

Amrutvahini Sheti and Shikshan Vikas Sanstha's

AMRUTVAHINI COLLEGE OF ENGINEERING, SANGAMNER

(An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune)

Amrutnagar, Ghulewadi, Sangamner – 422608



Syllabus

Of

M. Tech. Civil Engineering-Structural Engineering

w.e.f

S.Y. M.Tech: 2026 – 2027



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Abbreviation

AICTE - All India Council for Technical

MOOC - Massive Open Online Course NEP –

National Education Policy

NPTEL - National Program on Technology

PCC - Program Core

PEO - Program Educational Objectives

PSO - Program Specific Outcomes

SWAYAM - Study Webs of Active-learning for Young Aspiring Minds

UGC - University Grants Commission

WK - Knowledge and Attitude Profile

CCE - Comprehensive and Continuous Evaluation

ISO - International Organization for Standardization

EOMS - Educational Organization Management System

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Institute Vision

To create opportunities for rural students to become able engineers and technocrats through continual excellence in engineering education.

Institute Mission

Our mission is to create self-disciplined, physically fit, mentally robust and morally strong engineers and technocrats with high degree of integrity and sense of purpose who are capable to meet challenges of ever advancing technology for the benefit of mankind and nature.

We, the management, the faculty and staff, therefore promise to strive hard and commit ourselves to achieve this objective through a continuous process of learning and appreciation of needs of time.

Department Vision

Knowledge center for rural students with continual excellence in technical education

Department Mission

M1: To create self-disciplined, physically fit and competent Civil Engineers with high level of professional, moral and ethical values.

M2: To serve mankind and nature with high integrity and sense of purpose to meet challenges of ever advancing technology through research and development.

M3: To mentor students in pursuit of higher education, employability and entrepreneurship.

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ISO 21001:2018 - EOMS Policy

We, at AVCOE Sangamner, are committed to:

- Provide quality technical education to the rural students
- Provide conducive environment for all round development of the students.
- Develop as a premier institute for technical education & research as per the needs and expectations of all stake holders.
- Comply all applicable requirements.
- Develop students into technocrats having social responsibility.
- Keep abreast about the advances in technology and innovation.
- Enhance industry-institute interaction.
- Managing intellectual property.
- Maintain hygiene, health and safety for applicable requirements.
- Achieve continual improvement in academic and administrative processes.
- We shall strive to maintain Educational Organizational Management System.

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**Program Outcomes (PO's)**

PO1	Engineering knowledge	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO2	Problem analysis	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3	Design / Development of Solutions	complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO4	Conduct Investigations of Complex Problems	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO5	Engineering Tool Usage	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO6	The Engineer and the World	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	Individual and Collaborative Team work	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	Communication	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

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PO10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	Life-Long Learning	Recognize the need for, and have the preparation and ability for i) Independent and life-long learning ii) Adaptability to new and emerging technologies and iii) Critical thinking in the broadest context of technological change. (WK8)

Program Educational Objectives (PEOs)

PEO 1: The graduate will have professional competence with moral and ethical values to enhance their skills related to entrepreneurship, employability and higher education.

PEO 2: The graduate will have sense of commitment for integrated and sustainable socio-economic development of the nation.

PEO 3: The graduate will have an ability and motivation to carry out research and development activities using modern engineering tools and techniques.

PEO 4: The graduate will have capability for critical thinking, engineering reasoning, problem solving, experimentation and teamwork.

Program Specific Outcomes (PSOs)

PSO1: Develop knowledge of building planning constructions, concrete technology, surveying, fluid and hydraulics, structural analysis and design, geotechnical and foundation, construction management, transportation and infrastructure, quantity surveying, and environmental engineering to design, develop and manage the civil engineering structures considering safety, health, ethics and environment aspects.

PSO 2: Apply professional skills and fundamentals of mathematics, basic sciences, numerical methods, computer programming and applied mechanics in civil engineering field for the betterment of society through sustainable development.

PSO3: Excel careers in government, public and private sectors in addition to entrepreneurship and consultancy in the field of civil engineering.

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Preamble

The Post-graduate curriculum structure has been designed in accordance with the National Education Policy (NEP) 2020 and the credit framework prescribed through the relevant Government Resolution (GR). The two-year postgraduate program follows a semester-wise credit distribution that provides a balanced combination of Program Core Courses, Program Elective Courses, and experiential learning components. The structure ensures flexibility, skill development, and progressive attainment of program-specific competencies while adhering to the prescribed credit requirements for each semester and the overall two-year postgraduate program.

Credit Definition

The credit system adopted for the M. Tech. Civil Engineering-Structural Engineering program is based on the guidelines prescribed under the **NEP 2020 framework for Postgraduate Engineering Programs**. The following definitions are used for determining the credits assigned to theory, tutorial and practical components of a course.

Table 1: Credit Definition and Contact Hours

Academic Component	Contact Hours per Week	Credits
Lecture (L)	1 Hour	1 Credit
Practical (P)	2 Hours	1 Credit

Program Credit Requirement

As per the Government of Maharashtra guidelines for implementation of NEP 2020 in undergraduate engineering programs, the two-year M. Tech. Program carries a prescribed credit range of **80 credits (minimum)**. The Institute has adopted a total of **96 credits** for the two-year M. Tech. Civil Engineering-Structural Engineering program, which falls within the prescribed range.

Semester-wise Credit Distribution

The following table presents the semester-wise credit distribution adopted for the two-year M. Tech. Civil Engineering-Structural Engineering program. The credit load is planned within the **23–26 credit range prescribed per semester** under the NEP 2020 framework.

Table 2 -Semester-wise total credits

Year	Semester	Credits
First Year	Semester I	23
	Semester II	23
Second Year	Semester III	24
	Semester IV	26
Total		96

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Exit Point: For those who join 2 year PG program, there shall only be one exit point. Students who exit at the end of 1st year shall be awarded a Postgraduate Diploma.

