill.
2. J.N. Reddy, An introduction to the Finite Element Method, Tata McGraw Hill Pub.
3. R. D. Cook, Concept and Application of Finite Element Analysis, John Wiley & sons.
4. Hutton D.V, Fundamentals of Finite Element Analysis, Tata McGraw Hill Pub.
5. C. S. Desai & J. F. Abel, Introduction to the Finite Element Method, CBS Pub.
6. C. S. Krishnamoorthy, Programming in the Finite Element Method, Tata McGraw Hill.
7. T. R. Chandrupatla and Belegundu, Introduction to the Finite Element in Engineering, Prentice Hall of India, pvt.ltd.
8. Bathe K.J., Finite Element Procedures, PHI learning pvt.ltd.
9. Y.M. Desai, T.I Eldho, Finite Element Method with application in Engineering, Pearson,Delhi.
10. Seshu P., Finite Element Analysis, Prentice-Hall of India.
11. Buchanan G.R., Finite Element Analysis, McGraw Hill Publications, New York.

Class: **First Year M. Tech. Structural Engineering**	Semester: **II**
Course Code: **CES 1124**	Course Name: **Advanced Solid Mechanics**

L	T	P	Credits
3	---	--	3

Course Description:
It consists of study of stress, strain and displacement of deformable bodies and relationship between them. Also, torsion of solid non-circular cross sections and thin tubes is included in this course. Plasticity, yield criteria and elasto-plastic loading for beams and thick cylinders are also studied in this course.

Course Learning Outcomes
At the end of the course, students will be able to
1. Analyse bodies for stresses and strains.
2. Analyse prismatic bars and tubes subjected to torsion.
3. Analyse beams and thick cylinders for elasto-plastic loading.

Prerequisite: This course requires the knowledge of basic mathematics and structural analysis.

Unit No.	Description	Hrs
1	**Stress** Basic concepts of continuum, concept of stress, equilibrium equations, stress on oblique plane, stress transformation, principal stresses, stress invariants, deviatoric stresses, maximum shear stress, octahedral stresses, plane stress.	06
2	**Strain** Strain at a point, concept of strain, strain components, compatibility equations, strain transformation, principal strains, strain invariants, deviatoric strains, maximum shear strain, octahedral strains, plane strain.	06
3	**Stress-strain relations** Generalized Hooke's law, stress strain relationship for isotropic material, strain displacement and compatibility relations, Airy's stress function and its applications.	06
4	**Torsion** Torsion of Prismatic Bars: Saint Venant's method, Prandtl's membrane analogy, torsion of elliptical, triangular and rectangular bar, torsion of thin tubes.	06
5	**Plasticity** Strain Hardening, Idealized Stress- Strain curve, yield criteria, vonMises yield criterion, Tresca yield criterion, plastic stress-strain relations, principle of normality and plastic potential, isotropic hardening.	06
	Elasto-Plastic loading	06

6	Beams under elasto-plastic condition, collapse load, plastic hinge, elasto-plastic deflections of beams of rectangular cross sections, residual stresses, thick- walled cylinders.	

References:

Books:-

1. S.P. Timoshenko & J. N. Goodier, Theory of Elasticity, McGraw Hill International Editions.
2. Sadhu Singh, Theory of Elasticity, Khanna Publishers.
3. Sadhu Singh, Theory of plasticity, Khanna Publishers.
4. S. M. A. Kazimi, Solid Mechanics, Tata McGraw Publishing Company Limited.
4. L.S. Srinath, Advanced Mechanics of Solids, McGraw Publishing Company Limited.
5. Continuum Mechanics by Valiappan, Mc. GrawHill.

Class: **-First Year M. Tech. Structural Engineering**	Semester-**II**
Course Code: **CES 1184**	Course Name: **Research Methodology & Intellectual Property Rights(IPR)**

L	T	P	Credits
1	1	--	2

Course Description:
The research methodology is the specification of method of acquiring the information needed to solve the problem. This course explains the scope, research design, data collection, sampling technique; methods followed in carrying out the research, the techniques used and the limitations of the studyand make effective use of computers and computing tools to search information, analysis of information and prepare technical report. Intellectual Property Rights (IPR) includes industrial properties, patents or inventions, trademarks, trade names, biodiversity, plant breeding rights and other commercial interests. Also it includes a process to file the patents, right to use the Intellectual Property for the purposes of making money from the invention.

Course Learning Outcomes:
1. Formulate a research problem.
2. Analyse research related information.
3. Prepare and present research proposal/paper by following research ethics.
4. Make effective use of computing tools to analyse the data and prepare report.
5. Describe nature and processes involved in development of intellectual property rights.

Course Content

Unit No.	Description	Hrs
1.	Meaning of Research, Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem, Types of Research, Research Process, Problem definition, Objectives of Research, Research Questions, Research design, Approaches to Research, Quantitative vs. Qualitative Approach, Understanding Theory, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs Theoretical Research, Importance of reasoning in research.	06
2.	Effective literature studies approach, Research ethics, Plagiarism, Development of Hypothesis, Approaches of investigation of solutions for research problem, Data/Variable Types & Classification, Data collection, Data analysis with software, interpretation, Numerical and Graphical Data Analysis: Sampling,	06

	Observation, Surveys Necessary instrumentations, Validity of experiments.	
3.	Effective technical writing, how to write technical report and paper, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents, Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	**06**
4.	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. Procedure for grants of patents, Patenting under PCT, Patent Rights: Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Administration of Patent System, New developments in IPR; IPR of Biological Systems, Computer Software etc., Traditional knowledge Case Studies,	**06**

Note - Contact hrs are considered with tutorials hrs.*

References –

Text Books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to
2. Research Methodology, RBSA Publishers.
3. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age
4. International. 418p.
5. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess.
6. Publications. 2 volumes.
7. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.

