K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)
M. Tech. Structural Engineering
Curriculum Structure and Evaluation Scheme (NEP 2020)
To be implemented for 2023-25 & 2024-26 Batch

F.Y. M. Tech.						Semester: I					
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 1015	Advanced Solid Mechanics	3	-	-	3	ISE	30	40	40	-	-
						ESE	70	40		-	-
CES 1035	Advanced Structural Analysis	3	-	-	3	ISE	30	40	40	-	-
						ESE	70	40		-	-
CES 1055	Structural Dynamics and Earthquake Engineering	3	-	-	3	ISE	30	40	40	-	-
						ESE	70	40		-	-
	Program Elective - I	3	-	-	3	ISE	30	40	40	-	-
						ESE	70	40		-	-
	Program Elective - II	3	-	-	3	ISE	30	40	40	-	-
						ESE	70	40		-	-
SHP 5511	Technical Communication	2	-	-	Audit Course	P/NP					-
CES 1075	Computer Aided Design of Steel Structures Lab.	-	-	4	2	ISE	-	-	-	50	50
						ESE	-	-	-	50	50
CES 1095	Structural Dynamics Lab	-	-	2	1	ISE	-	-	-	100	50
CES 1115	Mini Project-I	-	-	2	1	ISE	-	-	-	100	50
TOTAL		17	-	8	19						

Total Contact Hours/week : 25
Total Credits : 19
ISE: In Semester Evaluation, ESE: End Semester Examination, P: Pass, NP: Not Pass

Program Elective -I

Sr. No.	Course Code	Course
1.	CES1135	Theory of Plates and Shells
2.	CES1155	Advanced Concrete Technology
3.	CES1175	Analysis and Design of Tall Structures

Program Elective -II

Sr. No.	Course Code	Course
1.	CES1195	Design of Bridges
2.	CES1213	Structural Health Monitoring
3.	SHP5171	Numerical Methods for Structural Engineers

F.Y. M. Tech.						**Semester: II**					
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 1025	Finite Element Analysis	3	-	-	3	ISE	30	40	40	-	-
						ESE	70	40		-	-
CES 1045	Design of Concrete Structures	4	-	-	4	ISE	30	40	40	-	-
						ESE	70	40		-	-
	Program Elective - III	3	-	-	3	ISE	30	40	40	-	-
						ESE	70	40		-	-
	Program Elective - IV	3	-	-	3	ISE	30	40	40	-	-
						ESE	70	40		-	-
CES 1065	Research Methodology & Intellectual Property Rights (IPR)	2	-	-	2	ISE	30	40	40	-	-
						ESE	70	40			
CES 1085	Computer Aided Design of Concrete Structures Lab	-	-	4	2	ISE	-	-	-	50	50
						ESE	-	-	-	50	50
CES 1105	Advanced Concrete Technology Lab	-	-	2	1	ISE	-	-	-	50	50
						ESE	-	-	-	50	50
CES 1125	Mini project II	-	-	4	2	ISE	-	-	-	100	50
SHP 552	Framework of Indian Constitution	2	-	-	Audit Course	ISE	-	-	-	P/NP	
CES 2015	Industry Internship	-	-	-	Audit Course	ISE	-	-	-	P/NP	
	TOTAL	**17**	**-**	**10**	**20**						

Total Contact Hours/week : 27
Total Credits : 20

ISE: In Semester Evaluation, ESE: End Semester Examination, P: Pass, NP: Not Pass

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

Program Elective -III

Sr. No.	Course Code	Course
1.	CES1145	Advanced Earthquake Engineering
2.	CES1161	Composite Structures
3.	CES1181	Maintenance and Rehabilitation of Structures

Program Elective -IV

Sr. No.	Course Code	Course
1.	CES1205	Design of Pre-stress Concrete Structures.
2.	CES1225	Design of Steel Structures
3.	CES1240	Design of Foundations

S.Y. M. Tech.						Semester: III				
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 2015	Industry Internship	-	-	2	Audit	ISE	-	-	P/NP	
	Open Elective	3	-	-	3	ESE	100	40	--	--
CES 2035	Dissertation Phase-I	-	-	08	4	ISE	-	-	100	50
CES 2055	Dissertation Phase-II	-	-	12	6	ISE	-	-	100	50
						ESE			100	50
TOTAL		**3**	**-**	**22**	**13**					

Total Contact Hours/week : 25
Total Credits : 13
ISE = In Semester Evaluation, ESE = End Semester Examination

Open Elective

Sr. No.	Course Code	Course
1.	MOE2011	Artificial Intelligence - Machine Learning
2.	MOE2021	Creative Thinking: Techniques and Tools
3.	MOE2031	MOOC Course
4.	MOE2041	Condition Monitoring and Signal Processing
5.	MOE2051	Aircraft Conceptual Design
6.	MOE2060	Augmented Reality and Virtual Reality
7.	MOE2070	Industrial Instrumentation
8.	MOE2080	Advanced Mechatronics systems

Note for Open Elective

An Open Elective course is included in the curriculum of S. Y. M. Tech (Semester-III), under which students need to learn either MOOC course or courses offered by department.

Guidelines for MOOC course under Open Elective

1. If students opt for MOOC course as an Open Elective, he/she should select this course from NPTEL platform only.
2. As three credits are allotted to open elective, selected MOOC course must be of minimum 6 weeks or 30 hours.
3. Students need to solve assignments given by platform and also, give the final certification exam at allotted NPTEL exam center.
4. Student must secure certification of NPTEL platform, otherwise he/she will not be eligible for final evaluation.
5. Final evaluation of the MOOC course will be based on oral examination conducted by department and marks secured in the exam conducted by NPTEL.
6. If student fails in NPTEL certification course, he or she should reregister for the course in the next semester.

Guidelines for other courses mentioned under Open Elective:

1. Student can opt for courses mentioned in the curriculum.
2. While selecting the course, students must take care that selected course from the list is not learned in UG or PG first year curriculum.
3. Lectures of these courses will be conducted by concerned department faculty by online mode.
4. Evaluation of these courses will be as mentioned in the curriculum.

S.Y. M. Tech.						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 2025	Dissertation Phase-III	-	-	12	06	ISE	-	-	100	50
CES 2045	Dissertation Phase-IV	-	-	20	10	ISE	-	-	100	50
						ESE			100	50
	TOTAL	-	-	**32**	**16**					

Total Contact Hours/week : 32
Total Credits : 16

ISE = In Semester Evaluation, ESE = End Semester Examination

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

TOTAL CONTACT HOURS : 25+27+25+32= 109

Class: **First Year M. Tech. Structural Engineering**	Semester: **I**
Course Code: **CES1015**	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.

	Course Content	
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, and 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, von Mises yield criterion, Tresca yield criterion, plastic stress-strain relations, principle of normality and plastic potential, isotropic hardening.	06
6	**Elasto-Plastic loading:** Beams under elasto-plastic condition, collapse load, plastic hinge, elasto-plastic deflections of beams of rectangular cross sections, residual stresses, thick- walled cylinders.	06

References:

Text Books:

- Timoshenko S.P. & Goodier J. N., "Theory of Elasticity", McGraw Hill International Editions.
- Sadhu Singh, "Theory of Elasticity", Khanna Publishers.
- Sadhu Singh, "Theory of Plasticity", Khanna Publishers.

Reference Books: -

- Kazimi S. M. A., "Solid Mechanics", Tata McGraw Publishing Company Limited.
- Srinath L.S, "Advanced Mechanics of Solids", McGraw Publishing Company Limited.
- Valiappan, "Continuum Mechanics" McGraw Publishing Company Limited.

Class: - **First Year M. Tech. Structural Engineering**	Semester-**I**
Course Code: **CES1035**	**Advanced Structural Analysis**

L	T	P	Credits
3	---	--	3

Course Description:

Advanced Structural Analysis is offered as core course at the first semester of Civil Structural Engineering post graduate program. This course is focuses on basic concept and different analytical tools for understanding the behaviour 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 stiffness and flexibility matrix methods of analysis of structures. 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, trusses, arches and portal frames. Also advanced topic such as beams curved in plan, beam-column analysis, matrix methods of analysis of structures.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Develop ILD for reactions, S.F. and B.M. for indeterminate structures
2. Construct SFD, BMD and TMD for beams curved in plan for various loading and support condition.
3. Analyse the beam-column structures
4. Analyse the structures by using the stiffness & flexibility matrix method.
5. Solve boundary value problems from civil engineering.