Program codes

The institute has assigned a unique program code to each branch

Table 1 – Program codes

Sr. No.	Program code	Code
PG Program		
1	M. Tech. Structural Engineering	MSE

Subject code Nomenclature

The following nomenclature demonstrates the subject codes:

- **R-Year** (of designing/revising syllabus) – **Program code** (as given in table 1) - **Course Type** (as per NEP) – **Course Number** (501 – M. Tech Subject 1, 502 - M. Tech Subject, etc.)

Guidelines for Examination Scheme

The evaluation of students shall be based on continuous academic performance in a course based on Comprehensive Continuous Evaluation (CCE) and End Semester Examination (ESE). Components of the Examination System:

1. Comprehensive Continuous Evaluation (CCE):

- CCE of 50 marks based on all the Units of course.
- To design a Comprehensive Continuous Evaluation scheme for a theory subject of 50 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Table 2: Allocation of marks & structure for 3-Credit Subject

Sr. No.	Examination	Conduction Marks	Coverage of Units
1	CCE –I (Class test – 1) (CT-I)	15	Units 1-(8 Marks) , Unit 2- (7 Marks)
2	CCE –II (Class test – II.) (CT-II)	15	Units 3-(8 Marks) , Unit 4- (7 Marks)
3	CCE –III (Open Book Test, Seminar, Assignment.)	20	Unit 5- 10 Marks- Open Book test Assignments – 5 Marks Seminar- 5 Marks
Total		50	

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2. End Semester Examination (ESE):

The ESE is a compulsory examination for all students. The ESE examination will be conducted at the end of the semester by the institute Department of Examination and Evaluation (DEE). The ESE will be based on 100% syllabus (Unit 1 to Unit 5). The ESE shall be of 50 marks (10 Marks / Unit) conducted for all theory courses as mentioned in the program structure.

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Curriculum Structure

Second Year M. Tech (Structural Engineering) (2025 Pattern) (Semester III)

Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks					Credits			
			Theory	Tutorial	Practical	CCE*	End-Sem	Term work	Practical	Oral	Theory	Tutorial	Practical	Total
Semester III														
R25-MSE-RM-601	RM	Research Methodology and IPR	4	-	-	50	50	-	-	-	4	-	-	4
R25-MSE-OJT/II-602	On job Training/ Internship	Industry Internship	-	-	10	--	--	100	-	-	--	-	5	5
R25-MSE-MOOC/ SWAYAM-603	Major Core Course	Program open elective courses based on MOOC / SWAYAM Prabha Platform. • Disaster Management • Artificial Intelligence in Structural Engg • Optimization Technique • Any others course	4	-	--	--	50	-	-	-	4	-		4
R25-MSE-RPS I-604	Research Project	Research Project Stage -I	--	-	18	--	--	-	-	50	--	-	9	9
R25-MSE-CTS-605	Civitech Skills Course	Introduction to Constitution of India	-	-	--	-	-	--	-	--	-	-	-	2
Total			08	-	28	50	100	100	--	50	08	--	14	24

CCE*: Comprehensive Continuous Evaluation

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**Second Year M. Tech (Structural Engineering) (2025 Pattern) (Semester VI)**

Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks					Credits			
			Theory	Tutorial	Practical	CCE*	End-Sem	Term work	Practical	Oral	Theory	Tutorial	Practical	Total
Semester IV														
R25-MSE-SEM III-606	Research Project	Seminar-II	-	-	08	--	--	50	-	50	-	-	04	4
R25-MSE-RPS II-607	Research Project	Research Project Stage-II	-	-	36	-	-	150	-	50	-	-	18	18
R25-MSE-CTS-608	Civitech Skills Course	Cyber Security	--	-		--	--	-	-	-	--	-	--	4
Total			-	-	44	--	--	200	--	100	--	--	18	26

CCE*: Comprehensive Continuous Evaluation

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M.Tech– Civil Engineering- Structural Engineering

S.Y. Syllabus Semester III

Program:	S. Y. M. Tech			Semester:	III		
Course:	Research Methodology			Course Code:	R25-MSE-RM-601		
Teaching Scheme (Hrs/week)			Credits	Examination Scheme			
Lecture	Practical	Tutorial		CCE	ESE	TW	PR
04 Hrs/Week	-	-	04	50	50	-	-

Course Description:

This course introduces the systematic principles, tools, and ethical frameworks required to design and execute robust engineering research. Students will learn to formulate scientific hypothesis statements, conduct structured literature surveys using advanced databases, and design rigorous experimental or computational frameworks. The curriculum covers statistical data analysis—including the Design of Experiments (DoE), regression analysis, and error propagation—alongside patent search strategies, intellectual property rights (IPR), and research ethics. By the end of the course, participants will be equipped to draft high-quality research proposals, technical journal manuscripts, and dissertation frameworks that meet global academic and publication standards.

Course Relevance:

Research Methodology is highly relevant for postgraduate students because it provides the systematic tools and statistical skills needed to convert raw engineering ideas into structured, scientifically valid research. It ensures data accuracy through advanced techniques like the Design of Experiments (DoE) while guiding students through patent filing and ethical journal publication practices. Mastering this course directly enhances the quality, credibility, and global acceptance of a student's master's dissertation or industrial R&D project.

Prerequisite: Research Methodology, need a basic foundation in Engineering Mathematics (Probability and Statistics) to comprehend data analysis and sampling techniques. Additionally, familiarity with basic Technical Writing or Communications is helpful for structuring reports, along with prior experience conducting fundamental literature searches during an undergraduate capstone project.

Bridge Content: Transitions from consumer-level knowledge to active, creator-level scientific research by connecting unstructured undergraduate projects to formal academic frameworks. It shows how to transform casual Google searches into systematic, peer-reviewed database queries and upgrades basic laboratory trial-and-error methods into mathematically rigorous, optimized Design of Experiments (DoE) matrices.

Course Objectives:

This course aims to train students to systematically design and execute scientifically valid engineering research using structured FEA/experimental validation and Design of Experiments (DoE) matrices. It focuses on equipping students with advanced statistical tools to analyze research data, identify patent-worthy innovation, and avoid plagiarism. By the end of the course, participants will be able to draft high-quality research proposals and technical journal manuscripts that conform to global publication ethics.