Reference Books

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students", Juta & Co Ltd, 2012.
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction", Juta Academic, 2016
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners", SAGE Publication 2014
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebe, "Product Design", McGraw Hill, 1974.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", Wolters Kluwar,2016.
8. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Class: **-First Year M. Tech. Structural Engineering**	Semester-**II**
Course Code: **CES 1194**	Course Name: **Structural Design Lab - II**

L	T	P	Credits
-	-	4	2

Course Description:
This laboratory course is mainly focused on analysis and design of concrete structures using standard software packages like STAAD- Pro, ETABS and SAP etc. Students are expected to design various steel structures and prepare drawing of the same.

Course Learning Outcomes:
1. Analyse and design of the RCC structures such as building, retaining wall, flat slab and foundations using standard software packages.
2. Interpret the results of analysis and design obtained from the software.
3. Prepare drawings of detailing of structural elements.

Course Content

Unit No	Description	Hrs
1.	Analysis and design RCC building.	8
2.	Structural drawing of RCC building.	8
3.	Analysis and design of RCC retaining wall.	8
4.	Analysis and design of flat slab.	8
5.	Analysis and design of water tank.	8
6.	Analysis and design of foundation.	8

References –

Books:-

1. Sinha and Roy, Fundamentals of Reinforced Concrete, 3rd Edition, S. Chand and Company Ltd, New Delhi.
   A. K. Jain, Reinforced Concrete Design.
2. Karve and Shah, Limit State Theory and Design, Structures Publications, Pune.
3. P. C. Varghese, Limit State Design of Reinforced Concrete, 2nd Edition, Prentice Hall of India, New Delhi.

IS Codes:-

1. IS: 456-2000
2. IS:3370- 1 to 4- Code of Practice for concrete structures for the storage of liquids.

Class: **-First Year MTech. Structural Engineering**	Semester-**II**		**L**	**T**	**P**	**Credits**
Course Code: **CES 1204**	Course Name: **Structural Dynamics and Earthquake Engineering Lab**		**-**	**-**	**2**	**1**

Course Description:
This lab focuses on study of behaviour of single and multi-storied structures under dynamic loads. The responses are measured with help of measuring instruments. This laboratory develops skills among the students such as leadership, lifelong learning skills and applications of fundamentals of vibrations for calculation of responses.

Course Learning Outcomes:
1. Examine damping effect on beam model T6.
2. Perform testing of various models of structures for dynamic loading.

Course Content		
Experiment No.	**Description**	**Lab Hrs**
1.	Dynamics of a three storied building frame subjected to harmonics base motion.	**4**
2.	Dynamics of a vibration absorber.	4
3.	Dynamics of one-span and two-span beams.	4
4.	Earthquake induced waves in rectangular water tanks.	4
5.	Dynamics of a one-storied building frame with planar asymmetry subjected to harmonic base motions.	4
6.	Vibration isolation of a secondary system.	4

References -
1.MadhujitMukophadhyay,Structural Dynamics: Vibrations and Systems, ANE Books.
2. Chopra A. K., Structural Dynamics and Introduction of Earthquake Engineering,
3. Mario Paz, Structural Dynamics: Theory and Computation, CBS Publisher.

Class: **First Year M. Tech. Structural Engineering**	Semester- **II**
Course Code: **CES 1214**	Course Name: **Mini Project II**

L	T	P	Credits
-	-	4	02

Laboratory Work (Mini Project):
Mini project shall be delivered on one of the advanced topics chosen in consultation with the supervisor, based on dissertation work/ societal problem / special structure. The students should apply any tool such as software, mathematical method, and development of programming, experimental method for solving selected problem. Here parametric study is not expected. Some lifelong learning abilities should be developed. A hard copy of the report (25 to 30 pages A4 size, 12 fonts, Times New Roman, single spacing single side printed, preferably in TRM format) should be submitted to the Department Post Graduate Committee (DPGC) before delivering the seminar. A copy of the report in soft form must be submitted to the supervisor, along with other details, if any. Minimum 03 presentations should be delivered by the students.

Course Outcomes:

1. Identify research problem.
2. Prepare and present statement of Purpose.
3. Perform analysis work.
4. Communicate with outside agencies.
5. Write report and Present the work carried out.
6. Develop self-learning ability.

Class:- **First Year M. Tech Structural Engineering**	Semester-II
Course Code: **CES 1134**	Course Name: **Advanced Earthquake Engineering (PE III)**

L	T	P	Credits
3	---	--	3

Course Description:
Advanced Earthquake Engineering is offered as a program elective course at the second semester of Civil Structural Engineering postgraduate programme. This course focuses on earthquake resistant to masonry structures, conceptual design of earthquake resistant structures, principles of planning, and strong column weak beam concept. This course also focuses on ductile detailing of elements, IS Code provisions for ductility of structures and water tanks. This course also focuses on vibration control methods.
This theoretical knowledge will help to student for studying behaviour of structures under earthquake loading and design structures for EQ Loads.

Course Learning Outcomes:
1. Design RCC structural elements for ductility requirements as per IS 13920 2016.
2. Apply clauses given in IS codes to design of water tanks for earthquake force.
3. Apply new techniques for controlling the vibrations of the structures.
4. Evaluate natural frequency of continuous elements/systems.
5. Apply IS code clauses masonry structures for improving resistance to earthquake forces.