Prerequisite:

The course learns through pre requisite 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 twohinged 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 udl, simply supported semi-circular beams, circular ring beam.	06
3	**Beam Columns:** Governing differential equation, geometric and material nonlinearity, analysis ofbeam- columns simply and fixed supported at ends with concentrated load, moment and uniformly distributed load, magnification factor.	06
4	**Stiffness Matrix Method:** Concept, stiffness matrices for beam, truss, plane frame, pin and rigid jointed space frame element on member axis, transformation of matrices on structureaxes, nodal and force vector, assembly rules, calculation of member end forces.	06
5	**Flexibility Matrix Method:** Concept, relation between flexibility and stiffness matrices, analysis of continuousbeams, trusses and plane frames by structure-oriented approach.	06
6	**Boundary Value Problems:** Initial value problem, Approximate solution of boundary value problems, Modified Galerkin method for one-dimensional BVP, Matrix formulation of theModified Galerkin method.	06

References:

Text Books:

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

Reference Books:

- Timoshenko and Gere, "Strength of Materials", East West Press Ltd.
- Gere and Weaver, "Matrix Analysis of Framed Structures", CBS Publishing, Delhi.
- Pandit & Gupta, "Structural Analysis - A matrix approach", Tata McGraw Hill, Delhi.
- Negi and Jangid, "Structural Analysis", Tata McGraw Hill Pub. Co. Delhi
- N. Krishnaraju and D.R. Gururaja, "Advanced Mechanics of Solids & Structures", Narosa Pub. House Delhi.
- Lewis P. E. and Ward J. P., "The Finite Element Method", Addison-Wesley Pub. Co.
- Meek J. L., E and FN, "Computer Methods in Structural Analysis", Span Pub.

Class: **First Year M. Tech Structural Engineering**	Semester-**I**
Course Code: **CES1055**	Course Name: **Structural Dynamics and Earthquake Engineering**

L	T	P	Credits
3	---	--	3

Course Description:
This course aims to provide an understanding of the dynamic behaviour of civil engineering structures with focus on buildings. Formulation approaches of dynamic governing equations of structural systems are first introduced. Free vibration and forced vibration of single-degree-of-freedom (SDOF) and multi degree of freedom (MDOF) systems will be analysed with examples. Further, course also introduces elements of engineering seismology along with principles of conceptual design. The different methods of evaluating lateral forces on building will be studied by referring IS 1893:2016.

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

1. Analyse the response of single and multi-degree freedom systems by fundamental theory.
2. Explain principles of seismology and conceptual design.
3. Evaluate lateral loads developed on multi-storeyed structures.

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 to Dynamics:** 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, Mathematical modelling of dynamic system, Equivalent stiffness.	06
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, transmissibility, Response of Single degree of freedom systems to arbitrary excitation	06

3	**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,	06
4	**Engineering Seismology:** Earthquake phenomenon, cause of earthquakes, Seismic waves, Terms associated with earthquakes, Magnitude/Intensity of an earthquake, scales, Energy Released, Earthquake measuring instruments, Characteristics of strong ground motions, Seismic zones of India, Some Case studies important earthquakes.	06
5	**Conceptual Design:** Effect of earthquake on different types of structures: Behaviour of RCC, Steel and masonry structures under earthquake loading, effect on non-structural element, Introduction to conceptual design, Ductility, definition, ductility relationships, flexible buildings.	04
6	**Earthquake Resistant Design:** Introduction to earthquake resistant design: seismic design requirements, regular and irregular configurations, basic assumptions, design earthquake loads, basic load combinations, seismic methods of analysis, factors in seismic analysis, Evaluation of lateral forces by equivalent static and response spectrum method (As per IS 1893:2016)	08

References:

Text Books:

- Chopra A. K. "Structural Dynamics and Introduction of Earthquake Engineering", Prentice Hall Publications.
- Mario Paz, "Structural Dynamics Theory and Computation", CBS Publisher.
- P. Agarwal & M. Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall Publications.

Reference Books:

- Clough R.W. & J. Penzien, "Dynamics of Structures", Mc Graw Hill Education.
- Willaim Thomson, "Theory of Vibration with applications" CRC Press.
- David Dowrick, "Earthquake Resistant Design and Risk Reduction", Willey Publication.

IS Codes:

- IS 1893:2016, Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards

Class: **-First Year M. Tech. Structural Engineering**	Semester-I
Course Code: **SHP5511**	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:
After successful completion of the course, students will be able to,
1. Use grammatically correct sentences in different types of technical writings.
2. Apply technical writing skills to improve readability of documents.
3. Demonstrate professional skills required in job interviews and at workplace.

Prerequisite:
Students who enroll themselves to this course should have adequate LSRW abilities ofEnglish language.

Course Content

Unit No.	Description	Hrs
1.	**Planning and Preparation:** Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.	04
2.	**Paraphrasing and Plagiarism:** Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism	03
3.	**Sections of Research Paper:** Sections of a Paper, Abstracts, Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, and The Final Check.	03

4.	**Sections of Research Paper:** 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,	04
5.	**Sections of Research Paper:** 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	04
6.	**Professional skills:** 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 Book:

- Adrian Wallwork , "English for Writing Research Papers", Springer New York Dordrecht Heidelberg London.

Reference Books –

- Day R, "How to Write and Publish a Scientific Paper", Cambridge University Press
- Goldbort R, "Writing for Science", Yale University Press (available on Google Books)
- Jeff Butterfield, "Soft Skills for Everyone", Cengage Learning India Private Limited,
- John Seely, "Oxford Guide to Effective Writing and Speaking", Oxford University Press.
- Thomas N. Huckin and Leslie A. Olsen, "Technical Writing and Professional Communication for Nonnative Speakers of English" Tata McGraw Hills, International Edition.

Class: - **First Year M. Tech. Structural Engineering**	Semester-I	L	T	P	Credits
Course Code: **CES1075**	Course Name: **Computer Aided Design of Steel Structures Lab**	-	-	4	2

Course Description:
This laboratory course is mainly focusing on analysis and design of steel structures using renowned software's 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

Project No.	Description	Lab Sessions
1.	Design and drawing of industrial shed	8
2.	Design of steel building (Frame)	6
3.	Design of hoarding boards	4
4.	Design of communication tower	4
5.	Application of MATLAB for analysis of truss	2

References

Text Books:

- Shiyekar M. R., "Limit State Design in Structural Steel", PHI Learning.
- Sai Ram K. S., "Design of Steel Structures", Pearson Education.

Reference Books:

- Duggal S. K, "Design of Steel Structures", Tata Mc-Graw Hill publishing company Ltd., New Delhi.
- Subramanian N., "Design of Steel Structures", Oxford University Press, New Delhi.

Class: -**First Year M. Tech. Structural Engineering**	Semester-I	L	T	P	Credits
Course Code: **CES1095**	Course Name: **Structural Dynamics 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.

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

Course Content

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

References:

Text Books:
- Chopra A. K, "Structural Dynamics and Introduction of Earthquake Engineering".
- Mario Paz, "Structural Dynamics, Theory and Computation", CBS Publisher.
- P. Agarwal & M. Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall Publications.

Reference Books:
- Clough R.W. and Penzien J., "Dynamics of Structures", Hill Education.
- Willaim Thomson, "Theory of Vibration with applications", CRC Press.
- David Dowrick, "Earthquake Resistant Design and Risk Reduction", Willey Publication.

Class: **First Year M. Tech. Structural Engineering**	Semester- **I**
Course Code: **CES1115**	Course Name: **Mini Project I**

L	T	P	Credits
-	-	2	1

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). 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. Prepare report and present the work carried out.
6. Develop self-learning ability.

Class: **-First Year M. Tech Structural Engineering**	Semester-**I**
Course Code: **CES1135**	Course Name: **Theory of Thin Plates and Shells**

L	T	P	Credits
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:

Text Books:

- Timoshenko, S., "Theory of plates and shells", McGraw Hills Book Comp.
- Chandrashekhar K, "Theory of Plates", Universities Press (India).
- Chandrashekhar K, "Analysis of Thin Concrete Shells", New Age International Pvt. Ltd.

Reference Books:

- Ramaswamy, "Design of concrete shell roofs", CBS publishers and distributors New Delhi.
- Reddy J. N., "Theory and analysis of elastic plates and shells", Taylor & Francis.

Class: - **First Year M. Tech Structural Engineering**	Semester-I
Course Code: **CES1155**	Course Name: **Advanced Concrete Technology**

L	T	P	Credits
3	-	--	3

Course Description:
The Advanced Concrete Technology course focuses on properties of newly prepared concrete and its 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, tests on fresh and hardened concrete. The course aims to give updated information in the field of concrete technology involving modern trends and techniques.

Course Learning Outcomes:
1. Select binders and admixtures to design strong, durable and sustainable concretes.
2. Describe various special processes and techniques involved in various concreting jobs.
3. Identify reasons affecting durability of concrete / concrete structures /elements.
4. Design concrete mix for special concretes.
5. Analyse qualities of concrete elements using appropriate destructive or non-destructive testing methods for evaluating quality.