Course Outcomes: After learning the course, students will be able to

CO	Course Outcome	Bloom's Level
CO1	FORMULATE structured engineering research problems and designs by translating initial literature gaps into bounded hypotheses, variables, and rigorous validation frameworks.	3
CO2	CONSTRUCT AND EVALUATE mathematical models and prediction metrics to analytically simulate physical engineering	3

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	performance and establish system behavioral bounds.	
CO3	DEPLOY basic instrumentation systems for precise data acquisition and apply applied statistics (such as ANOVA, regression, and error propagation) to validate data reliability and significance.	3
CO4	DRAFT high-quality research reports, patents, and journal manuscripts that strictly adhere to global publication ethics, rigorous peer-review structures, and indexing requirements.	3
Course Content		
Unit 1	Introduction, Research Problem and Research Design	8 Hrs.
CO Mapped: CO 1		
Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Criteria of Good Research, Definition of good research problem, Feasibility study of research problem, Importance of research problem, Sources of research problem, Criteria of good research problem, Meaning of Hypothesis, Characteristics of Hypothesis, Errors in selecting a research problem, Concept & need of research design, Meaning of variable, Selection of variables.		
Unit 2	Mathematical Modelling and prediction of performance	8 Hrs.
CO Mapped: CO 2		
Steps in Setting up a computer model to predict performance of experimental system, Validation of results, Multi-scale modelling and verifying performance of process system, Nonlinear analysis of system and asymptotic analysis, verifying if assumptions hold true for a given apparatus setup, Plotting family of performance curves to study trends and tendencies, Sensitivity analysis.		
Unit 3	Basic instrumentation	8 Hrs.
CO Mapped: CO 3		
Instrumentation schemes, Static and dynamic characteristics of instruments used in experimental set up, Performance under flow or motion conditions, Data collection using a digital computer system, Linear scaling for receiver and fidelity of instrument, Role of DSP in data collection in noisy environment, Good measurement practice.		
Unit 4	Applied statistics	8 Hrs.
CO Mapped: CO 4		
Regression analysis, curve fitting and developing Correlation, Parameter estimation, Multivariate statistics, Principal component analysis, Moments and response curve methods, State vector machines and uncertainty analysis, Probable errors in the research, Error analysis and methods to reduce errors in research process.		
Unit 5	Research report writing and Publication	8 Hrs.
CO Mapped: CO 4		
Research Report: Dissemination of research findings, outline and structure of research report, different steps and precautions while writing research report, methods and significance of referencing		
Publishing Research work: Selection of suitable journal for publishing research work, Open access Vs Subscription Journals, identifying indexing of selected journals, Impact factor of the journal, structure of research paper, Check for plagiarism of the article, Research paper submission and review process.		
Reference Books:		
1. Research methodology: An Introduction for Science & Engineering students, by Stuart Melville and Wayne Goddard 2. Research Methodology: Methods and Trends, by Dr. C. R. Kothari 3. Research Methodology: An Introduction by Wayne Goddard and Stuart Melville 4. Research Methodology: A Step by Step Guide for Beginners, by Ranjit Kumar, 2nd Edition 5. Operational Research by Dr. S.D. Sharma, Kedar Nath Ram Nath & Co. 6. Software Engineering by Pressman		
MOOCs Links and additional reading material:		
1. https://onlinecourses.nptel.ac.in/noc24_ge21/preview 2. https://onlinecourses.nptel.ac.in/noc26_ge42/preview		



3. https://onlinecourses.nptel.ac.in/noc22_ma20/preview
4. https://onlinecourses.nptel.ac.in/noc24_ec03/preview

CO-PO mapping table:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO	PSO	PSO
CO1	3	-	2	2	2	-	-	2	2	-	-	2	2	2
CO2	3	-	3	2	2	-	-	2	2	-	-	2	2	2
CO3	2	-	3	2	2	-	-	2	2	-	-	2	2	2
CO4	3	-	2	2	2	-	-	2	2	-	-	2	2	2
Avg	3	-	2.6	2	2.2	-	-	2	2	-	-	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

BT Level	CCE						ESE
	CT1	CT2	Open Book Test	Assignment	Seminar / Case Study	Quiz / presentation etc.	
L1	✓	✓	✓	✓	✓		✓
L2	✓	✓	✓	✓	✓		✓
L3	✓	✓	✓	✓	✓		✓
L4				✓	✓		
L5							
L6							

Unit wise Weightage:

Exam	Unit1	Unit2	Unit3	Unit4	Unit5	Total
CT1	8	7				15
CT2			8	7		15
Open Book Test					10	10
Assignments	5					05
Seminar	5					05
ESE	10	10	10	10	10	50
						100

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Program:	S. Y. M. Tech			Semester:	III		
Course:	On job Training/ Internship			Course Code:	R25-MSE-OJT/II-602		
Teaching Scheme (Hrs/week)			Credits	Examination Scheme			
Lecture	Practical	Tutorial		CCE	ESE	TW	OR
-	10 Hrs/Week	-	05	-	-	100	-
Course Description: 1. Internship/On Job Training provide students the opportunity of hands-on experience that includes personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. 2. An internship is the phase of time for students when they are trained for their skills, they are good at, and it gives them a chance to apply their knowledge practically in industries 3. The internship can be carried out in any industry/R&D Organization/Research Institute/Institute of national repute. 4. The Department shall nominate a faculty to facilitate, guide and supervise students under internship.							
Course Relevance: Internships are designed to bridge the gap between academic learning and industry practice. They aim to provide hands-on experience, expose students to the industrial environment, develop technical and soft skills (communication, teamwork, problem-solving), and help in career exploration.							
Course Objectives: 1. To put theory into practice and expand thinking and broaden the knowledge and skills acquired through coursework in the field. 2. To relate to, interact with, and learn from current professionals in the field. 3. To understand and adhere to professional standards in the field. 4. To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality. 5. To develop the initiative and motivation to be a self-starter and work independently.							
Course Outcomes: After learning the course, students will be able to							
CO	Course Outcome					Bloom's Level	
CO1	GAIN practical experience within industry in which the internship is done.					3	
CO2	ACQUIRE knowledge of the industry in which the internship is done.					3	
CO3	APPLY knowledge and skills learned to classroom work.					3	
CO4	DEVELOP oral and written communication skills.					3	
CO5	ACQUIRE the knowledge of administration, marketing, finance and economics.					3	
Course Content							
Guidelines							
• Internship Duration and Academic Credentials – Students can take internship work in the form of Online/Offline mode from any of the Industry / Government Organization Internship Program approved by AICTE/UGC portals – An intern is expected to spend 10 - 12 hours per week on the Internship. Training will result in about 160-170 hours of total internship duration. – The minimum requirement regarding Internship duration should not be below 8 weeks							
• Type of Internship – Industry/Government Organization Internship: Working directly with a company or government body. – Research Internship: Focused on research projects, often in collaboration with academic institutions or R&D labs.							