Prerequisite:
As a prerequisite to study this course, the students must possess the knowledge of Fundamentals of vibration, natural frequency, resonance condition, mode shapes.

Course Content

Unit No	Description	Hrs
1.	**Masonry Buildings** Introduction-Elastic properties of masonry assemblage- Categories of masonry buildings- Behaviour of unreinforced and reinforced masonry walls- Behaviour of walls- Box action and bands- Behaviour of infill walls- Improving seismic behaviour of masonry buildings- Load combinations and permissible stresses- seismic design requirements- Lateral load analysis of masonry buildings. **Structural Walls and Non-structural Elements:** strategies in the location of structural walls- sectional shape+ variations in elevation- cantilever walls without openings- Failure mechanism of non-structures- Effects of non-structural elements on structural system- Analysis of non- structural elements- prevention of non-structural damage.	06

2.	**Ductility considerations in Earthquake Resistant Design of RC Buildings** Introduction- Impact of Ductility, Requirements for Ductility, Assessment of ductility, Factors-affecting Ductility, Ductile detailing considerations as per IS 13920 2016. Behaviour of beams, columns and joints in RC buildings during earthquakes- Vulnerability of open ground storey and short columns during earthquakes. Case studies.	**06**
3.	**New Techniques in Seismic Design** Cyclic loading behaviour of RC C and pre-stressed concrete elements, modern concepts, base isolation, dampers, Adoptive systems, case studies, Field visit.	**06**
4.	**Water Tank** Seismic design of Elevated RC Circular Water Tanks. Ductility requirements, types of ductility, factors affecting ductility. IS code provisions.	**06**
5.	**Continuous systems** Flexural vibration of beams, simply supported and cantilever beams, Longitudinal vibrations of bars, Longitudinal waves in bars, Waves and vibration response of simply supported beams under uniformly distributed triangular pulse loading, Matrix formulation of beams with lumped masses.	**06**
6.	**Special Topics in Structural Dynamics** Dynamic effects of wind loads, moving loads, Vibration caused by traffic, blasting and pile driving. Vibration control by applying new techniques such as Tuned mass Dampers.	**06**

References -

Text Books:

1. P. Agarwal & M. Shrikhande, Earthquake Resistant Design of Structures, Prentice Hall Publications.
2. Jai Krisna, A. R. Chandrashekharan, Elements of earthquake Engineering, Chandra, South Asian Publishers Private Limited.
3. A. K. Mallick, Principles of Vibration Control.
4. Mario Paz, Structural Dynamics, CBS publications, New Delhi.
5. Vinod Hosur Earthquake Resistant Structures.

Reference Books:

1. Madhujit Mukophadhyay, "Structural Dynamics Vibrations and Systems", Publisher: ANE Books ISBN: 9788180520907, 8180520900 Edition: 01, 2008.
2. R,W. Clough and J.Penzien, McGraw ,Dynamics of Structures, Hill Education.
3. Willaim Thomson, Theory of Vibration with applications, CRC Press.
4. I. S. 1893 2016, Criteria for Earthquake Resistant Design of Structures. Part I & II.
5. IS 13920 2016, Ductile Detailing of RCC Structures.

IS Codes:-

1. IS 4326:
2. IS 13828:
3. IS 13827:

Class: **F.Y.M. Tech. Structural Engineering**	Semester: **II**
Course Code: **CES 114**	Course Name: **Composite Structures (PE-III)**

L	T	P	Credits
3	--	--	3

Course Description:
Composite structures is offered as program elective course ay the second semester of Civil Structural engineering post graduate program. This course focuses on design of composite structure includes the Composite Floors, Composite Beams and Composite Columns used individually or in varying combinations to make the design cost-effective and efficient to the desired performance and service requirements as this is fast gaining acceptance in the non-residential multi-storey building sector of India. Its success is mainly due to the strength and stiffness achieved, with minimum use of materials which can be exploited to create a highly efficient and lightweight design.

Course Learning Outcomes:
1. Design composite structural elements like beams, columns, floors, trusses.
2. Design of Multi-storeyed commercial and residential composite building.
3. Design composite girder bridges.

Prerequisite:
Fundamental knowledge of design of structural elements

Course Content

Unit No	Description	Hrs
1.	**Introduction:** Introduction of composite structures, benefits of composite structures, Introduction to IS, BS and Euro codal provisions. **Composite beams:** elastic behavior of composite beams, Shear Connectors, Ultimate load behavior, Serviceability limits, Effective breadth of flange, Interaction between shear and moment, Basic design consideration and design of composite beams.	**06**
2.	**Composite Floors:** Structural elements, Profiled sheet decking, Bending resistance, Serviceability criterion, Analysis for internal forces and moments	**06**
3.	**Composite Columns:** Composite Column design, Fire Resistance. Encased columns, partially encased columns, Materials, Concrete filled circular tubular sections, local buckling of steel sections, Effective elastic flexible stiffness, resistance of members to axial compressions,	**06**

4.	**Composite Trusses:** Design of truss, Configuration, Application range, Analysis and Design aspects	**06**
5.	**Composite Frames:** Design of Multi-storeyed commercial and residential composite building, Design basis, load calculations.	**06**
6.	**Design of Composite Construction in Bridges:** IRC specifications and code of practice for loads and composite construction. Composite Deck Slab Design of Cantilever Portion of deck Slab. Design of longitudinal girders.	**06**