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

Course Content

Unit No	Description	Hrs
1	**Admixtures & Construction Chemicals:** Admixtures: mineral and chemical admixtures, various dispersion mechanisms of admixtures, effect of admixtures on concrete properties, Use of relevant IS codes.	06
2	**Special Concretes:** Light-weight concrete, foamed concrete, sulphur infiltrated concrete, high strength concrete, high performance concrete, self-compacting concrete, pervious concrete, polymer concrete, fibre-reinforced concrete, high density and radiation-shielding concrete. Use of relevant IS codes.	06

3	**Special techniques of concreting:** Sprayed concrete, underwater concrete, ferrocement, gunite/shotcrete, grouting, vacuum concrete, mass concrete, slip form construction, pumped concrete, concrete for liquid retaining structures, hot and cold weather concreting, Ready mixed concrete. Use of relevant IS codes.	06
4	**Durability of concrete and concrete construction:** Introduction, significance, permeability of concrete, surface wear, reinforcement corrosion, fire resistance, frost damage, sulphate attack, alkali silica reaction, delayed ettringite formation, durability of concrete in sea water, short-term tests to assess long-term behaviour. Use of relevant IS codes.	06
5	**Concrete mix design:** Different methods of mix design, Acceptance criteria, comparison between IS, BS and ACI method of mix design. Mix design of high strength concrete, high-performance concrete, self-compacting concrete, mass concrete by IS method.	06
6	**Testing of Hardened Concrete:** Non-destructive testing methods of concrete: rebound hammer test, pulse velocity method, probe penetration, break off maturity method, stress wave propagation method, electrical methods, magnetic methods, nuclear methods and radioactive methods. Tests on hardened concrete, Core cutting and testing of concrete. Use of relevant IS codes.	06

References -

Text Books:

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

Reference Books:

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

Class: **First Year M. Tech Structural Engineering**	Semester-I
Course Code: **CES1175**	Course Name: **Analysis and Design of Tall Structures**

L	T	P	Credits
3	---	--	3

Course Description:
This course deal with analysis of tall structures under wind loads by referring IS 875(Part 3):2015. In addition, approximate analysis of method of analysis of multi-storied frame will be elaborated. It also covers design of RCC shear wall, chimney, silos and bunkers.

Course Learning Outcomes:
After completion of this course students will be able to,
1. Evaluate forces on tall structures due to wind load.
2. Construct SFD and BMD in building frame by approximate analysis method.
3. Design RC shear wall, chimney, bunkers and silos.

Prerequisite: Structural Analysis, Design of Reinforced Concrete Structures.

Course Content

Unit No	Description	Hrs
1	**Wind Analysis:** Introduction: Basic wind speed, Design wind speed (As per IS 875:2015), Design wind pressure, offshore wind velocity, wind pressures and forces in buildings/structures, External pressure coefficients for various roofs, dynamic effects, Lateral load	06
2	**Analysis of Multistorey Building Frames: I** Analysis of Multistorey Building Frames for lateral loads by Cantilever method and Portal method.	06
3	**Analysis of Multistorey Building Frames: II** Analysis of Multistorey Building Frames for lateral loads by Factor method and Substitute Frame Method.	06
4	**Design of Shear Wall:** Introduction, Types of shear walls, Behaviour of cantilever wall with rectangular cross-section, flange cantilever shear walls, Moment-Axial load interaction for shear wall section, Interaction of shear walls and rigid joined frames, Shear walls with openings, Coupled shear walls.	06

5	**Design of Chimneys (RCC):** Introduction, Wind pressure, Stress in chimney shaft due to self-weight and wind, Stress in horizontal reinforcement due to wind shear, Stresses due to temperature difference, Design of RC chimney.	06
6	**Design of Bunkers and Silos:** Introduction, Differences between bunker and silo, Design of square or rectangular bunkers, Design of circular bunkers, Design of silos, Silos for storage of cement.	06

References -

Text Books:

- Krishnaraju N., "Advanced Reinforced Concrete Design", CBS Publisher.
- Punmia B. C. & Jain A. K., "Reinforced Concrete Structures", Laxmi Publications
- Manohar S. N., "Tall Chimneys", Mcgraw-Hill Publications.

Reference Books:

- Park R. & Paulay T., Reinforced Concrete Structures, John Wiley & Sons.
- Varghese P.C., "Advanced Reinforced Concrete Design", Prentice Hall of India.
- Shah H. J., "Reinforced Concrete design", Charotar Publishing House.
- Purushothaman P., "Reinforced Concrete Structural Elements", Tata McGraw-Hill Publishing.

Class: -**First Year M. Tech Structural Engineering**	Semester-**I**
Course Code: **CES1195**	Course Name: **Design of Bridges**

L	T	P	Credits
3	-	--	3

Course Description:
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. 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.

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

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:** 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

References:
Text Books:

- Raina V.K, "Concrete Bridge Practice", Tata McGraw Hill. Delhi.
- Punmia B.C., Jain Ashok Kumar, "Reinforced Concrete Structures", Laxmi Publications.
- Jagadish & Jayaram, "Design of Concrete Bridges", Tata McGraw Hill.

Class: **First Year M. Tech Structural Engineering**	Semester-I
Course Code: **CES1213**	Course Name: **Structural Health Monitoring**

L	T	P	Credits
3	---	--	3

Course Description:
Structural Health Monitoring (SHM) deals with assessment, evaluation and technical diagnosis of different structural systems of strategic importance. Extensive knowledge of SHM shall lead to a clear understanding of risk and reliability assessment of structures, which is currently mandatory for structures of strategic importance like bridges, offshore structures etc.

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

1. Discuss the concept and various components of SHM
2. Identify suitable Sensors and Instruments required in SHM for in-service performance structures.
3. Assess the health of structures using different techniques of SHM
4. Select the appropriate strengthening and retrofitting techniques for regaining the structur strength.
5. Design the sensor layouts of SHM for the civil engineering structures

Prerequisite:
As a prerequisite to study this course, the students must possess the knowledge of concrete technology, RCC Structures, Steel Structures,

Course Content

Unit No	Description	Hrs
1.	**Introduction of Structural Health Monitoring:** Necessity of Structural Health Monitoring (SHM), Definition and Concept of SHM, Components of SHM, Challenges in SHM, Comparison of SHM with NDT, Structural Safety in Alteration, Procedure of SHM.	05
2.	**Instrumentations & Sensors for SHM** Basics of Instrumentations and Measurements, Classifications, Input-Output Configurations of Instruments, Static and Dynamic Characteristics, Functions. Various Types of Electromechanical, Electronics and Digital Instruments for SHM. Data Acquisition Systems-Types, Hardware and its components. Basics of Sensors, Transducers and Actuators, Classification of Sensors, and Characteristics and Working Principles of Various Types of Sensors like Strain Gauges, LVDT, and Accelerometers etc. Concept of Smart Materials & Smart Structures with SHM.	07

3.	**Static and Dynamic Field-Testing Methods of SHM:** **Static Field-Testing Methods:** Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement. **Dynamic Field-Testing Methods:** Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring.	06
4.	**Vibration Based SHM Techniques**: Use and Demonstration of Dynamic Properties of Structures for Damage Detection and SHM, Ambient Vibration Test, Acoustic Emission Technique, Electromechanical Impedance Technique, Wave Propagation Based Techniques, Fibre Optics Based Techniques, Remote & Wireless SHM Techniques,	06
5.	**Structural Assessment and Retrofitting of Structures** Introduction to health assessment of structures, structural damages and failures, Factors affecting Health of Structures, Causes of Distress, Regular Maintenance, Principles of structural assessment, Classification and levels of assessment. Fundamental of retrofitting, Methods of retrofitting, Materials for retrofitting (conventional and smart materials), selection of retrofitting methods	08
6.	**Applications of SHM:** Applications of SHM on bridges and buildings, offshore structures.	04

References -

Text Books:

- Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes, "Structural Health Monitoring", John Wiley and Sons.
- Douglas E Adams, "Health Monitoring of Structural Materials and Components, Methods with Applications", John Wiley and Sons

Reference Books:

- J. P. Ou, H. Li and Z. D. Duan, "Structural Health Monitoring and Intelligent Infrastructure", Vol1, Taylor and Francis Group, London.
- Victor Giurglutiu, "Structural Health Monitoring with Wafer Active Sensors", Academic Press Inc.