- Innovation/Entrepreneurship: Working on developing new products, processes, or even starting a venture.
- Social Internship: Engaging in community-based projects.

• Assessment Details (TW and Practical)

- Term work for 100 marks
- A daily log submitted by the student and a work log signed by the office HoD where the student has interned will be considered towards the TW marking.

Indicative List of Areas for On-Job Training (OJT) – Civil Engineering

1. Advanced Structural Design and Analysis – Analysis and design of RCC, steel and composite structures using STAAD.Pro, ETABS, SAP2000 or equivalent software.
2. Structural Engineering and Seismic Analysis – Structural modelling, earthquake-resistant design, response spectrum analysis, wind analysis and structural performance assessment.
3. Building Information Modelling (BIM) – BIM-based modelling, coordination, quantity take-off, clash detection and documentation using Revit, Navisworks or equivalent software.
4. Computer-Aided Design (CAD) – Preparation of 2D drawings, detailed structural drawings, architectural drawings and construction documentation using AutoCAD or equivalent software.
5. Geotechnical Engineering and Foundation Design – Soil investigation, bearing capacity, settlement analysis and design of isolated, combined, raft and pile foundations.
6. Advanced RCC and Steel Design – Design and detailing of beams, slabs, columns, shear walls, staircases, connections, trusses and industrial structures.
7. Construction Planning and Project Management – Planning, scheduling, resource management, cost control and monitoring using Primavera, MS Project or equivalent software.
8. Quantity Surveying and Estimation – Quantity take-off, rate analysis, preparation of BOQ, tender documentation, billing and cost estimation.
9. Construction Technology and Site Management – Site supervision, construction methodology, material management, quality control and execution of building and infrastructure projects.
10. Highway and Transportation Engineering – Highway geometric design, pavement design, traffic studies, road safety, transportation planning and highway construction.
11. Traffic Engineering and Intelligent Transportation Systems – Traffic surveys, capacity analysis, signal design, traffic modelling, road safety assessment and smart transportation systems.
12. Water Resources and Hydraulic Engineering – Design and analysis of water supply systems, drainage systems, irrigation structures, canals, reservoirs and hydraulic networks.
13. Environmental Engineering and Sustainable Infrastructure – Water and wastewater treatment, solid waste management, environmental monitoring and sustainable construction practices.
14. Structural Health Monitoring and Condition Assessment – Structural inspection, non-destructive testing, damage assessment, instrumentation, monitoring and performance evaluation.
15. Structural Audit, Retrofitting and Rehabilitation – Condition assessment of existing structures, identification of defects, strengthening techniques, repair methods and rehabilitation strategies.
16. Earthquake Engineering and Disaster-Resistant Construction – Seismic vulnerability assessment, earthquake-resistant detailing, structural strengthening and disaster mitigation techniques.
17. Advanced Construction Materials and Concrete Technology – High-performance concrete, self-compacting concrete, fiber-reinforced concrete, geopolymer concrete and sustainable construction materials.
18. Construction Automation, Digitalization and Industry 4.0 – Digital twins, IoT-based monitoring, drones, automation, smart construction sites, data analytics and digital project management.
19. AI/ML Applications in Civil Engineering – AI/ML applications in structural prediction, construction planning, quantity estimation, defect detection, traffic forecasting and infrastructure management.
20. Surveying, GIS and Remote Sensing – Total station, GPS/GNSS, drone surveying, GIS mapping, remote sensing, topographic surveys and digital terrain modelling.

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21. Advanced Geotechnical and Foundation Engineering – Ground improvement, slope stability, retaining structures, deep foundations, soil-structure interaction and geotechnical instrumentation.
22. Industrial Research and Development (R&D) in Civil Engineering – Experimental research, material testing, structural testing, prototype development, field investigations, technical documentation and development of innovative construction technologies.

Faculty Supervision: Students are usually assigned an internal faculty guide/mentor who supervises their internship activities. This faculty member acts as a teacher, mentor, and critic, and ensures the internship aligns with academic goals. **External Supervision:** In many cases, an external expert from the host organization also guides the student.

• Documentation and Reporting:

- Joining Report: To be submitted within a specified time frame (e.g., one week from joining).
- Daily/Periodical Diary: Students are often required to maintain a daily or weekly record of their observations, work, and learning.

• Internship Report: A comprehensive report detailing the work done, learning outcomes, and achievements during the internship. This report needs to be duly signed by the company official and the faculty mentor.

- Completion Certificate: Issued by the host organization upon successful completion.

• Evaluation:

- Evaluation is typically done by the institute, often within a short period after the internship ends.
- It may involve presentations, viva-voce examinations, and assessment of the internship report and daily diary.
- Performance-based feedback from the industry mentor is usually a key component.