References -

Reference Books:

1. Johnson R. P., "Composite Structures of Steel and Concrete", Vol I, Beams, Columns and Frames in Buildings, Oxford Blackwell Scientific Publications. (Third Edition) U.K. 2004.
2. Owens .G.W, & Knowels.P. "Steel Designs Manual", (sixth Edition) Steel Concrete Institute (UK) Oxford Black; well Scientific Publications, 2003.
3. IS:11384, 1985 Code of Practice for Composite Construction in Structural Steel and Concrete, Bureau of Indian Standards, New Delhi.
4. INSDAG teaching resources for structural steel design Vol II, Institute for Steel Development and Growth Publishers, Calcutta
5. INSDAG Handbook on Composite Construction: Multi-Storey Buildings, Institute for Steel Development and Growth Publishers, Calcutta
6. INSDAG Design of Composite Truss for Building, Institute for Steel Development and Growth Publishers, Calcutta
7. INSDAG Handbook on Composite Construction: Bridges and Flyovers, Institute for Steel Development and Growth Publishers, Calcutta

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Class: -**First Year M. Tech Structural Engineering**	Semester-**II**
Course Code: **CES 1144**	Course Name: **Structural Optimization (PE-III)**

L	T	P	Credits
3	**-**	**--**	**3**

Course Description:
Structural optimization can be defined as the process of finding the optimal parameters, which yield maximum or minimum value of an objective function, subject to certain set of specified requirements called constraints. Such problem of optimization is known as constrained optimization problems or nonlinear programming problems. Most design optimization problems in structural engineering are highly nonlinear, involving mixed (discrete and continuous) design variables under complex constraints, which cannot be solved by traditional calculus - based methods and enumerative strategies.

Course Learning Outcomes:
1. Use variational principle for optimization.
2. Apply optimization techniques to structural steel and concrete members.
3. Design using frequency constraint.

Prerequisite: Reinforced Concrete Structures, Design of Steel Structures.

Course Content

Unit No	Description	Hrs
1.	**Introduction:** Simultaneous Failure Mode and Design, Classical External Problems.	**06**
2.	**Calculus** of Variation: Variational Principles with Constraints.	**06**
3.	**Linear Programming,** Integer Programming, Nonlinear Programming, Dynamic Programming.	**06**
4.	**Geometric** Programming **and** Stochastic Programming.	**06**
5.	**Applications:** Structural Steel and Concrete Members, Trusses and Frames.	**06**
6.	**Design:** Frequency Constraint, Design of Layouts.	**06**

Reference Books:
1.Haftka, Raphael T., Gurdal, Zafer, Elements of Structural Optimization, Springer.
2.Cherkaev Andrej, Variational methods for Structural optimization, Springer.

Class: -**First Year M. Tech Structural Engineering**	Semester-**II**
Course Code: **CES 1154**	Course Name: **Design of Bridges and Flyovers (PE-IV)**

L	T	P	Credits
3	**-**	**--**	**3**

Course Description:
This course in Bridge engineering generally introduces the fundamental concepts, principles and application of superstructure and substructure analysis and design for the undergraduate students of civil engineering. This course "Design of bridges" goes deeper into the various aspects of Bridge engineering along with bringing out the advanced theories and practical knowledge of Bridge engineering. Each topic will be developed in logical progression with up-to-date information with reference to codal provisions and journals. The topics cover overall analysis of Bridge engineering including Design of super-structure, sub-structure, foundation, and hydrological properties along with details of other bridge components of Reinforced Concrete structures.

Course Learning Outcomes:
1. Study various components and loadings on bridge.
2. Analyse and design of super-structure of various bridges and flyovers.
3. Analyse and design of sub-structure of various bridges and flyovers.

Course Content

Unit No	Description	Hrs
1.	**Introduction** Introduction, types, geometric design parameters, loading standards.	**06**
2.	**Design of slab and girders of bridges** Design of deck slab, slab culvert, box culvert, longitudinal and cross girders.	**06**
3.	**Theory of bridges** Pieguads and Courbon's theory, design problem.	**06**
4.	**Multi-span bridges and flyovers** Analysis and Design of Multi-span bridges, flyovers.	**06**
5.	**Foundation design** Design of bridge foundation, piers, abutments, wing walls.	**06**
6.	**Bearing and joints** Design of various joints, bearings for various types of bridges.	**06**

Reference:-

Books:

1. Dr.V.K.Raina, Concrete Bridge Practice, Tata McGraw Hill. Delhi.
2. Dr.B.C.Punmia, Ashok Kumar Jain, Arun Kumar Jain, "Reinforced Concrete Structures", Vol. II Laxmi Publications.
3. Jagadish & Jayaram, "Design of Concrete Bridges", Tata McGraw Hill.
4. Victor, "Design of Concrete Bridges", Tata McGraw Hill.

Class: **First Year M. Tech Structural Engineering**	Semester-**II**
Course Code: **CES 1164**	Course Name: **Design of Pre-stress Concrete Structures(PE-IV)**

L	T	P	Credits
3	**-**	**--**	**3**

Course Learning Outcomes:

1. Explain the concept of pre-stressing, behaviour of the pre-stressed structures vis-à-vis that of the RCC structure.
2. Choose the decision with respect to the choice of pre-stressed section over RCC.
3. Describe the application of these techniques in civil engineering construction.
4. Analyze the various pre-stressed components of the structures and design the same.
5. Design the various pre-stressed components of the structures and design the same.

Prerequisite: Reinforced Concrete Structures, Strength of materials, Concrete Technology.