Class: **First Year M. Tech Structural Engineering**	Semester-I
Course Code: **SHP5171**	Course Name: **Numerical Methods for Engineers**

L	T	P	Credits
3	-	--	3

Course Description:
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, Locating Roots of Equations, Interpolations, Curve Fitting, Roots of Polynomials, Elements of Matrix Algebra

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

1. Apply numerical methods for error analysis.
2. Compute the roots of the given equations and polynomials
3. Apply the relevant numerical method for interpolating the polynomial.
4. Develop the equation to be fitted to the given data.
5. Solve problems involving linear algebraic equations

Prerequisite: Undergraduate Engineering Mathematics

Course Content

Unit No.	Details of Content	Hrs.
1.	**Error Analysis:** Approximation and rounding off errors: Significant figures, Accuracy and precision, Error definitions, Round-off errors, Truncation errors and the Taylor series: The Taylor series, Taylor series approximation of polynomial, Taylor series expansion to approximation a function with infinite number of derivatives, the remainder for the Taylor Series expansion, Using the Taylor series to estimate truncation errors, Control of numerical errors, Blunders, formulation errors and data uncertainty.	06
2.	**Locating Roots of Equations:** Graphical approach, Bisection method, False-position method, Newton-Raphson method, The Secant method, Modified Secant method	06

3.	**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.	06
4.	**Curve Fitting:** Motivation, Mathematical background: Simple statistics, The Normal distribution, Linear regression: Criteria for a "Best" fit, Least Squares Fit of a Straight line, Quantification of error of Linear regression, Linearization of Nonlinear relationships: Linearization of a Power Equation $y = ax^b$, Polynomial regression, Multiple Linear regression	06
5.	**Roots of Polynomials:** Polynomials in Engineering and Science, Computing with Polynomials: Polynomial Evaluation and Differentiation, Polynomial Deflation, Muller"s Method, Bairtow"s Method, Case Studies in Civil Engineering	06
6.	**Elements of Matrix Algebra**: Gaussian Elimination method, Pitfalls of Elimination Methods, Techniques for improving Solutions, Gauss Jordan method, LU-decomposition, LU-decomposition Version of Gaussian Elimination method, Doolittle Decomposition, Crout Decomposition, Case Studies in Civil Engineering	06

References:

Text Books:

- Steven C. Chapra & Raymond P. Canale, "Numerical Methods for Engineers" McGraw Hill Education.
- Sastry S. S, "Introductory Methods of Numerical Analysis, Prentice Hall of India.

Reference Books:

- Atkinson K. E., J. Wiley and Sons, "An Introduction to Numerical Analysis". Shaum Series
- Scheid F, "Theory and Problems of Numerical Analysis". McGraw Hill Book Company
- E. Ward Cheney and David R. Kincaid, "Numerical Methods and Applications"

Class: **First Year M. Tech Structural Engineering**	Semester-**II**
Course Code: **CES1025**	Course Name: **Finite Element Analysis**

L	T	P	Credits
3	-	--	3

Course Description:
This course in focuses on basic concept and finite element procedure, Variational methods. This course divided into three modules. The first module contains 1D and 2D problems, it includes discretization, selection of polynomials, application to springs & bars subjected to axial forces. Development of force and nodal displacement vector, element stiffness matrix for truss, beam and plane frame, transformation of matrices. It also includes 2D elements of triangular and quadrilateral for plane stress and stain problems, Pascal"s triangle, convergence requirements and compatibility conditions. This module contains development of element matrix for tetrahedron, hexahedral elements. The module second consists of shape function, Isoperimetric and Axi symmetric elements, development of element stiffness matrix. The module three includes formulation of stiffness matrix for plate and shell elements. It also includes finite element application, use of commercial FEA software, Result interpretation and MATLAB applications

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

1. Describe the finite element method and convergence requirement
2. Apply the basic finite element formulation techniques to solve civil engineering problems by 1D, 2D and axisymmetric elements
3. Explain shape function and isoparametric element
4. Derive element stiffness matrix for thin plate and shell element
5. Use commercial software to solve problems related to civil engineering

Prerequisite: The course learns through prerequisite courses of Engineering Mathematics, Engineering Mechanics and Numerical methods should have a clear understanding of methods of analysis of structures. This course intends to build the competency in the students to analyse structures and use of matrix methods and FEM of analysis for beams, trusses and frames.

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.	**Analysis of Beam, Truss, frame:** 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.	**Selection criteria of displacement model:** 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 strain and stress, CST, LST, QST element, plane strain rectangular element, Shape functions, Natural coordinate system, Isoperimetric formulation, 1D & 2D isoperimetric elements, axisymmetric elements	**06**
5.	**Plate and Shell Elements:** Assumptions, Moment curvature relation, Formation of stiffness matrix for plate bending elements of triangular and quadrilateral shapes, types of shells elements, formation of stiffness matrix for thin shell element	**06**
6.	**Computer Applications:** FEM procedure, pre-processing, solution, post-processing, use of commercial FEA software, Result interpretation, MATLAB applications	**06**

References:

Text Books:

- Zienkiewicz O.C. & Taylor R.L., "The Finite Element Method", Tata McGraw Hill.
- Desai Y.M., Eldho T. I., A. H. Shah, "Finite Element Method with application in Engineering", Pearson, Delhi.

Reference Books:

- Reddy J.N., "An introduction to the Finite Element Method", Tata McGraw Hill Pub.
- Cook R. D., "Concept and Application of Finite Element Analysis", John Wiley & sons.
- Hutton D. V, "Fundamentals of Finite Element Analysis", Tata McGraw Hill Pub.
- Desai C. S. & Abel J. F, "Introduction to the Finite Element Method", CBS Pub.
- Krishnamoorthy C. S., "Programming in the Finite Element Method", Tata McGraw Hill.
- Chandrupatla T. R. & Belegundu, "Introduction to the Finite Element in Engineering", Prentice Hall of India, Pvt. Ltd.
- Bathe K.J., "Finite Element Procedures", PHI learning Pvt. Ltd.

Class: -**First Year M. Tech Structural Engineering**	Semester-II	L	T	P	Credits
Course Code: **CES1045**	Course Name: **Design of Concrete Structures**	4	-	--	4

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 water tanks, flat slabs, deep beam, counterfort and cantilever retaining wall 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:
At the end of the course, students will be able to
1. Analyse R.C. slabs using yield line theory.
2. Design R.C.C. deep beam and flat slab.
3. Design R.C.C. elevated service reservoir, retaining wall
4. Design R.C. members for fire resistance.

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.	**Design of Slab (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.	08
2.	**Deep Beam:** Introduction, Assumptions and analysis of deep beam, Design of rectangular beams	08
3.	**Flat Slabs:** Introduction, Proportioning of flat slabs, Design of flat slab by direct design method.	08

4.	**Cantilever and Counterfort Retaining Walls:** Introduction, classification, drainage arrangements for retaining walls, stability requirements of retaining wall, design of cantilever retaining wall, design of counterfort retaining wall, detailing of reinforcement.	08
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.	08
6.	**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.	08

References:

Text Books: -

- Bhavikatti S. S., "Advance R.C.C. Design", New Age International Publishers.
- Punmia B.C., Jain A.K., "Reinforced Concrete Structures", Laxmi Publications.
- Sinha N.C. & Roy S.K. "Fundamentals of Reinforced Concrete", Co.Ltd, New Delhi.

Reference Books:

- Varghese P.C., "Advanced Reinforced Concrete Design", Prentice Hall of India.
- Shah H. J., "Reinforced Concrete design", Charotar Publishing House.
- Purushothaman P., "Reinforced Concrete Structural Elements", Tata McGraw- Hill Publishing.

IS Code:

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

Class: -**First Year M. Tech. Structural Engineering**	Semester-**II**
Course Code: **CES1065**	Course Name: **Research Methodology & Intellectual Property Rights (IPR)**

L	T	P	Credits
2	-	--	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 study and 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. Prepare abstract through literature review.
2. Formulate a research problem.
3. Prepare and present research proposal/paper by following research ethics.
4. Prepare and present report on intellectual property rights.

Course Content

Unit No.	Description	Hrs
1.	**Introduction:** 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.	04
2.	**Literature Study:** 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, Necessary instrumentations. Validity of experiments	04

3.	**Technical Writing:** Effective technical writing, how to write technical report and paper, Developing a Research Proposal, Format of research proposal, presentation and assessment by a review committee.	04
4.	**Nature of Intellectual Property:** Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting development. International scenario: International cooperation on intellectual property, procedure for grants of patents, patenting under PCT.	04
5.	**Patent Rights:** Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases. Geographical indications.	04
6.	**New Development in IPR:** Administration of Patent System, New developments in IPR: IPR of Biological Systems, Computer Software etc., Traditional knowledge Case Studies. IPR and IIT's	04

References –

Text Books:

- Garg B.L, Karadia R., Agarwal, F. and Agarwal, U.K., "An introduction to Research Methodology", RBSA Publishers.
- Kothari, C.R., "Research Methodology: Methods and Techniques", New Age International.
- Sinha, S.C. and Dhiman, A.K., "Research Methodology", Ess. Publications.
- Trochim, W.M.K., "Research Methods: the concise knowledge base", Atomic Dog Publishing.

Reference Books

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students", Juta & Co Ltd,
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction", Juta Academic
- Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for beginners", SAGE Publication.