CO-PO mapping table:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 01	PSO 02	PSO 03
CO1	3	-	2	2	2	-	-	2	2	-	-	2	2	2
CO2	3	-	3	2	2	-	-	2	2	-	-	2	2	2
CO3	2	-	3	2	2	-	-	2	2	-	-	2	2	2
CO4	3	-	2	2	2	-	-	2	2	-	-	2	2	2
Avg.	3	-	2.6	2	2.2	-	-	2	2	-	-	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Approved By:



Program:	S. Y. M. Tech			Semester:	III		
Course:	Program open elective courses based on MOOC / SWAYAM Platform.			Course Code:	R25-MSE-MOOC/ SWAYAM-603		
Teaching Scheme (Hrs/week)			Credits	Examination Scheme			
Lecture	Practical	Tutorial		CCE	ESE	TW	PR
04 Hrs/week	-	-	04	-	50	-	-
Course Description: The Program Open Elective shall be offered through SWAYAM/NPTEL/MOOC platforms or through an equivalent approved blended-learning mode. Students shall select one course from the list. The course shall be supported by faculty mentoring, application-based assignments, case studies, and/or a mini-project. The final evaluation shall consider SWAYAM/NPTEL/MOOC performance, internal assessment, and application-based evaluation as prescribed by the Institute. The list of courses are 1.Disaster Management 2.Artificial Intelligence in Structural Engg 3.Optimization Technique 4.Any others course							

Approved By:



Program:	S. Y. M. Tech			Semester:	III		
Course:	Research Project Stage -I			Course Code:	R25-MSE-RPS I-604		
Teaching Scheme (Hrs./week)			Credits	Examination Scheme			
Lecture	Practical	Tutorial		CCE	ESE	TW	OR
-	18 Hrs./Week	-	09	-	-	-	50

Course Description:

Project Stage I is intended to develop the student's ability to identify, formulate, and investigate a relevant engineering research or industrial problem in the field of Civil Engineering. Students shall carry out an extensive literature survey to understand the current state of knowledge, identify research gaps, and establish the significance of the proposed study.

The project work includes problem definition, formulation of objectives, development of methodology, and preparation of an experimental, analytical, numerical, or field investigation plan. Students may use modern civil engineering tools and technologies such as CAD, Building Information Modelling (BIM), structural analysis and design software, Finite Element Analysis (FEA), GIS, remote sensing, numerical modelling, optimization, artificial intelligence, machine learning, and simulation techniques, as applicable.

The work may be based on experimental investigation, analytical modelling, numerical analysis, structural analysis and design, construction materials and technology, geotechnical engineering, transportation engineering, environmental engineering, water resources engineering, construction management, structural health monitoring, structural assessment, rehabilitation and retrofitting, infrastructure development, or industrial applications.

Emphasis shall be given to innovation, sustainability, safety, durability, constructability, cost-effectiveness, environmental considerations, and practical relevance of the proposed work. Students shall review their progress periodically with the project guide and departmental review committee.

At the end of Stage I, students shall submit a detailed project report containing the problem statement, literature review, research gap, objectives, scope of work, proposed methodology, work plan, and preliminary results/findings, wherever applicable.

The project work completed in Stage I shall form the foundation for further investigation, implementation, validation, analysis, and completion during Project Stage II.

Course Relevance:

Project Stage I provides students with an opportunity to apply advanced Civil Engineering knowledge and practices to real-world research, infrastructure, construction, and industrial problems. It develops skills in problem identification, literature review, research methodology, field investigation, experimental work, numerical modelling, structural analysis, and engineering evaluation.

The course promotes innovation, sustainable construction practices, independent learning, and the effective use of modern civil engineering tools and technologies such as BIM, structural analysis software, GIS, FEA, numerical simulation, and data-driven techniques. It also strengthens students' research, analytical, design, technical, and problem-solving capabilities essential for professional practice in Civil Engineering.

The work carried out in Project Stage I provides a strong foundation for advanced research, practical implementation, infrastructure development, and successful completion of Project Stage II.

Prerequisite:

Students should have fundamental knowledge of Civil Engineering principles and practices, including structural engineering, construction materials, geotechnical engineering, transportation engineering, environmental engineering, and surveying. They should be familiar with engineering mathematics, basic statistics, and research methodology.

Knowledge of CAD/BIM tools, structural analysis and design software, numerical modelling, GIS, and computational techniques is desirable. Students should have the ability to search, review, interpret, and critically evaluate technical and research literature.

Basic knowledge of engineering problem-solving, data collection and analysis, field investigation, experimental methods, and engineering applications is expected.

**Course Objectives:**

- To enable students to identify and formulate relevant **research, infrastructure, construction, or industrial problems in Civil Engineering**.
- To develop the ability to conduct a **systematic literature review** and identify research gaps related to Civil Engineering problems.
- To formulate appropriate **objectives, scope, and research questions** and develop a suitable research methodology.
- To apply **advanced Civil Engineering knowledge and modern tools and techniques** such as BIM, CAD, structural analysis, FEA, GIS, numerical modelling, simulation, and data analysis for problem investigation and preliminary analysis.
- To develop **research, analytical, problem-solving, innovation, field investigation, and technical communication skills** required for successful completion of the project.

Course Outcomes: After learning the course, students will be able to

CO	Course Outcome	Bloom's Level
CO1	IDENTIFY, FORMULATE, AND DEFINE a relevant research, infrastructure, construction, or industrial problem in Civil Engineering.	3
CO2	CONDUCT a systematic literature review and IDENTIFY research gaps related to the selected Civil Engineering problem.	3
CO3	DEVELOP an appropriate research methodology and APPLY suitable analytical, computational, experimental, field investigation, or simulation tools for the selected Civil Engineering problem.	3
CO4	PRESENT AND DOCUMENT the project work effectively through technical reports, presentations, drawings, data analysis, and preliminary research outcomes.	3

Course Content**Phases of Project Stage 1 and Evaluation Weightage**

Phase	Project Activity	Weightage
Phase I	Topic selection, problem identification and project guide allocation	10%
Phase II	Detailed literature review and identification of research gap	20%
Phase III	Problem formulation, objectives and scope of work	15%
Phase IV	Research methodology, design approach and work plan	20%
Phase V	Preliminary analytical/experimental/computational work and validation plan	20%
Phase VI	Project presentation, report preparation and submission	15%