Course Content

Unit No	Description	Hrs
1.	Mechanics of Pre-stressed concrete, Advantages of pre-stressed concrete, High strength materials- concrete and steel, Classification and types of pre-stressing, Stress concept, Strength concept and Load balancing concept	**06**
2.	Introduction to losses of pre-stress, Loss due to elastic deformation of concrete, shrinkage of concrete, creep of concrete, relaxation of stress in steel, friction and anchorage slip. Pre-tensioning and Post-tensioning losses, immediate and time dependent losses, systems of pre-stressing.	**06**
3.	Analysis and design of pre-stress concrete beams, box, T and I Sections, shear, deflection, I.S. recommendations for quality of materials, pre-stressing steel, pre-stressing equipment and design. Design of end block by IS code method.	**06**
4.	Analysis and Design of continuous beams, linear transformation and concordant cable profile.	**06**
5.	Analysis and design of cylindrical structures in pre-stressed concrete- pipes and tanks.	**06**
6.	Composite construction, behaviour, I.S. recommendations for composite action, differential shrinkage and creep, deflection and flange width of composite beams, Analysis and design of composite beam, and shrinkage stresses.	**06**

References -

Text Books:

1. N. Rajaopalan, Prestressed Concrete, Alpha Science International Ltd.
2. Sinha. N.C. and Roy. S.K., Fundamentals of Prestressed Concrete, S. Chand & Company Pvt. Ltd., New Delhi.

Reference Books:

1. Lin, T.Y. and Burns, N.H,John Wiley and Sons, Design of Prestressed Concrete Structures.
2. S. Ramamrutham, Design of Reinforced Concrete Structures, DhanpatRai Publishing Company.
3. Krishna Raju, Prestressed Concrete, McGraw Hill Education.

Class: **-First Year M. Tech Structural Engineering**	Semester-II	L	T	P	Credits
Course Code: **CES 1174**	Course Name: **Theory of Thin Plates and Shells (PE-III)**	**3**	**-**	**--**	**3**

Course Description:
This course, deals with the theory of plate and shell structures, using the membrane and bending theories for various types of shells and their applications. In this course, thin plate will be analysed by Classical Plate Theory Bending Buckling problems will be discussed for Plates.

Course Outcomes:
1. Analyse various problems using different theories based on plates and shells.
2. Derive equilibrium equations related with different theories of plates and shells.

Prerequisite: Theory of Structural Analysis.

Course Content

Unit No	Description	Hrs
1.	**Fundamental concepts of plate analysis** Elasticity approach to solution, Stress, Strain, Plane Stress and Strain, Constitutive relationships, Equilibrium Equations	**06**
2.	**Classical plate theory** Assumptions, boundary conditions, Stress Resultants, General Equations	**06**
3.	**Analysis of plate by Navier's method** Simply supported plates and various boundary and loading conditions. Problems.	**06**
4.	**Analysis of plate by Levy's method** Simply supported plates and various boundary and loading conditions. Problems	**06**
5.	**Membrane theory of Shells** Introduction, Types of theories, membrane theory of cylindrical Shell equilibrium equations, limitations, problems	**06**
6.	**Bending theory of Shells** Equilibrium equation , Bending theory , synclastic and anticlastic shell, problems on bending theory	**06**

Reference:-

Books:

1. Timoshenko, S., Theory of plates and shells, McGraw Hills Book Comp.
2. Chandrashekhar K, Theory of Plates, Universities Press (India).
3. Chandrashekhar K, Analysis of Thin Concrete Shells, New Age International (P) Ltd.
4. Ramaswamy, Design of concrete shell, roofs CBS publishers and distributors New Delhi.
5. Reddy, J. N., Theory and analysis of elastic plates and shells,Taylor& Francis.

SEMSTER - III

Class: **S.Y.M. Tech. Structural Engineering**	Semester- **III**
Course Code:**CES2014**	Course Name: **Industry Internship**

L	T	P	Credits
-	-	2	**Audit**

Field Work:
In the field training work, the student is expected to get training in the industry related to structural engineering for duration of 4 weeks for at least 6 hours per day. Student should work as an employer of the organization. He should learn work culture and latest development in structural engineering. Student should write a report on the field training and submit to department for ISE evaluation at the beginning of third semester. Student should include the certificate from company regarding satisfactory completion of the field training.

Course Outcomes:

1. Identify training area.
2. Prepare on site work report of training.
3. Perform analysis work.
4. Communicate with agencies.
5. Generate report and Present the work carried out.

Class:- **Second Year M. Tech**	Semester- **III**
Course Code : **MOE2010**	Course Name : **Artificial Intelligence - Machine Learning**

L	T	P	Credits
3		--	3

Course Description:
Machine learning is a part of Artificial Intelligence. It uses interdisciplinary techniques such as statistics, linear algebra, optimization, and computer science to create automated systems that can sift through large volumes of data at high speed to make predictions or decisions without human intervention. Machine learning as a field is now incredibly pervasive, with applications spanning from business intelligence to homeland security, from analyzing biochemical interactions to structural monitoring of aging bridges, and from emissions to astrophysics, etc. This class will familiarize students with a broad cross-section of models and algorithms for machine learning, and prepare students for research or industry application of machine learning techniques.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Describe central machine learning methods and techniques and how they relate to artificial intelligence
2. Differentiate between supervised and unsupervised learning techniques
3. Apply the ML algorithms to a real-world problem,
4. Optimize the models learned and report on the expected accuracy that can be achieved by applying the models.
1. Evaluate a given problem and apply appropriate machine learning technique