Class: -**First Year M. Tech. Structural Engineering**	Semester-II
Course Code: **CES1085**	Course Name: **Computer Aided Design of Concrete Structures Lab.**

L	T	P	Credits
-	-	4	2

Course Description:
This laboratory course is mainly focusing on analysis and design of concrete structures using renowned software"s like STAAD- Pro, ETABS and SAP etc. Students are expected to design various RCC 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

Project No	Description	Lab sessions
1.	Design and drawing of RCC building (G+4)	10
2.	Design and drawing of elevated water tank.	06
3.	Design and drawing of flat slab.	04
4.	Design and drawing of retaining wall	04
5.	Preparation of simple program for design of slab, beam, column using MATLAB	04
	Students have to complete Project 1 & 2 and any two projects from project 3, 4 & 5	

References
Reference Books:

- Sinha and Roy, "Fundamentals of Reinforced Concrete", S. Chand and Company Ltd, New Delhi.
- Varghese P. C., "Limit State Design of Reinforced Concrete", Prentice Hall of India, New Delhi.

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

Class: **First Year M. Tech. Structural Engineering**	Semester- **II**
Course Code: **CES1105**	Course Name: **Advanced Concrete Technology Lab**

L	T	P	Credits
-	-	2	01

Course Description:
The"Advanced Concrete Technology Lab" course focuses on the experimental study of special concretes mix design. The course deals testing of durability properties of hardened concrete and to carry out condition survey of any structure for assessing its quality status using NDT tools / equipment.

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

1. Design special concretes using IS 10262-2019.
2. Evaluate durability properties of concrete.
3. Judge the quality of concrete using NDT.
4. Write a technical report on special concreting techniques based on site visit.

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

Course Content

Expt. No.	Description	Lab Sessions
1.	Mix Design of Special Concretes (any two) 1. High strength concrete 2. Self-compacting concrete 3. Pervious concrete 4. Fibre-reinforced concrete 5. High performance concrete	4
2.	Durability Tests on Concrete (any one) 1. Carbonation test 2. Permeability test 3. Effect of elevated temperatures 4. Effect of acids, sulphates and chlorides 5. Rapid chloride penetration test	2

3.	Site visits demonstrating special concreting techniques (any two) 1. Pumped concrete 2. Temperature controlled concrete (mass concrete), 3. Gunite/shotcrete 4. Ferrocement 5. Under water concreting 6. Pile foundation	4
4.	Preparation of structural audit and condition survey report of any one structure by testing of concrete elements/structure using NDT equipment's.	2

References -

Text Books:

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

Reference Books:

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

Class: **First Year M. Tech. Structural Engineering**	Semester- **II**
Course Code: **CES1125**	Course Name: **Mini Project II**

L	T	P	Credits
-	-	4	2

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. Prepare report and present the work carried out.
6. Develop self-learning ability.

Class: - **First Year M. Tech. Structural Engineering**	Semester-II
Course Code: **SHP552**	Course Name: **Framework of Indian Constitution**

L	T	P	Credits
02	-	--	Audit Course

Course Description: This course is designed to help students to know the constitution of India. It draws a limit on the power of the Government by outlining a framework within which the Government must function. They act as a bedrock to democracy as they guarantee equality to the citizens of the nation. Due to the principle of equality, one can ensure dignity and respect in the country. These rights apply to a man as a protection against his will and expression. Union has jurisdiction over subjects of national importance such as defence of the country, foreign affairs, banking, communications, and currency and also subjects present in concurrent list. States have jurisdiction over education, agriculture, public health, sanitation, hospitals and dispensaries and many other departments. The state governments also have to maintain the internal security, law and order in the state.

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

1. Realize the significance of constitution of India to students from all walks of life and help them to understand the basic concepts of Indian constitution.
2. Identify the importance of fundamental rights as well as fundamental duties
3. Understand the functioning of Union, State and Local Governments in Indian federal system
4. Learn procedure and effects of emergency, composition and activities of election commission and amendment procedure.

Pre-Requisite- NIL

Course Content

Unit No	Description	Hrs
1	**Introduction to Constitution:** Meaning and importance of the Constitution, salient features of Indian Constitution. Preamble of the Constitution. Fundamental rights- meaning and limitations. Directive principles of state policy and Fundamental duties -their enforcement and their relevance	06
2	**Union Government:** Union Executive- President, Vice-president, Prime Minister, Council of Ministers. Union Legislature- Parliament and Parliamentary proceedings. Union Judiciary-Supreme Court of India – composition and powers and functions.	06
3	**State and Local Governments:** State Executive- Governor, Chief Minister, Council of Ministers. State Legislature-State Legislative Assembly and State Legislative Council. State Judiciary-High court. Local Government-	06

	Panchayat raj system with special reference to 73rd and Urban Local Self Govt. with special reference to74th Amendment.	
4	**Election provisions, Emergency provisions, Amendment of the constitution:** Election Commission of India-composition, powers and functions and electoral process. Types of emergency-grounds, procedure, duration and effects. Amendment of the constitution- meaning, procedure and limitations.	06

Reference:

Text books:

- M.V.Pylee, "Introduction to the Constitution of India",4th Edition, Vikas publication,
- Durga Das Basu(DD Basu), "Introduction to the constitution of India", Prentice-Hall EEE.

Reference Books:

- Merunandan, "Multiple Choice Questions on Constitution of India", Meraga publication,

Class: - **First Year M. Tech Structural Engineering**	Semester-II
Course Code: **CES1145**	Course Name: **Advanced Earthquake Engineering**

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:

- Agarwal P.& M. Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall Publications.
- Jai Krisna, A. R. Chandrashekharan, "Elements of earthquake Engineering", Chandra, South Asian Publishers Private Limited.
- Mallick A. K., "Principles of Vibration Control". Prentice Hall Publications.

Reference Books:

- Madhujit Mukophadhyay, "Structural Dynamics Vibrations and Systems", Publisher: ANE
- Clough R.W. and J. Penzien, "Dynamics of Structures", McGraw Hill Education.

IS Codes:

- IS 1893 2016, Criteria for Earthquake Resistant Design of Structures. Part I & II.
- IS 13920 2016, Ductile Detailing of RCC Structures.

Class: **First Year M. Tech. Structural Engineering**	Semester: **II**
Course Code: **CES1161**	Course Name: **Composite Structures**

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:
At the end of this course student will be able to:
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 behaviour 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:

- Johnson R. P., "Composite Structures of Steel and Concrete",Oxford Blackwell Scientific Publications.
- Owens. G.W, & Knowels.P. "Steel Designs Manual", Steel Concrete Institute (UK) Oxford Black; well Scientific Publications.
- IS:11384, 1985 Code of Practice for Composite Construction in Structural Steel and Concrete, Bureau of Indian Standards, New Delhi.
- INSDAG teaching resources for structural steel design Vol II, Institute for Steel Development and Growth Publishers, Calcutta
- INSDAG Handbook on Composite Construction: Multi-Storey Buildings, Institute for Steel Development and Growth Publishers, Calcutta.
- INSDAG Design of Composite Truss for Building, Institute for Steel Development and Growth Publishers, Calcutta
- INSDAG Handbook on Composite Construction: Bridges and Flyovers, Institute for Steel Development and Growth Publishers, Calcutta.

Class: **First Year M. Tech Structural Engineering**	Semester-**II**
Course Code: **CES1181**	Course Name: **Maintenance and Rehabilitation of Structures**

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. 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 and methods for strengthening the existing structures.

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

1. Diagnose the causes of distress and deterioration of concrete structure
2. Describe the procedures of various repair techniques or methods.
3. Suggest appropriate materials and techniques for repair and strengthening of structures/elements
4. Prepare a report on condition assessment of buildings based on observations

Prerequisite: Basic concepts and principles of Concrete Technology, Structural Analysis, Design of Reinforced Concrete structure, Earthquake Engineering are required

Course Content

Unit No.	Description	Hrs
1.	**Introduction:** Need for Repair and Rehabilitation of structures, distress in structures. Definitions and terminologies, deterioration of RC structures, physical, chemical and other causes.	06

2.	**Condition Assessment of Structures:** Condition assessment of concrete structures, exposure conditions, stages visual inspection, on situ and laboratory testing of concrete, Interpretation and reporting of NDT results, preparation of report, Case studies of condition assessment of distressed due to corrosion, fire, leakage, earthquake, landslide.	06
3.	**Service Life Prediction methods:** Introduction, service life, types, parameters affecting service life, methods for prediction of service life viz. life 365 software.	06
4.	**Repair Materials:** 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, admixtures of latest origin	06
5.	**Repair Materials:** Cement based repair materials, polymer modified repair materials, resin-based products, micro concrete, composites	06
6.	**Repair Techniques and strengthening of structures:** Repairs using mortars, Dry pack and Epoxy bonded dry pack, preplaced aggregate concrete, gunite or shotcrete, grouting, polymer impregnation, resin injection, routing and sealing, stitching, surface patching. shoring and underpinning. Strengthening techniques: section enlargement, composite construction, post tensioning, flexural and shear strengthening of beam, strengthening of columns, footings.	06

References:

Text Books:

- Santhakumar A.R., "Concrete Technology", Oxford University Press.
- Shetty M.S., "Concrete Technology", S. Chand &Company Ltd.