CO-PO mapping table:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO	PSO	PSO
CO1	3	-	2	2	2	-	-	2	2	-	-	2	2	2
CO2	3	-	3	2	2	-	-	2	2	-	-	2	2	2
CO3	2	-	3	2	2	-	-	2	2	-	-	2	2	2
CO4	3	-	2	2	2	-	-	2	2	-	-	2	2	2
Avg	3	-	2.6	2	2.2	-	-	2	2	-	-	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Approved By:



Program:	F. Y. M. Tech			Semester:	III		
Course:	Introduction to Constitution of India			Course Code:	R25-MSE-CTS-605		
Teaching Scheme (Hrs/week)			Credits	Examination Scheme			
Lecture	Practical	Tutorial		CCE	ESE	TW	PR
-	-	-	02	-	-	-	-

Course Description:

The Constitution is the supreme law of the land, the course is designed to ensure every citizen and higher-education student understands its foundational principles, structural philosophy, and civil responsibilities.

Course Relevance:

- **The Preamble as a Foundation:** The course highlights the Preamble to clarify the core source of authority ("We, the people of India") and its guiding ideals: Sovereignty, Socialism, Secularism, Democracy, and the Republic status of the nation.
- **Awareness of Rights & Limitations:** It is designed to acquaint students with their Fundamental Rights, while simultaneously emphasizing that no individual right is absolute—each is subject to the rights of others and the broader public interest.
- **Socio-Economic Goals:** It frames the Directive Principles of State Policy as the non-enforceable moral and policy obligations of the government aimed at establishing socio-economic justice.

Course Objectives:

The primary objectives of the Introduction to Constitution of India postgraduate course are to:

- To understand the history and philosophy of the Indian Constitution, exploring its background, foundational goals, and structural architecture.
- To analyze the functional mechanics of the Union, State, and local governance systems, alongside the constitutional division of powers.
- To internalize civil rights and responsibilities, ensuring students can distinguish between fundamental rights, state directive policies, and individual duties.
- To cultivate constitutional morality, nurturing a deep respect for democratic processes, social justice, and rule-of-law principles in daily civic life.

Course Outcomes: Upon successful completion of this course, students will be able to:

- **CO1 - Gain Structural Knowledge:** Understand the basic features, the federal architecture, and the division of powers between the Union, State, and local political institutions
- **CO 2 - Develop Civic Sense:** Cultivate a deep sense of responsible citizenship, democratic values, and constitutional morality.
- **CO3 - Internalize National Duties:** Recognize and execute fundamental duties, such as safeguarding public property, respecting national ideals, and promoting communal harmony.

NOTE: This is self-paced Course, Students should study as per course content and submit one summary Assignment for the Course for the evaluation of 1 Credit.

Course Content			
Unit 1	Fundamental Rights (Part III)	-	CO Mapped: CO 1
Right to equality, freedoms, and exploitation protection. Freedom of religion, cultural/educational rights, and constitutional remedies.			
Unit 2	Directive Principles of State Policy (Part IV)	-	CO Mapped: CO 1
International and national standards on Human Rights and Women's Rights. International and national legal benchmarks for the Human Rights of Children.			
Unit 3	Equal justice, free legal aid, and the right to work	-	CO Mapped: CO 2



Equal justice, free legal aid, and the right to work. Uniform Civil Code, public health, environment protection, and separation of the judiciary from the executive.

Unit 4	Fundamental Duties (Part IV-A)	-	CO Mapped: CO 3
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Duties to abide by the Constitution, defend the country, preserve composite culture, and safeguard public property.

Unit 5	Structure of Government	-	CO Mapped: CO 3
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Overview of the Union and State executive, legislature, and federal dynamics.

Reference Books:

1. Introduction to the Constitution of India by Dr. D.D. Basu (or M. Laxmikanth)
2. Our Constitution by Subhash Kashyap (National Book Trust)
3. Introduction to the Constitution of India by Brij Kishore Sharma (PHI Learning)

MOOCs Links and additional reading material:

1. https://onlinecourses.nptel.ac.in/noc26_lw10/preview
2. https://onlinecourses.nptel.ac.in/noc24_lw09/preview
3. https://onlinecourses.nptel.ac.in/noc20_lw03/preview



Amrutvahini College of Engineering, Sangamner

M. Tech– Civil Engineering- Structural Engineering

S.Y. Semester IV

Program:	S. Y. M. Tech			Semester:	IV		
Course:	Seminar II			Course Code:	R25-MSE-SEM III-606		
Teaching Scheme (Hrs/week)			Credits	Examination Scheme			
Lecture	Practical	Tutorial		CCE	ESE	TW	PR
-	08 Hrs/Week	-	04	-	-	50	50

Course Description:

Seminar II is entirely based on case studies related to the student's project topic.

Course Relevance:

The course develops the ability to critically analyse real-world Civil Engineering, infrastructure, construction, and research case studies. It enables students to connect theoretical knowledge with practical engineering problems and contemporary practices in structural engineering, construction technology, geotechnical engineering, transportation, environmental engineering, water resources, and infrastructure development.

The course supports the selection and application of appropriate construction materials, design methods, structural analysis techniques, BIM/CAD tools, numerical modelling, simulation, optimization, field investigation, testing, and experimental techniques for project development.

It strengthens students' research, analytical, problem-solving, innovation, engineering judgement, and technical communication skills. The knowledge gained through case studies provides a strong foundation for the successful planning, execution, analysis, documentation, and evaluation of Project Stage I and Project Stage II.