Prerequisite:
Statistics, linear algebra, optimization techniques, programming language

Course Content

Unit No	Description	Hrs
1.	**Introduction to Artificial Intelligence and Machine learning:** Introduction: What Is AI and ML? Examples of AI and ML, Applications, Supervised Learning, Un-Supervised Learning and Reinforcement Learning, Important Elements of Machine Learning- Data formats, Learnability, Statistical learning approaches, Elements of information theory	06
2.	**Feature Selection:** Scikit- Learn Dataset, Creating training and test sets, managing categorical data, Managing missing features, Data scaling and normalization, Feature selection and Filtering, Principle Component	06

	Analysis(PCA)- non-negative matrix factorization, Sparse PCA, Kernel PCA. Atom Extraction and Dictionary Learning.	
3	**Regression:** Linear regression- Linear models, A bi-dimensional example, Linear Regression and higher dimensionality, Polynomial regression, Logistic regression-Linear classification, Logistic regression, Implementation and Optimizations, Stochastic gradient descendent algorithms	06
4	**Naïve Bayes and Support Vector Machine:** Bayes Theorom, Naïve Bayes Classifiers, Naïve Bayes in Scikit- learn- Bernoulli Naïve Bayes, Multinomial Naïve Bayes, and Gaussian Naïve Bayes. **Support Vector Machine(SVM)-** Linear Support Vector Machines, Scikit-learn implementation, Linear Classification, Kernel based classification, Non- linear Examples. Controlled Support Vector Machines, Support Vector Regression.	06
5	**Decision Trees and Ensemble Learning:** Decision Trees- Impurity measures, Feature Importance. Decision Tree Classification with Scikit learn, Ensemble Learning-Random Forest, AdaBoost, Gradient Tree Boosting, Voting Classifier. Clustering Fundamentals- Basics, K-means: Finding optimal number of clusters, DBSCAN, Spectral Clustering. Evaluation methods based on Ground Truth- Homogeneity, Completeness, Adjusted Rand Index.	04
6	**Clustering Techniques:** Hierarchical Clustering, Expectation maximization clustering, Agglomerative Clustering Dendrograms, Agglomerative clustering in Scikit- learn, Connectivity Constraints. Introduction to Recommendation Systems- Naïve User based systems, Content based Systems, Model free collaborative filtering-singular value decomposition, alternating least squares.	08

`Reference Books:

1. Ethem Alpaydin, Introduction to Machine Learning, PHI .
2. Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press.

Text Books:

1. Giuseppe Bonaccorso, Machine Learning Algorithms, Packt Publishing Limited.
2. Josh Patterson, Adam Gibson, Deep Learning: A Practitioners Approach, O"REILLY, SPD.

Class:- **Second Year M. Tech.**	Semester-**III**
Course Code : **MOE2020**	Course Name : **Creative Thinking: Tools & Techniques**

L	T	P	Credits
3	--	--	3

Course Description:
In today's ever-growing and changing world, being able to think creatively and innovatively are essential skills. It can sometimes be challenging to step back and reflect in an environment which is fast paced or when students required to assimilate large amounts of information. Making sense of or communicating new ideas in an innovative and engaging way, approaching problems from fresh angles, and producing novel solutions are all traits which are highly sought after by employers. This course will equip with a 'tool-box', introducing to a selection of behaviours and techniques that will augment innate creativity. Some of the tools are suited to use on own and others work well for a group, enabling you to leverage the power of several minds. People can pick and choose which of these tools or techniques suit needs and interests, focusing on some or all of the selected approaches and in the order that fits best.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Comprehend importance in tackling global challenges as well as in everyday problem-solving scenarios
2. Apply different brainstorming techniques in group activities
3. Be proficient in the application of the 6 thinking hats tool in different life scenarios
4. Develop a systematic approach to idea generation through the use of morphological analysis
5. Innovate on an existing product, service or situation applying the SCAMPER method
6. Get confident with the theory of inventive problem solving, called TRIZ
7. Select and apply the appropriate technique based on the opportunity to seize or the problem to tackle

Prerequisite:
There are no prerequisites to this online Creative Thinking course.

Course Content

Unit No	Description	Hrs
1.	**Introduction to the Principles of Creativity:** Basic principles of creativity and highlight its importance in tackling global challenges. Creativity is explored and applied at two different levels, lower and higher-level	06

	creativity	
2.	**Creativity Tools:** Augment our creativity using different methods of Brainstorming, a creativity approach that aids the generation of ideas in solving a stated problem. Particularly focus on the application of brainstorming tools in group activities, with the aim of enabling to understand, evaluate and apply different types of brainstorming techniques in own context.	06
3.	**Six Thinking Hats:** Principles as well as application of the 6 Hats thinking tool both at an individual level and in a group, under various professional and personal situations, allowing students to develop competency and accelerate proficiency on the use of technique.	06
4.	**Clarifying the Problem:** Organizing a process, turning problems into opportunities, facts, feelings & hunches, problem as question.	06
5.	**Generating Ideas:** Brainstorming, scamper, forced connections, portable think tank, case studies on generating ideas.	06
6.	**Developing Ideas & Planning for action:** Organizing ideas, ideas to solutions, implementing solutions, case studies of development of ideas and plan of action.	06

References –

Text Books:

1. Thinker toys. A Handbook of Creative-Thinking Techniques, Ten Speed Press.
2. Michael Michalko. Cracking Creativity: The Secrets of Creative Genius. Ten Speed Press.
3. Edward de Bono. Lateral Thinking: A Textbook of Creativity.Penguin.
4. Edward de Bono. Six Thinking Hats. Penguin.