Reference Books:

- Denison C., Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair", Longman Scientific and Technical.
- Allen R.T. & Edwards, S.C, "Repair of Concrete Structures", Blakie and Sons.
- Ravishankar K., Krishnamoorthy, T.S., "Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures", Allied Publishers.
- Handbook on repair and rehabilitation of RCC buildings, CPWD, Government of India.

Class: **First Year M. Tech Structural Engineering**	Semester-II
Course Code: **CES1205**	Course Name: **Design of Pre-stress Concrete Structures**

L	T	P	Credits
3	-	--	3

Course Description:
The "Design of Pre-stress Concrete Structures" course deals the concept of concrete pre-tensioning and post-tensioning with their material properties and losses. The course focuses on analysis & design of statically determinate, indeterminate pre-stressed concrete beams, end block, pipes and tanks.

Course Learning Outcomes:
At the end of this course student will be able to:
1. Explain the concept, material requirement and behaviour of the pre-stressed concrete.
2. Calculate the losses of pre-stress in pre-tensioning and post-tensioning concrete.
3. Analyse & design the statically determinate, indeterminate pre-stressed concrete beams and end block.
4. Analyse & design the pre-stressed concrete pipes and tanks.

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

Course Content

Unit No	Description	Hrs
1.	**Introduction:** Concept of concrete pre-stressing, advantages & disadvantages of pre-stressed concrete, I.S. recommendations for quality of materials for pre-stressed concrete -high strength concrete and high tensile steel, Classification of types of pre-stressing, systems of pre-stressing.	04
2.	**Analysis of pre-stress concrete elements:** Stress concept, Strength concept and Load balancing concept.	06

3.	**Losses:** Introduction to losses of pre-tensioning and post-tensioning concrete, immediate and time dependent losses, Loss due to elastic deformation of concrete, shrinkage of concrete, creep of concrete, relaxation of stress in steel, friction and anchorage slip.	06
4.	**Design of Beams:** Design of statically determinate pre-stress concrete beams- rectangular, T and I Sections. Shear, deflection. Design of end block by IS code method.	08
5.	**Design of Beams:** Analysis and Design of two span continuous beams (statically indeterminate), choice of cable profile, linear transformation and concordancy.	06
6.	**Design of Cylindrical Structures:** Analysis and design of cylindrical structures in pre-stressed concrete- pipes and tanks.	06

References -

Text Books:

- N. Krishna Raju, "Prestressed Concrete", McGraw Hill Education.
- Sinha. N. C. and Roy. S. K., "Fundamentals of Prestressed Concrete", S. Chand & Company Pvt. Ltd., New Delhi.

Reference Books:

- Lin, T.Y. and Burns, "Design of Prestressed Concrete Structures", N. H, John Wiley and Sons.
- Ramamrutham S., "Design of Reinforced Concrete Structures", Dhanpat Rai Publishing Company.
- N. Rajagopalan, Prestressed Concrete, Alpha Science International Ltd.

Class: **First Year M. Tech. Structural Engineering**	Semester-II
Course Code: **CES1225**	Course Name: **Design of Steel Structures**

L	T	P	Credits
3	---	--	3

Course Description:
It consists of design of steel structures, components, design of plate girders, beam-columns, 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:
After successful completion of the course, students will be able to,
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.	**Hoarding Structures:** Analysis and design of hoarding structures under dead, live and wind load condition as per codal provisions.	04
3.	**Transmission Towers:** Introduction, structural configuration, bracing system, analysis and design as per codal provisions. Use working stress method.	06
4.	**Steel Beams with Web Openings:** Shape of the web openings, practical guide lines, and Force distribution and failure patterns, Analysis of beams with perforated thin and thick webs, Design of laterally restrained castellated beams for given sectional properties, Vierendeel girders.	06

5.	**Design of Steel Truss Girder Bridges:** Types of truss bridges, component parts of a truss bridge, economic Proportions of trusses, self-weight of truss girders, design of bridge Compression members, tension members; wind load on truss girder Bridges; wind effect on top lateral bracing; bottom lateral bracing; portal Bracing; sway bracing Design of Lacing	06
6.	**Connections:** 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.	08

References-

Text Books:

- Sai Ram K. S., "Design of Steel Structures", Pearson Education.
- Shiyekar M. R., "Limit State Design in Structural Steel", PHI Learning Private Limited.

Reference Books:

- N. Subramanian, "Design of Steel Structures", Oxford University Press.
- Duggal S. K., "Design of Steel Structures", Mc-Graw Hill Education (India) Private Limited.
- Dayaratnam, Design of Steel Structures, Wheeler Publishing, New Delhi.

IS Codes:

- IS:800-2007, General Construction in Steel- Code of Practice,
- IS: 802-2015, Use of Structural Steel in Overhead Transmission Line Towers-Code of Practice.

Class: **First Year M. Tech. Structural Engineering**	Semester: II
Course Code: **CES1240**	Course Name: **Design of Foundations**

L	T	P	Credits
3	--	--	3

Course Description:
The first module focuses on various concepts and introductory information about different foundations. The design concepts of different types of foundations such as raft, pile and machine foundations. It also includes software applications.The idea behind these is the theory & numerical analysis, visit to site, model study & studying various practical and equipment related This course intends to build the competency in the student to identify various needs of construction industry.

Pre-requisite: students should possess the basic knowledge of soil mechanics and design of structures.

Course Learning Outcomes:
At the end of this course student will be able to:
1. Explain various types of foundations and their design procedures
2. Design different types of foundations.
3. Perform the analysis and design of various types of foundation using available software's.

Course Content

Unit No	Description	Hrs
1.	**Introduction:** Bearing capacity of shallow foundation, design criteria, factors affecting bearing capacity, factors influencing selection of depth of foundation, modes of shear failures, types of shallow foundations, contact pressure under rigid and flexible footings, Terzaghi's, Meyerhof, Hansen's bearing capacity theories, IS code method	06
2.	**Shallow Foundation:** Introduction to types of foundations, design of isolated footing, continuous footing and combined footing. RCC Design of shallow foundation; principles of design of footing, design of isolated footings and strip footing.	06
3.	**Raft Foundation:** Design of Combined Footing and Raft Foundations	06

4.	**Deep Foundation:** Design of deep foundation- RCC Design of pile foundation and pile cap.	06
5.	**Machine Foundation:** Types of Machine Foundations General Requirements of Machine Foundations and Design Criteria, Dynamic Loads, Physical Modeling and Response Analysis, Analysis by Lysmer and Richart, General Analysis of Machine-Foundation-Soil Systems Using Analog Models, General Equations of Motion, Methods of Solution Framed Foundation	06
6.	**Foundations for special structures:** Design of foundations for seashore structures and elastic foundations.	06

References:

Text Books:

- Winterkorn H.F. & Fang H.Y, "Foundation Engineering Hand Book", Van Nostand Reinhold Company.
- Kasmalkar B.J., "Foundation Engineering", Pune Vidyarthi Griha Prakashan.
- Naik N.V, "Foundation Design Manual", Dhanpat Rai and sons.

Reference Books:

- Bowles J.E., "Foundation Analysis and Design"Tata McGraw Hill BookCompany. Poulos, H.G. and Davis, E.H.Pile Foundation Analysis and Design",John Wiley and Sons, New York.
- Mohan, Dinesh, "Pile Foundations", Oxford & IBH Pub. Co. Pvt. Ltd., Delhi.
- Swami Saran, "Soil Dynamics and machine foundation", Galgotia Publications Pvt. Ltd., New Delhi.
- Teng W. C., "Foundation Design", Prentice Hall of India Pvt. Ltd., New Delhi

Class: **S. Y. M. Tech.**	Semester- **III**
Course Code: **CES2015**	Course Name: **Industry Internship**

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

Field Work:

In the industry internship work, the student is expected to get training in the industry related to structural engineering for duration of 2 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 submit the certificate from company regarding satisfactory completion of industry internship

Course Outcomes:

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

List of Open Elective -I

Sr. No.	Course Code	Course
1.	MOE2011	Artificial Intelligence - Machine Learning
2.	MOE2021	Creative Thinking: Techniques and Tools
3.	MOE2031	MOOC Course
4.	MOE2041	Condition Monitoring and Signal Processing
5.	MOE2051	Aircraft Conceptual Design
6.	MOE2060	Introduction to Augmented Reality and Virtual Reality
7.	MOE2070	Industrial Instrumentation
8.	MOE2080	Advanced Mechatronics systems

Open Elective

Class: **S. Y. M. Tech**	Semester- **III**	L	T	P	Credits
Course Code: **MOE2011**	Course Name: **Artificial Intelligence - Machine Learning**	**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.
5. Evaluate a given problem and apply appropriate machine learning technique

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

Course Content

Unit No	Description	Hrs
01	**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
02	**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 Analysis(PCA)- non-negative matrix factorization, Sparse PCA, Kernel PCA. Atom Extraction and Dictionary Learning.	06

03	**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
04	**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
05	**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, and 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
06	**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

References –

Text Books:

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

Reference Books:

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

Open Elective

Class:- **S. Y. M. Tech**	Semester-**III**
Course Code : **MOE2021**	Course Name : **Creative Thinking: Techniques &Tools**

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 behaviors 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

Prerequisite: There are no prerequisites to this course.