Course Objectives:

1. To develop the ability to identify and analyse relevant **industrial, infrastructure, construction, and research case studies in Civil Engineering**.
2. To understand and critically evaluate existing **civil engineering methodologies, construction materials, design practices, construction processes, and engineering solutions**.
3. To develop skills in selecting and applying appropriate **CAD/BIM, structural analysis, numerical modelling, GIS, simulation, optimization, experimental, field investigation, and computational techniques**.
4. To identify **research gaps, technological challenges, sustainability issues, and opportunities for innovation** through the study of Civil Engineering case studies.
5. To enhance students' **analytical, problem-solving, research, engineering judgement, technical documentation, and presentation skills** for successful project planning and execution.

Course Outcomes: After learning the course, students will be able to

CO	Course Outcome	Bloom's Level
CO1	IDENTIFY AND ANALYSE relevant industrial, infrastructure, construction, and research case studies related to advanced Civil Engineering applications.	3
CO2	CRITICALLY EVALUATE existing Civil Engineering methodologies, construction materials, design practices, construction processes, and CAD/BIM, structural analysis, simulation, optimization, experimental, and field investigation approaches.	3
CO3	APPLY insights gained from case studies to formulate suitable	3

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	methodologies and develop innovative and sustainable solutions for their M.Tech Civil Engineering project.	
CO4	PRESENT AND DOCUMENT case-study findings, comparative analysis, technical observations, project outcomes, and potential industrial and infrastructure applications effectively.	3

Course Content

Seminar – Case Study Based on Project

1. To study and critically analyse relevant **industrial, infrastructure, construction, and research case studies** related to the selected M.Tech Civil Engineering project.
2. To examine existing **structural design approaches, construction materials, construction methodologies, analytical methods, numerical modelling, simulation techniques, and optimization strategies** used in similar Civil Engineering applications.
3. To compare different **Civil Engineering solutions** and evaluate their performance, advantages, limitations, sustainability, and practical applicability.
4. To identify **research gaps, technological challenges, sustainability issues, and opportunities for innovation** based on the selected case studies.
5. To develop an understanding of appropriate **CAD/BIM, structural analysis, FEM, GIS, experimental, numerical modelling, optimization, AI/ML, and computational techniques** applicable to the selected project.
6. To relate the findings of the case studies to the proposed **project methodology, design requirements, construction practices, and performance criteria**.
7. To analyse and discuss the project's **preliminary and final results/findings** in comparison with relevant published research, field studies, and industrial case studies.
8. To evaluate the proposed Civil Engineering solution in terms of **structural performance, safety, durability, sustainability, constructability, cost-effectiveness, and potential industrial or infrastructure application**.
9. To develop students' skills in **technical literature analysis, critical thinking, research interpretation, engineering judgement, data analysis, and technical presentation**.
10. To present the **case-study analysis, project progress, findings, and engineering contribution** before the review committee and submit a comprehensive seminar report.

Evaluation Criteria: The technical seminar will be evaluated based on the following criteria:

- **Topic Selection and Scope (10%):** Relevance, timeliness, and appropriate depth of the chosen topic. Clarity and focus of the topic proposal.
- **Literature Review and Research (25%):** Breadth and depth of literature surveyed. Quality and credibility of sources used. Critical analysis and synthesis of information.
- **Seminar Report/Paper (30%):** Clarity, organization, and logical flow of content. Technical accuracy and depth of discussion. Adherence to academic writing standards (grammar, spelling, formatting, referencing). Originality in synthesis and critical insights. Absence of plagiarism.
- **Oral Presentation (35%):** Content: Clarity, completeness, and accuracy of the presented material. Organization: Logical flow, effective use of time. Visual Aids: Quality, clarity, and effectiveness of slides. Delivery: Confidence, clarity of speech, enthusiasm, engagement with the audience. Q&A: Ability to answer questions accurately, comprehensively, and confidently

**CO-PO mapping table:**

CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 01	PSO 02	PSO 03
CO1	3	-	2	2	2	-	-	2	2	-	-	2	2	2
CO2	3	-	3	2	2	-	-	2	2	-	-	2	2	2
CO3	2	-	3	2	2	-	-	2	2	-	-	2	2	2
CO4	3	-	2	2	2	-	-	2	2	-	-	2	2	2
Avg.	3	-	2.6	2	2.2	-	-	2	2	-	-	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Approved By:



Program:	S. Y. M. Tech			Semester:	IV		
Course:	Research Project Stage -II			Course Code:	R25-MSE-RPS II-607		
Teaching Scheme (Hrs/week)			Credits	Examination Scheme			
Lecture	Practical	Tutorial		CCE	ESE	TW	OR
-	36 Hrs/Week	-	03	-	-	150	50

Course Description:

Project Stage II focuses on the implementation and completion of the research/project work initiated in Project Stage I. Students shall carry out detailed analytical, experimental, computational, simulation, or prototype development work as per the approved methodology. The course emphasizes systematic data collection, analysis, validation, interpretation of results, and comparison with existing work. Students shall demonstrate innovation, engineering judgement, practical applicability, and technical competence in solving the selected Design Engineering problem. The course culminates in the preparation and presentation of the final project report, highlighting the methodology, results, conclusions, contributions, and future scope..

Course Relevance:

Project Stage II enables students to implement and complete the approved Design Engineering project. It provides practical experience in analysis, experimentation, simulation, prototype development, and data interpretation. The course develops problem-solving, innovation, validation, and engineering decision-making skills. It promotes application of research outcomes to real-world industrial and engineering problems. It prepares students for professional practice, research publications, patents, and further research.

Prerequisite:

Students should have successfully completed Project Stage I and obtained approval of the project proposal. Students should have adequate knowledge of Design Engineering principles, engineering analysis, and research methodology. Familiarity with relevant CAD/CAE, FEM, simulation, experimental, or computational tools is expected. Students should have basic skills in data collection, analysis, interpretation, and technical documentation. Students should have completed the literature review, methodology development, and preliminary work required for continuation of the project.

Course Objectives:

- To implement the approved project methodology through analytical, experimental, computational, simulation, or prototype-based investigations.
- To analyse, interpret, and validate the results obtained from the project work using appropriate engineering techniques.
- To develop innovative and technically feasible solutions to the selected Design Engineering problem.
- To evaluate the performance, reliability, sustainability, and practical applicability of the developed design solution.
- To develop students' skills in technical documentation, research communication, project presentation, and dissemination of project outcomes.