Reference Books:

1. Creative Thinkering: Putting Your Imagination to Work, New World Library.
2. Chris Griffiths, Kogan. The Creative Thinking Handbook: Your Step by Step Guide to Problem Solving in Business.

K.E. Society's
Rajarambapu Institute of Technology, Sakharale
(An Autonomous Institute, Affiliated to Shivaji University, Kolhapur)
Syllabus (Theory Courses)
To be implemented for 2020-22 Batch
Department of Civil Engineering
Rev: CES Course Structure/RIT/04/2020-22

Class: - **Second Year M. Tech.**	Semester-**III**
Course Code : **MOE2030**	Course Name : **MOOC Course**

L	T	P	Credits
3	-	-	3

Online Certification Course:
1. Student should select any one course floated by NPTEL related to their dissertation topic in consultation with supervisor.
2. Student should report and maintain file of weekly submission as per assignments given by NPTEL.
3. Student should attach weekly grade sheet in the hard copy form to weekly submission file.
4. Final written exam is compulsory to all and it will be scheduled by NPTEL.
5. Submit the final grade sheet with course completion certificate.
6. The final grades will be given based on grades offered by NPTEL and file submission.

Course Outcomes:
1. Develop technical competence in skills of structural engineering field.
2. Apply the techniques for structural engineering practice.
3. Develop oral and written presentation skills for structural engineering projects.
4. Design and interpret data for structural engineering projects.

Description:
1. If student completes the MOOC course such as NPTEL/SWAYAM etc. it will be considered with valid certificate from respective authorised agency along with internal oral examination. Student needs complete online/certification course approved by DPGC and produce certificate of online or certification course at the time of ESE. if student fails to produce this certificate, he or she will not be eligible to give ESE of Online/certification course.
2. If student completes certificate course such as C++/JAVA/PYTHON/VB, then supervisor has to conduct in semester evaluation and submit marks to COE.

 # Note:
Topic should be selected based on relevance to societal needs, value addition to existing facilities in the institute, industry need, problems of national importance, research and development in structural engineering. The student should complete the following:

- Comprehensive Literature survey based on papers published in standard journals.
- Gap Analysis.
- Problem Identification.
- Define dissertation objectives.
- Complete Preliminary design with feasibility analysis.
- Implementation and Validation of models.
- Prepare report and give presentation.

Class:- **Second Year M. Tech**	Semester-**III**
Course Code : **MOE2040**	Course Name : **Condition Monitoring and Signal Processing**

L	T	P	Credits
3	--	--	3

Course Description:
The subject of condition monitoring and signal processing has been recently receiving considerable attention in India owing to concerns related to equipment reliability and safety. This increasing interest is primarily due to the significant impact of economic changes and strong competition in the global market. This course will provide students with the state of the art techniques in condition monitoring along with the recent developments in the field of signal processing, thermography, ultrasonics apart from the traditional noise and vibration monitoring. There will be demonstration of real-time machinery health monitoring by various condition monitoring aspects.

Course Learning Outcomes:
After successful completion of the course, students will be able to,

1. Identify the maintenance scheme, their scope and limitations – apply the maintenance strategies to various problems in the industrial sectors.
2. Analyze for machinery condition monitoring and explain how this compliments monitoring the condition.
3. Develop an appreciation for the need of modern technological approach for plant maintenance to reduce the maintenance expenditure.
4. Emphasizes on case studies that require gathering information using the modern testing equipment and processing it to identify the malfunction in that system.
5. Identify vibration measurement, lubrication oil analysis.

Prerequisite: Mechanical Vibration

Course Content

Unit No	Description	Hrs
1.	**Introduction:** Introduction to condition based maintenance, application and economic benefits. Typical defects in gears and rolling element bearings Vibrations of Gears and Bearings, Vibration characteristics of non-defective gears; Vibration characteristics of non-defective bearings; Vibration characteristics of defective gears; Vibration characteristics of defective bearings.	06
2.	**Monitoring Methods:** Early time domain methods, spectral methods, cepstral methods, envelope methods. Vibration Analysis: Vibration- simple harmonic motion concept, vibration monitoring equipment, system monitors and	06

	vibration limit detectors, vibration monitoring examples, and critical vibration levels.	
3.	**Sound Monitoring:** Sound frequencies, sound loudness measurement, acoustic power, sound measurement, sound level meters, sound analyzers, and sound signal data processing, sound monitoring.	**06**
4.	**Discrete Frequencies:** Simple vibrations, transverse vibration of bars approximate frequency calculations, more precise evaluations- overtones, torsional oscillation of flywheel-bearing shafts, belt drives, whirling of shafts, gear excitation, rolling element bearing, blade vibration, cam mechanism vibration.	**06**
5.	**Machine Condition Indicators:** RMS value, peak value and crest factor, kurtosis, defect severity index. Measurement Techniques: Instrumentation, data acquisition, signal filtering, signal analysis - online and offline techniques, normalized order analysis.	**06**
6.	**Signal Processing Tools:** Sample rate and aliasing, time and frequency domain analysis. Case Studies: Practical applications of diagnostic maintenance, condition monitoring of mechanical and electrical machines. (Rotating Machines, Bearings and Gears, Fans, Blowers, Pumps, IC Engines, Motor Current Signature Analysis, Wear Debris and Oil Analysis, NDT, Ultrasonics, Eddy Current)	**06**

References

Text Books:

1. Norton, M. P., and Karczub, D. Fundamentals of Noise and Vibration Analysis for Engineers. Cambridge University Press.
2. Collacott, R. A. Mechanical Fault Diagnosis and Condition Monitoring. Chapman and Hall.
3. Fahy, F. J., and Walker, J. G. Fundamentals of Sound and Vibration. Spon Press.
4. Mohanty, A. R. Machinery Condition Monitoring: Principles and Practices. CRC Press.
5. Isermann, R. Fault Diagnosis Applications. Springer-Verlag, Berlin.
6. Rao, J. S. Vibration Condition Monitoring. Narosa Publishing House.
7. M. Abom, M. Sound and Vibration. KTH.

Reference Books:

1. Davies,A, Handbook of Condition Monitoring- Techniques and Methodology. Springer.

Class:- **Second Year M. Tech**	Semester-**III**
Course Code : **MOE2050**	Course Name : **Aircraft Conceptual Design**

L	T	P	Credits
3	--	--	3

Course Description:
This course gives students the aircraft conceptual design process. It is a combination of numerous disciplines which are combined together to give optimum configuration as per customer's requirements. Students can design their aircraft layout, choose powerplant, and decide wing area and type. Students can evaluate lift, drag and mass for aircraft design synthesis process. He can optimize the design by altering various influencing factors so that the aircraft can go for next phase of design i.e. preliminary design.

Course Learning Outcomes:
After successful completion of the course, students will be able to:
1. Understand the design process of aircraft and decide the aircraft configuration.
2. Choose type of power plant as per flight regime.
3. Decide the fuselage layout as per type of aircraft.
4. Design the wing for type of aircraft and its wing loading.
5. Accurately evaluate lift, drag and mass for design synthesis process.
6. Examine the influence of various design requirements on the configuration of an aircraft to derive an optimized design.

Prerequisite:
Students should know the design of mechanical systems and components.

Course Content

Unit No.	Description	Hrs
1.	**Design Process and Aircraft Configuration:** Aircraft design process, cost considerations, optimization, and synthesis process. Conventional configuration, alternative configurations, special considerations. Case study of Tejas aircraft.	06
2.	**Flight Regime and Power plant Consideration:** Power plant characteristics, types of power plant, typical engine parameters, flight regimes of power plants, power plant performance representation. Case study of Kaveri Engine.	06
3.	**Fuselage Layout:** Primary considerations, overall layout, local layout aspects, crew and payload, fuselage procedures. Case study of Boring 787 aircraft.	06
4.	**Configuration of the Wing:** Aerofoil section and high lift devices, planform shape and geometry, interaction between aerodynamic structural	06

	and wing volume considerations, wing loading.	
5.	**Basic Lift, Drag and Mass Representation:** Lift: aircraft configurations, initial assumptions, moderate to high aspect ratio wing configurations, low aspect ratio wing configuration. Drag: subsonic and transonic aircraft, transonic and supersonic configurations. Mass: absolute mass contributions, variable mass contributions, total mass.	**06**
6.	**Parametric Analysis and Optimization:** Procedure for parametric analysis (first stage), power plant representation, selection of performance equations, constraints and checks, case study: short/medium haul airliner. Procedure for parametric analysis and optimization (second stage), mass calculation, wing location and control surface areas, overall layout of the aircraft, case study: short/medium haul airliner.	**06**

References –

Text Books:

1. Denis Howe, Aircraft Conceptual Design Synthesis, WILEY.

Reference Books:

1. John Cutler, Understanding Aircraft Structures, WILEY Blackwell.
2. A.C Kermode, Flight without Formulae, 10th Edition, Pearson Education.
3. A.C Kermode, Mechanics of Flight, 5th Edition, Pearson Education.
4. Ian Moir, Allan Seabridge, Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, WILEY India Edition.

SEMSTER - IV

Class: **S Y M. Tech. Structural Engineering**	Semester- **IV**
Course Code:**CES2064**	Course Name: **Dissertation Phase-III**

L	T	P	Credits
-	-	10	06

Dissertation Phase III:
Student is required to present his/her progress of dissertation work before the committee consisting of supervisor and members of DPGC. Student will make the presentation and seek the suggestions from the supervisor and DPGC. Supervisor and DPGC will ensure that work carried out by the student till this stage is satisfactory and in compliance with synopsis of the dissertation submitted by student. This is In Semester Evaluation (ISE).

Course Outcomes:

1. Perform experimental/software analysis for developing research work.
2. Generate report work carried out.
3. Present the work carried out.

Class: **S Y M. Tech. Structural Engineering**	Semester- **IV**
Course Code:**CES2074**	Course Name: **Dissertation Phase IV**

L	T	P	Credits
-	-	18	10

Dissertation Phase IV:

This is final presentation, i.e. viva voce of the dissertation. Student will be allowed to make this presentation only if he has submitted duly completed and certified dissertation report. Examiners will check whether the dissertation work is in full compliance with synopsis of dissertation or not. Dissertation will be evaluated on the basis of quality of dissertation work, efforts taken by the student, quality of paper(s) published on the dissertation work, etc. Student should publish work carried by him along with supervisor in reputed journals as per institute rules and regulations.

The write up of this phase also needs revision (rewriting of the para...)

Course Outcomes:

1. Perform experimental/software analysis for developing research work.
2. Generate report work carried out.
3. Publish a research paper in journals/conference.
4. Prepare report using total work done as dissertation report.
5. Present the work carried out.