Course Content		
Unit No	**Description**	**Hrs**
01	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 creativity	06
02	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
03	**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
04	**Clarifying the Problem:** Organizing a process, turning problems into opportunities, facts, feelings & hunches, problem as question.	06
05	**Generating Ideas:** Brainstorming, scamper, forced connections, portable think tank, case studies on generating ideas.	06
06	**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:

- Michael Michalko, Thinkertoys: A Handbook of Creative-Thinking Techniques, second edition, Ten Speed Press.
- Michael Michalko, Cracking Creativity: The Secrets of Creative Genius, revised edition, Ten Speed Press.
- Edward de Bono, Penguin, Lateral Thinking: A Textbook of Creativity.
- Edward de Bono, Penguin, Six Thinking Hats.

Reference Books:

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

Open Elective

Class: - **S. Y. M. Tech.**	Semester-III
Course Code : **MOE2031**	Course Name : **MOOC Course**

L	T	P	Credits
3	-	-	3

Course Description:
Student can opt for online certification course and produce certificate.

- The students who are doing course on MOOC/NPTEL Course /Courses suggested by DPGC should select the course in consultation with supervisor and submit the details to Head of Program.
- The course should be minimum 25 hours duration and should have certification facility.
- Student should complete course and get certificate. The certificate copy should be submitted to head of program with supervisor signature.

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

1. Identify the real applications and practices of courses studied, at industry level
2. Recognize various modelling, analysis and validation techniques adopted at industries.
3. Demonstrate the issues at design, manufacturing and assembly levels.
4. Summarize and present technical data in report format.

Open Elective

Class:- **S. Y. M. Tech**	Semester-**III**
Course Code: **MOE2041**	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 these 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
01	**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
02	**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 vibration limit detectors, vibration monitoring examples, and critical vibration levels.	06
03	**Sound Monitoring:** Sound frequencies, sound loudness measurement, acoustic power, sound measurement, sound level meters, sound analyzers, and sound signal data processing, sound monitoring.	06

04	**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
05	**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
06	**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:

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

Reference Books:

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

Open Elective

Class:- **S.Y. M. Tech.**	Semester-**III**
Course Code : **MOE2051**	Course Name : **Aircraft Conceptual Design**

L	T	P	Credits
3	-	--	3

Course Description:
This course elaborates 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 power plant, 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. Analyze the design process of aircraft and decide the aircraft configuration.
2. Choose type of power plant as per flight regime.
3. Design the fuselage layout as per type of aircraft.
4. Design the wing for type of aircraft and its wing loading
5. Evaluate lift, drag and mass for design synthesis.
6. Examine the influence of various design requirements on the configuration of an aircraft to derive an optimized design.

Course Content

Unit No	Description	Hrs
01	**Design Process and Aircraft Configuration**: Aircraft design process, cost considerations, optimization, and synthesis process. Conventional configuration, alternative configurations, special considerations.	06
02	**Flight Regime and Power plant Consideration** : Power plant characteristics, types of powerplant, typical engine parameters, flight regimes of power plants, power plant performance representation.	06
03	**Fuselage Layout:** Primary considerations, overall layout, local layout aspects, crew and payload, fuselage procedures.	06
04	**Configuration of the Wing**: Aerofoil section and high lift devices, planform shape and geometry, interaction between aerodynamic structure and wing volume considerations, wing loading.	06
05	**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
06	**Parametric Analysis and Optimization**: Procedure for parametric analysis	06

	(first stage), powerplant 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.	

References -

Text Books:

- Denis Howe, Aircraft Conceptual Design Synthesis, John Wiley & Sons
- John Cutler, Understanding Aircraft Structures, WILEY Blackwell

Reference Books:

- A.C. Kermode, Mechanics of Flight, Person Education.
- Ian Moir & Allan Seabridge, Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, John Wiley & Sons

Open Elective

Class: - **S. Y. M. Tech.**	Semester - **III**
Course Code: **MOE2060**	Course Name: **Augmented Reality and Virtual Reality**

L	T	P	Credits
3	-	-	3

Course Description:
This course presents an introduction to virtual and augmented reality technologies, with an emphasis on designing and developing interactive virtual and augmented reality experiences. The course will cover the history of the area, fundamental theory, and interaction techniques. Students are provided with hands-on experience developing applications for modern virtual and augmented reality systems. In the course, students will also explore libraries and tools for creating AR/VR experiences such as Vuforia and UNITY.

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

1. Define the basic concepts of Virtual and Augmented Reality
2. Identify the differences in AR/VR concepts and technologies
3. Describe the fundamental concepts relating to Virtual Reality such as presence, immersion, and engagement
4. Evaluate usability of AR/VR applications and critique their use of AR/VR capabilities
5. Design and prototype effective AR/VR applications using UNITY platform for various application.

Prerequisites: Programming and Data Structures

Course Content

Unit No	Description	Hrs
01	**Introduction to Augmented Reality:** Definition and Scope , Brief History of Augmented Reality, Displays (Multimodal Displays, Spatial Display Model, and Visual Displays) ,Strong vs Weak ,AR Applications AR Challenges in AR.	06
02	**Introduction to Virtual Reality:** Definition and Scope, Types of VR Characteristics, Basic VR environments, Limitations of VR environments, Immersion Vs Presence.	06
03	**Interaction design for AR/VR environments:** Interaction design process Identifying user needs, AR/VR design considerations Typical AR/VR Interface Metaphors, User experience (UX) guidelines for AR/VR, UX challenges for AR/VR, Prototyping for AR/VR, Evaluation of the developed AR/VR prototype	06
04	**Introduction to UNITY :** Unity Overview: Windows, Interface, Navigation, Terminology, Game Objects, Hierarchy, Parenting Objects, Asset Store, Importing Plug-ins, Creating a Terrain, Materials, Colors, Transparency, Introduction to Mono behaviours: Awake, Start, Update	06

05	**Introduction to Vuforia and Physics in UNITY:** Vuforia Overview: Interface, Navigation, Terminology, Image Targeting, Custom Images, Overview of Physics in Unity, Introduction to Scripting: Terminology, Creating Objects, Accessing Components, Debugging, Lists, Loops	06
06	**Expanding on Scripting and Interaction:** Creating Trigger Events, Manipulating Components in Scripts, Programming Interactions between Objects and Tracked Images in AR, designing a simple User Interface in AR, Introduction to colliders and their use: On Collision Enter, On Collision Exit. On Collision Stay, On Trigger vs On Collision, Rigid bodies and how Colliders report to them.	06

References:

Text Books:

- Vince, "Virtual Reality Systems", Pearson Education.
- Grigore Burdea, Philippe Coiffet,"Virtual Reality Technology", Wiley.
- Schmalstieg, D., & Hollerer, T. Augmented reality: principles and practice.Addison-Wesley Professional.

Reference Books:

- Azuma, R.T. A survey of augmented reality. Presence: Teleoperators & Virtual Environments, 6(4), 355–385.
- Azuma, R., Baillot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. Recent advances in augmented reality. IEEE computer graphics and applications, 21(6), 34-47.
- Bhagat, K. K., Liou, W.-K., & Chang, C.-Y.A cost-effective interactive 3D virtual reality system applied to military live firing training. Virtual Reality, 20(2), 127-140. doi:10.1007/s10055-016-0284-x
- Carmigniani, J., Furht, B., Anisetti, M., Ceravolo, P., Damiani, E., & Ivkovic, M. Augmented reality technologies, systems and applications. Multimedia tools and applications, 51(1), 341-377.
- Raisamo, R., Rakkolainen, I., Majaranta, P., Salminen, K., Rantala, J., & Farooq, A. Human augmentation: Past, present and future. International journal of human-computer studies, 131, 131-143. doi: https://doi.org/10.1016/j.ijhcs.2019.05.008
- Schuemie, M. J., Van Der Straaten, P., Krijn, M., & Van Der Mast, C. A. Research on presence in virtual reality: A survey. CyberPsychology & Behavior, 4(2), 183-201.

Open Elective

Class:- **S. Y. M. Tech**	Semester-**III**
Course Code : **MOE2070**	Course Name : **Industrial Instrumentation**

L	T	P	Credits
3	-	--	3

Course Description:
This course is an overview of the principles, concepts, and applications of process transmitters found in an industrial plant. Continuous measurement and control of all the parameters will be emphasized. Also practical installation and calibration procedures of various types of sensors and transducers will be covered. Open and closed loop control systems will also be discussed, including such concepts as on/off control, set point, overshoot, undershoot, gain, feedback, PID loops, and reverse/direct acting systems.

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

1. Elaborate working principal of different transducers.
2. Select suitable transducer/sensor for specific application.
3. Justify the use of specific measurement technique for specific task.
4. Evaluate the Calibration and Interfacing of the transducers.

Prerequisite: Basic knowledge of sensor and measurement

Course Content

Unit No	Description	Hrs
01	**Metrology:** Measurement of length – Gauge blocks – Plainness – Area using Simpson's rule, Plain meter – Diameter – Roughness – Angle using Bevel protractor, sine bars and Clinometer – Mechanical, Electrical, Optical and Pneumatic Comparators. Optical Methods for length and distance measurements using Optical flats and Michelson Interferometer.	06
02	**Velocity and Acceleration Measurement:** Relative velocity – Translational and Rotational velocity measurements – Revolution counters and Timers – Magnetic and Photoelectric pulse counting stroboscopic methods. Accelerometers-different types, Gyroscopes-applications.	06
03	**Force and Pressure Measurement:** Force measurement – Different methods – Gyroscopic Force Measurement – Vibrating wire Force transducer. Basics of Pressure measurement –Manometer types – Force-Balance and Vibrating Cylinder Transducers – High and Low Pressure measurement – McLeod Gauge, Knudsen Gauge, Momentum Transfer Gauge, Thermal Conductivity Gauge, Ionization Gauge, Dual Gauge Techniques, Deadweight Gauges, Hydrostatic Pressure Measurement	06
04	**Flow Measurement and Level Measurement:** Flow Meters- Head type, Area type (Rota meter), electromagnetic type, Positive displacement type, mass flow meter, ultrasonic type, vertex shedding type, Hotwire anemometer type, Laser Doppler Velocity-meter. Basic Level measurements – Direct, Indirect, Pressure, Buoyancy, Weight, Capacitive Probe methods	06

05	**Density, Viscosity and Other Measurements:** Density measurements – Strain Gauge load cell method – Buoyancy method – Air pressure balance method – Gamma ray method – Vibrating probe method. Units of Viscosity, specific gravity scales used in Petroleum Industries, Different Methods of measuring consistency and Viscosity –Two float viscorator –Industrial consistency meter. Sound-Level Meters, Microphones, Humidity Measurement	06
06	**Calibration and Interfacing:** Calibration using Master Sensors, Interfacing of Force, Pressure, Velocity, Acceleration, Flow, Density and Viscosity Sensors, Variable Frequency Drive. Open and closed loop control system with on/off control, setpoint, overshoot, undershoot, gain, feedback, PID loops, and reverse/direct acting systems.	06

References:

Text Books:

- Doeblin E.O., "Measurement Systems – Applications and Design", McGraw Hill International.
- Patranabis D, "Principles of Industrial Instrumentation", Tata McGraw Hill.

Reference Books:

- Considine D. M., "Process Instruments and Control Handbook", McGraw Hill International.
- Jain R.K., "Mechanical and Industrial Measurements", Khanna Publications.

Open Elective

Class: **S. Y.M. Tech.**	Semester-**III**
Course Code: **MOE2080**	Course Name: **Advanced Mechatronics Systems**

L	T	P	Credits
3	-	-	3

Course Description:
The course will be helpful to provide overview of mechanical and electronic systems used in industrial atmosphere. This will be helpful for upcoming automation in industry. Mechatronics is a multidisciplinary field of science that includes a combination of Mechanical Engineering, Electronics, Computer Engineering, Telecommunications Engineering and Control Engineering. Mechatronics is a multi-disciplinary study dealing with the integration of mechanical devices, actuators, sensors, electronics, intelligent controllers and computers. Mechatronics generally involves

(i) implementing electronics control in a mechanical system
(ii) enhancing existing mechanical design with intelligent control and
(iii) replacing mechanical component with an electronic solution.

This course will cover all aspects related with mechatronics such as sensors and transducers, actuators and mechanisms, signal conditioning, microprocessors and microcontrollers, modeling & system response and design of mechatronics systems.

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

1. Explain Mechatronics System
2. Analyze the Mechatronics Based System
3. Model, simulate, and verify the mechatronics systems.
4. Identify Electrical, Hydraulic and Pneumatic Components.

Prerequisite: Basic knowledge of research related activities.

Course Content

Unit No.	Description	Hrs
01	**Introduction:** What is Mechatronics, Integrated Design Issues in mechatronics, Mechatronics Design Process, Mechatronics Key elements, applications in mechatronics.	06
02	**Modelling and Analysis of Mechatronics Systems:** Block Diagram Modelling, Analogy approach, Impedance Diagrams, Electrical Systems, Mechanical systems and electromechanical systems. Mass-Spring-Oscillation and Damping system, Dynamic response of systems, Transfer function and frequency response. Labview, MATLAB, Scilab	06
03	**Sensors and Actuators:** Performance terminology of sensors, Displacement, Position & Proximity Sensors, Displacement, Position sensors, Force, Fluid	06

	pressure, Liquid flow sensors, temperature, light sensor, Acceleration and Vibration measurement, Electrical and Mechanical Actuation Systems.	
04	**Signal Conditioning:** Introduction to signal processing, Op-Amp as signal conditioner, Analogue to Digital Converter, Digital to Analogue Converter, Signal processing devices, relays, contactors and timers. Microcontrollers, PID controllers and PLCs.	06
05	**Hydraulic system and Pneumatic system :** Flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, and pumps, Pneumatic system components and graphic representations, Advantages and limitations of pneumatic systems.	06
06	**Case Study:** List of various mechatronics systems, Case study of pick and place mechanism of robotic arm using pneumatic power, Hydraulic circuit for CNC Lathe machine, 3D Printer, Auto-control system for Green House Temperature and Auto-focusing in Digital Cameras.	06

References –

Text Books:

- Bradley, D. Dawson, N.C.Burd and A.J. Loader, "Mechatronics: Electronics in product and process", Chapman and Hall, London.
- Devadas Shetty, Richard A.Kolkm, "Mechatronics system design, PWS publishing company.
- David G. Alciatore, Michael B. Histand, "Introduction to mechatronics and measurement systems" Mc Graw Hill Education.

References Books:

- Intelligent Mechatronic Systems: Modeling, Control and Diagnosis, R. Merzouki, A. K. Samantaray, P. M. Pathak, B. Ould Bouamama, Springer, London.
- Technical website: https://onlinecourses.nptel.ac.in/noc21_me27/course

Class: **S. Y.M. Tech.**	Semester- **III**
Course Code: **CES2035**	Course Name: **Dissertation Phase-I**

L	T	P	Credits
-	-	8	4

Dissertation phase I and synopsis approval presentation:
Under the guidance of faculty called as Supervisor PG student from second year is required to do innovative and research-oriented work related to various theory and laboratory courses he/she studied during previous semesters. Dissertation work should not be limited to analytical formulation, experimentation or software-based project. Student can undertake an interdisciplinary type project with the prior permission of DPGC from both departments.

Synopsis:
Student need to carry out exhaustive literature survey with consultation of his/her supervisor for not less than 25 reputed national international journal and conference papers. Student should make the Synopsis Submission Presentation (SSP) with literature survey report to DPGC and justify about the innovativeness, applicability, relevance and significance of the work. At the time of presentation, student shall also prepare Synopsis of the work and submit to department for approval. Student shall submit synopsis of dissertation as per the prescribed format in 02 copies to department.

Course Outcomes:

1. Identify research problem from literature survey.
2. Prepare research design for identified problem.
3. Prepare synopsis report.
4. Present the work plan to be carried out.

Class: **S.Y. M. Tech.**	Semester- **III**
Course Code: **CES2055**	Course Name: **Dissertation Phase-II**

L	T	P	Credits
-	-	12	6

Dissertation phase II:

Phase II evaluation is based on End Semester Examination (ESE) which is based on the work carried out during the semester. It is expected that student shall present preliminary results from his/her work during the semester with report as per prescribed format. DPGC including external examiner as expert will approve the report and progress of student.

Student will submit a report (soft bound before 1 week of date of presentation) as per prescribed format and present to DPGC for ISE and ESE. If student is not showing satisfactory performance in, then he/she will be given grace period of two weeks. After two weeks student will again be evaluated as per guidelines given in rules and regulations.

Course Outcomes:

1. Prepare the set up for experimentation/ develop/ learn software.
2. Perform experimental/software analysis for validation of research work.
3. Generate report of work carried out.
4. Present the work carried out.

Class: **S. Y. M. Tech.**	Semester- **IV**
Course Code: **CES2025**	Course Name: **Dissertation Phase-III**

L	T	P	Credits
-	-	12	6

Dissertation Stage- 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.**	Semester- IV
Course Code: **CES2045**	Course Name: **Dissertation Phase-IV**

L	T	P	Credits
-	-	20	10

Dissertation Phase IV:

In Dissertation Phase-IV, it is expected that student should complete 100% implementation of the objectives defined in approved synopsis. 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 and prepare of a final-copy of the dissertation report with Plagiarism report.

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.