Course Outcomes: After learning the course, students will be able to

CO	Course Outcome	Bloom's Level
CO1	IMPLEMENT appropriate analytical, experimental, computational, or simulation-based methodologies to solve the selected Design Engineering problem.	3
CO2	ANALYSE, INTERPRET, AND VALIDATE project results using suitable engineering tools, techniques, and performance criteria.	3
CO3	DEVELOP AND EVALUATE innovative, technically feasible, and practically applicable design solutions for real-world engineering problems.	3
CO4	DEMONSTRATE research competence through effective technical	

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	documentation, presentation, and communication of project findings and outcomes.	3
Course Content		
Phases of Project Stage II and Evaluation Weightage		
Phase	Project Activity	Weightage
Phase I	Review of Project Stage I work, finalization of methodology, and detailed work planning	5%
Phase II	Detailed design, modelling, simulation, experimentation, prototype development, or computational implementation	20%
Phase III	Data collection, testing, performance evaluation, and optimization of the proposed design	20%
Phase IV	Results analysis, validation, comparison with published/industrial case studies, and interpretation	20%
Phase V	Finalization of design solution, assessment of innovation, practical applicability, sustainability, and future scope	15%
Phase VI	Final project report, technical presentation, viva-voce, and submission of project outcomes, Publication of research work in reputed journal.	20%

CO-PO mapping table:

CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 01	PSO 02	PSO 03
CO1	3	-	2	2	2	-	-	2	2	-	-	2	2	2
CO2	3	-	3	2	2	-	-	2	2	-	-	2	2	2
CO3	2	-	3	2	2	-	-	2	2	-	-	2	2	2
CO4	3	-	2	2	2	-	-	2	2	-	-	2	2	2
Avg.	3	-	2.6	2	2.2	-	-	2	2	-	-	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Approved By:



Program:	S. Y. M. Tech	Semester:	IV
Course:	Cyber Security	Course Code:	R25-MSE-CTS-608
Teaching Scheme (Hrs/week)		Examination Scheme	
Lecture	Practical	Tutorial	Credits
-	-	-	04

Course Description:

The Cyber Security course in Mechanical Design Engineering program is a mandatory foundational module designed to safeguard modern industrial systems and product designs against digital threats. It bridges the gap between mechanical hardware and digital architecture by teaching engineers how to secure smart factories, automation tools, and cloud-connected systems. Students learn crucial defensive concepts, including threat landscapes, cryptographic frameworks (like encryption and digital signatures), and endpoint device security. The syllabus highlights engineering risk assessment, training students to evaluate and mitigate vulnerabilities in software-hardware ecosystems. Ultimately, it prepares postgraduates to design secure, resilient engineering systems compliant with global data protection standards

Course Relevance:

This course is highly relevant as modern mechanical engineering relies heavily on interconnected digital technologies like IoT, smart factories (Industry 4.0), and automated design networks. It equips design engineers with the essential skills to identify digital vulnerabilities, protect intellectual property (IP) from cyber theft, and build secure, tamper-proof hardware-software systems.

Course Objectives:

Identify Vulnerabilities: Train engineers to recognize security risks, threats, and architectural flaws in interconnected hardware-software systems.

Protect Intellectual Property: Equip students with the knowledge of cryptography and cyber laws to safeguard proprietary engineering designs and sensitive corporate data.

Implement Resilient Systems: Teach structural risk assessment methodologies to design and deploy secure, tamper-proof automation networks ready for Industry 4.0.

Course Outcomes: After learning the course, students will be able to

CO	Course Outcome	Bloom's Level
CO1	ANALYZE AND IDENTIFY security vulnerabilities within interconnected engineering systems, smart factories, and digital design networks.	3
CO2	IMPLEMENT fundamental cryptographic techniques, such as encryption and digital signatures, to ensure data integrity and secure communication.	3
CO3	DESIGN robust risk-mitigation strategies to protect proprietary engineering blueprints and intellectual property from cyber threats..	3
CO4	NAVIGATE Indian and global cyber laws (like the IT Act 2000) to maintain regulatory compliance during digital product development.	3

Course Content

Note: This is self-paced course to be completed on NPTEL/MOOC/SPPU ECLM PORTAL 4 Credits will be awarded on successful completion of course with certification.

Unit 1	Fundamentals of Cyber Security	-	CO Mapped: CO 1
Introduction to cybercrimes, individual vs. property crimes, cyber terrorism, and information asset identification			
Unit 2	System and Device Security	-	CO Mapped: CO 2
Securing endpoints, cloud computing security risks, and identifying vulnerabilities in hardware/software design ecosystems			
Unit 3	Cryptography & Technical	-	CO Mapped: CO 3

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	Countermeasures		
Basics of Symmetric & Asymmetric key cryptography (DES, AES, RSA), hash functions, digital signatures, and secure protocol extensions.			
Unit 4	Engineering Risk Assessment	-	CO Mapped: CO 4
Risk identification, quantitative vs. qualitative risk control strategies, and data protection frameworks			
Reference Books:			
1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunit Belapure (Wiley India) 2. Monali R. Borade and Sachin P. Godse (Technical Publications)			
MOOCs Links and additional reading material:			
1. https://onlinecourses.nptel.ac.in/noc26_cs57/preview 2. https://eclm.unipune.ac.in/topics.aspx			

CO-PO mapping table:

CO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 01	PSO 02	PSO 03
CO1	3	-	2	2	2	-	-	2	2	-	-	2	2	2
CO2	3	-	3	2	2	-	-	2	2	-	-	2	2	2
CO3	2	-	3	2	2	-	-	2	2	-	-	2	2	2
CO4	3	-	2	2	2	-	-	2	2	-	-	2	2	2
Avg.	3	-	2.6	2	2.2	-	-	2	2	-	-	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Approved By: