MLRITM

MARRI LAXMAN REDDY INSTITUTE OF TECHNOLOGY AND MANAGEMENT

Outcome Based Education (OBE) Manual

Department of Civil Engineering

Regulation: R22

Contents

OVERVIEW

Outcome Based Education (OBE) is an educational model that forms the base of a quality education system. There is no single specified style of teaching or assessment in OBE. All educational activities carried out in OBE should help the students to achieve the set goals. The faculty may adapt the role of instructor, trainer, facilitator and/or mentor, based on the outcomes targeted.

OBE enhances the traditional methods and focuses on what the Institute provides to students. It shows the success by making or demonstrating outcomes using statements able to do in favor of students. OBE provides clear standards for observable and measurable outcomes.

National Board of Accreditation (NBA) is an authorized body for the accreditation of higher education institutions in India. NBA is also a full member of the Washington Accord. NBA accredited for the programs and not the institutions.

Higher Education Institutions are classified into two categories by NBA

Tier1: Institutions consists of all IITs, NITs, Central Universities, State Universities and Autonomous Institutions. Tier-1 institution can also claim the benefits as per the Washington Accord.

Tier-2: Institutions consists of affiliated colleges of universities.

What is Outcome Based Education (OBE)?

Institutions adopting OBE try to bring changes to the curriculum by dynamically adapting to the requirements of the different stakeholders like Students, Parents, Industry Personnel and Recruiters. OBE is all about feedback and outcomes.

Four levels of outcomes from OBE are:

1. Program Educational Objectives (PEOs)
2. Program Outcomes(POs)
3. Course Outcomes(COs)

Why OBE?

1. International recognition and global employment opportunities.
2. More employable and innovative graduates with professional and soft skills, social responsibility and ethics.
3. Better visibility and reputation of the technical institution among stakeholders.
4. Improving the commitment and involvement of all the stakeholders.

5. Enabling graduate to excel in their profession and accomplish greater heights in their careers.
6. Preparing graduates for the leadership positions and challenging them and making them aware of the opportunities in the technology development.

Benefits of OBE

Clarity: The focus on outcome creates a clear expectation of what needs to be accomplished by the end of the course.
Flexibility: With a clear sense of what needs to be accomplished, instructors will be able to structure their lessons around the students' needs.
Comparison: OBE can be compared across the individual, class, batch, program and institute levels.
Involvement: Students are expected to do their own learning. Increased student's involvement allows them to feel responsible for their own learning, and they should learn more through this individual learning.

- Teaching will become a far more creative and innovative career
- Faculty members will no longer feel the pressure of having to be the "source of all knowledge".
- Faculty members shape the thinking and vision of students towards a course.

India, OBE and Accreditation:

From 13 June 2014, India has become the permanent signatory member of the Washington Ac- cord Implementation of OBE in higher technical educational so started in India. The National Assessment and Accreditation Council (NAAC) and National Board of Accreditation (NBA) are the autonomous bodies for promoting global quality standards for technical education in India. NBA has started accrediting the programs running with OBE from 2013.

The National Board of Accreditation mandates establishing a culture of outcome-based education in institutions that offer Engineering, Pharmacy, and Management program Reports of outcome an analysis help to find gaps and carry out continuous improvements in the education system of an Institute, which is very essential.

1. Vision, Mission, Quality Policy, Philosophy & Core Values

Vision

To empower students to **be skilled, competitive** and dedicated Civil Engineers by imparting advanced technical knowledge and **ethical values**, equipping them to play a key role in the planning and execution of the nation's infrastructure and development activities.

Mission

M1: Provide **exceptional education in civil engineering** through a **combination of excellent teaching, advanced facilities, and continuous mentorship.**
M2: Produce **civil engineering graduates** who **demonstrate exceptional skills and expertise**.
M3: Encourage professional **development to address complex technical challenges and engage in innovation with creativity, leadership, ethics, and social awareness.**

Quality Policy

Our policy is to nurture and build diligent and dedicated community of engineers providing a professional and unprejudiced environment ,thus justifying the purpose of teaching and satisfying the stakeholders.

A team of well qualified and experienced professional's ensure equality education with its practical application in all areas of the Institute.

Philosophy

The essence of learning lies in pursuing the truth that liberates one from the darkness of ignorance and Marri Laxman Reddy Institute of Technology and management firmly believes that education is for liberation.

Contained there in is then option that engineering education includes all fields of

Science that plays a pivotal role in the development of world-wide community contributing to the progress of civilization. This institute, adhering to the above understanding, is committed to the development of science and technology in congruence with then natural environs. It lays great emphasis on intensive research and education that blends professional skills and high moral standards with a sense of individuality and humanity. We thus promoteties with local communities and encourage transnational interactions in order to be socially accountable. This accelerates the process of transfiguring the students into complete human beings making the learning process relevant to life, instilling in them a sense of courtesy and responsibility.

Core Values

Excellence: All activities are conducted according to the highest international standards.

Integrity: Adheres to the principles of honesty, trust worthiness, reliability, transparency and accountability.

Inclusiveness: To show respect for ethics, cultural and religious diversity, and freedom of thought.

Social Responsibility: Promotes community engagement, environmental sustainability ,and global citizenship. It also promotes awareness of, and support for,the needs and challenges of the local and global communities.

Innovation: Supports creative activities that approach challenges and issues from multiple perspectives in order to find solutions and advance knowledge.

2. Program Educational Objectives (PEOs)

Program Educational Objectives (PEOs) should be defined by the Head of the Department in consultation with the faculty members. PEO area promise by the department to the aspiring students about what they will achieve once they join the program. PEO assessment is not made compulsory by NBA as it is quite difficult to measure in the Indian context. NBA assessors usually do no task for PEO assessment. PEOs are about professional and career accomplishment after 4 to 5 years of graduation. PEOs can be written from different perspectives like Career, Technical Competency, and Behaviour. While writing the PEOs, do not use technical terms as it will be read by prospective students who want to join the program. Three to five PEOs are recommended.

PEO 1	**Professional Excellence** Analyze, design, build, maintain, or improve civil engineering-based systems, considering environmental, economic, and societal requirements.
PEO 2	**Multidisciplinary Approach** Develop a strong educational foundation to design and conduct experiments, meeting needs within multidisciplinary constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability, while analyzing and interpreting data.
PEO 3	**Continued Self-Learning** Identify, formulate, and solve engineering problems, and engage in lifelong learning in advanced areas of civil engineering and related fields.
PEO 4	**Effective Contribution to Society** Utilize modern engineering techniques, skills, and tools necessary for civil engineering practice, serving the community as ethical and responsible professionals.

2.1. Mapping of program educational objectives to program outcomes and program specific outcomes:

The following Figure1 shows the correlation between the PEOs and the P Os

PEO-I	PEO-II	PEO-III	PEO-IV
PO:1,2,3,4,5,6,9,11,12	**PO:**1,2,3,4,5,7,9,11,12	**PO:**2,3,4,5,9,10,11,12	**PO:1,2,**6,7,8,10,

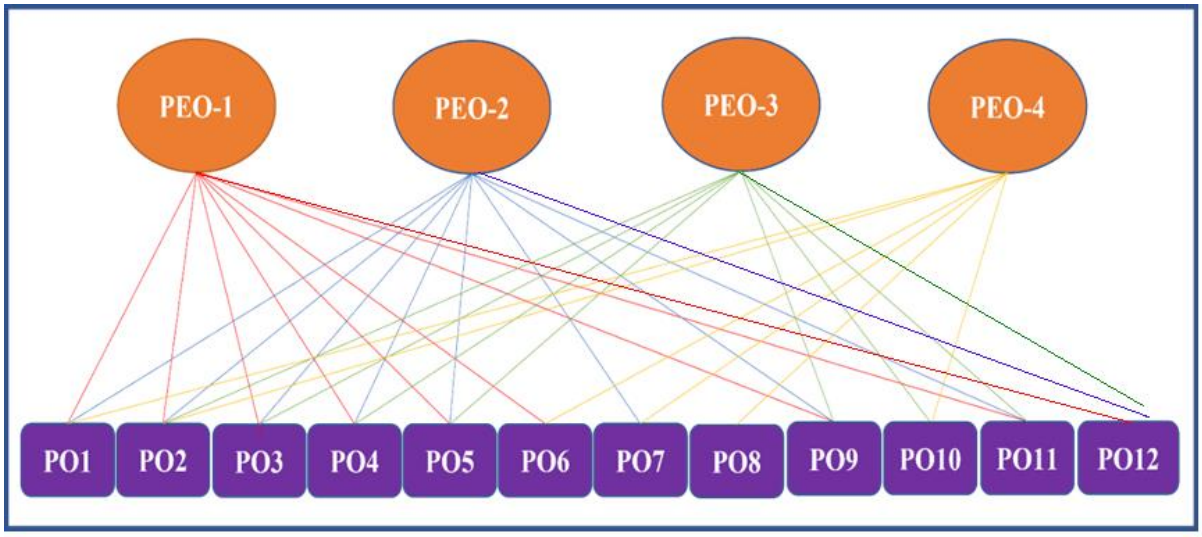


FIGURE1: Correlation between the PEOs and the Pos

The following Figure 2 shows the correlation between the PEOs and the PSOs

PEO-I	PEO-II	PEO-III	PEO-IV
PSO:1,2	**PSO:**1,2	**PSO:**2,3	**PSO:**2,3

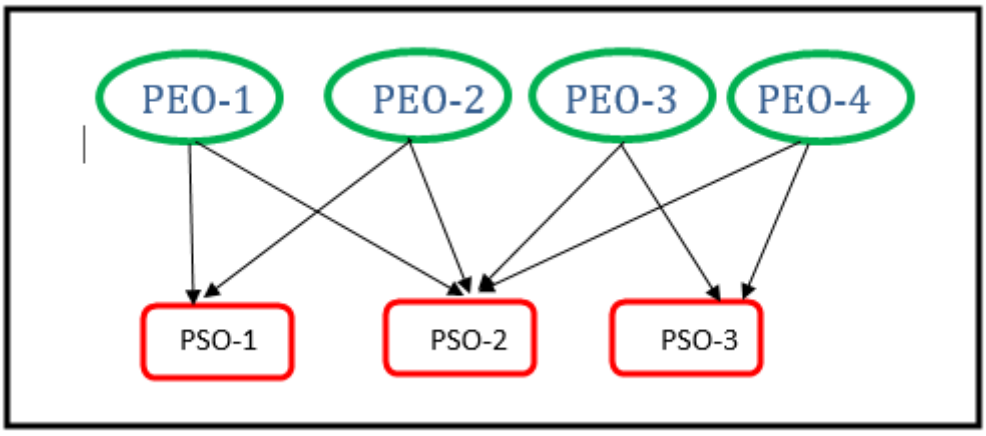


FIGURE 2: Correlation between the PEOs and the PSOs

3. Program Outcomes (POs)

A Program Learning Outcome is broad in scope and describes what a student should be able to do at the end of the program. Pos are aligned with the graduate attributes specified in the **Washington Accord**. POs should be specific, measurable and achievable.
The **NBA** has defined **12 POs**, which are common for all institutions in India.

In the syllabus book given to students, there should be a clear mention of **course objectives** and **course outcomes**, along with a **CO-PO course articulation matrix** for all the courses.

B. Tech (CIVIL) – PROGRAMOUTCOMES (PO's)	
A graduate of the Civil Engineering Program will be demonstrated:	
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems, reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, as well as cultural, societal, and environmental considerations.
PO4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods, including the design of experiments, analysis and interpretation of data, and synthesis of information, to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, andmodernengineeringandITtoolsincludingpredictionandmodelingtocomplex engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society:**Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues, and the consequent responsibilities relevant to professional engineering practice.
PO7	**Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate knowledge of and the need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics, responsibilities, and norms of engineering practice.

PO9	**Individual and Teamwork:** Function effectively as an individual, as well as a member or leader in diverse teams and multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and society at large. This includes the ability to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO11	**Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work as a member and leader in a team to manage projects in multidisciplinary environments.
PO12	**Life-Long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

4. Program Specific Outcomes (PSOs)

Program Specific Outcomes (PSOs) are statements that describe what the graduates of a specific engineering program should be able to do.

A list of PSOs written for the Department of Civil Engineering is given below.

B. Tech (CIVIL) – PROGRAM SPECIFIC OUTCOMES (PSO's)	
A graduate of the Civil Engineering Program will demonstrate:	
PSO1	Demonstrate the ability to plan, design, implement, and supervise civil engineering systems in various sectors.
PSO2	Focus on safety, serviceability, and eco-friendly technologies while operating, maintaining, and rehabilitating civil engineering systems.
PSO3	Utilize advanced civil engineering technologies to continue education, achieve entrepreneurial success, and explore various career options.

5. Relation between the Program Educational Objectives and the POs

Broad relationship between the program objective sand the program outcomes are given in the following Table below:

PEO's→ ↓PO's		(1) Professional Excellence	(2) Multidisciplinary Approach	(3) Continued Self-Learning	(4) Effective Contribution to Society
PO1	Apply the knowledge of mathematics, science, engineering fundamentals ,and an engineering specialization to the solution of complex engineering problems.	3	3		1
PO2	Identify, formulate, review research literature, and analyse complex engineering problems, reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	2	1	1
PO3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, as well as cultural, societal, and environmental considerations.	2	3	2	
PO4	Use research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	1	2	
PO5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.	2	2	3	
PO6	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to professional engineering practice.	1			2

PO7	Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.		1		2
PO8	Applyethicalprinciplesandcommittoprofessionalethicsandresponsibilitiesandnormsoftheengineeringpractice.				1
PO9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	2	1	2	
PO10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.			2	1
PO11	Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work as a member and leader in a team, to manage projects in multidisciplinary environments.	2	2	1	
PO12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.		2	3	

6. Relation between the Program Specific Outcomes and the Program Educational Objectives

PEO's→ ↓PSO's		(1) Professional Excellence	(2) Multidisciplinary Approach	(3) Continued Self-Learning	(4) Effective Contribution to Society
PSO1	Students acquire necessary technical skills in mechanical engineering that make them an employable graduate.	3	2	1	1
PSO2	An ability to impart technological inputs towards the development of society by becoming an entrepreneur.	2			2
PSO3	Utilize advanced civil engineering technologies to continue education, achieve entrepreneurial success, and explore various career options.	1	1	3	2

Relationship between Program Specific Outcomes and Program Educational Objectives Key: 3 = High; 2 = Medium; 1 = Low

Note:

- The assessment process of Pos and PSOs can be direct or in direct.
- The direct assessment will be done through interim assessment by conducting continuous internal exam and semester end exams.

- The indirect assessment on the other hand could be done through student's program exit questionnaire, alumni survey and employment survey.

7. Blooms Taxonomy

Bloom's taxonomy is considered the global language for education. Bloom's Taxonomy is frequently used by teachers in writing course outcomes as it provides a ready-made structure and a list of action verbs. The stages ascend in complexity and what they demand of students.

First, students need to simply remember information provided to them—but reciting something doesn't demonstrate having learned it, only memorization. With understanding comes the ability to explain the ideas and concepts to others. The students are then challenged to apply the information and use it in new ways, helping to gain a deeper understanding of previously covered material and demonstrating it moving forward.

Questioning information is a vital part of learning, and both analysis and evaluation do just this. Analysing asks a student to examine the information in a new way, and evaluation demands the student appraise the material in a way that lets them defend or argue against it as they determine.

The final step in the revised taxonomy is creating, which entails developing a new product or point of view. How does this learned information impact your world? How can it be used to impact not just your education but the way you interact with your surroundings? By utilizing Bloom's Taxonomy, students are not going to forget the information as soon as the class ends—rather, they retain and apply the information as they continue to grow as a student and in their careers, staying one step ahead of the competition.

7.1. Incorporating Critical Thinking Skills into Course Outcome Statements

Many faculty members choose to incorporate words that reflect critical or higher-order thinking into their learning outcome statements. Bloom (1956) developed a taxonomy outlining the different types of thinking skills people use in the learning process. Bloom argued that people use different levels of thinking skills to process different types of information and situations. Some of these are basic cognitive skills (such as memorization) while others are complex skills (such as creating new ways to apply information). These skills are often referred to as critical thinking skills or higher-order thinking skills.

Bloom proposed the following taxonomy of thinking skills. All levels of Bloom's taxonomy of thinking skills can be in corporate into expected learning outcome statements. Recently, Anderson and Krathwohl's (2001) adapted Bloom's model to include language that is oriented towards the language used in expected learning outcome statements. A summary of Anderson and Krathwohl's revised version of Bloom's taxonomy of critical thinking is provided in Figure 3.

FIGURE 3: Revised version of Bloom's taxonomy

7.2. Definitions of the different levels of thinking skills in Bloom's taxonomy:

Remember: Recalling relevant terminology, specific facts, or different procedures related to information and/or course topics. At this level, a student can remember something but may not really understand it.

Understand – The ability to grasp the meaning of information (facts, definitions, concepts, etc.) that has been presented.

Apply – Being able to use previously learned information in different situations or in problem-solving.

Analyse– The ability to break information down into its component parts. Analysis also refers to the process of examining information in order to make conclusions regarding cause and effect, interpreting motives, making inferences, or finding evidence to support statements/arguments.

Evaluate – Being able to judge the value of information and/or sources of information based on personal values or opinions.

Create–the ability to creatively or uniquely apply prior knowledge and/or skills to produce new and original thoughts, ideas, processes, etc. At this level, students are involved in creating their own thoughts and ideas.

7.3.List of Action Words Related to Critical Thinking Skills

Here is a list of action words that can be used when creating the expected student learning outcomes related to critical thinking skills in a course. These terms are organized according to the different levels of higher-order thinking skills contained in Anderson and Krathwohl's (2001) revised version of Bloom's taxonomy.
Here is the revised Bloom's document with action verbs, which we frequently refer to while writing COs for our courses.

The cognitive process dimensions - categories:

Lower Order of Thinking(LOT)			**Higher Order of Thinking(HOT)**		
Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Interpreting Illustrating Classifying Summarizing Inferring (concluding) comparing explaining	Recognizing (identifying) Recalling (retrieving)	Executing Implementing	Differentiating Organizing Attributing	Checking (Coordinating) detecting, testing, monitoring) Critiquing (judging)	Planning Generating Producing (constructing)

The Knowledge Dimension			
Concrete Knowledge → Abstract knowledge			
Factual	**Conceptual**	**Procedural**	**Meta cognitive**
• Knowledge of terminologies • Knowledge of specific details and elements.	• Knowledge of classifications and categories • Knowledge of principles and generalizations • Knowledge of theories, Models and structures	• Knowledge of subject specific skills and algorithms • Knowledge of subject specific techniques and methods • Knowledge of criteria for determining when to use appropriate procedures	• Strategic Knowledge • Knowledgeaboutcognitivetask,includinggappropriatecontextualandconditionalKnowledge • Self-Knowledge

Action Verbs for Course Outcomes

Lower Order of Thinking(LOT)				Higher Order of Thinking(HOT)		
Definitions	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Bloom's Definition	Exhibit memory of previously learned material by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpret in, giving descriptions, and Stating main ideas.	Solve problems on new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations.	Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria.	Compile information together in a different way by combining elements in a new pattern or proposing alternative solution.
Verbs	• Choose • Define • Find • How • Label • List • Match • Extend	• Classify • Compare • Contrast • Demonstrate • Explain • Illustrate • Infer • Interpret	• Apply • Build • Choose • Construct • Develop • Interview • Make use of • Model	• Analyze • Assume • Categorize • Classify • Compare • Discover • Dissect • Distinguish	• Agree • Appraise • Assess • Award • Choose • Criticize • Decide • Deduct • Importance	• Adapt • Build • Solve • Choose • Combine • Invent • Compile • Compose • Construct
Verbs	• Name • Omit • Recall • Relate • Select • Show • Spell • Tell • What • When • Where • Which • Who • Why	• Outline • Relate • Rephrase • Show • Summarize • Translate • Experiment with • Illustrate • Infer • Interpret • Outline • Relate • Rephrase • Show • Summarize • Translate • Experiment with	• Organize • Plan • Select • Solve • Utilize • Identify • Interview • Make use of • Model • Organize • Plan • Select • Solve • Utilize • Identify	• Divide • Examine • Function • Inference • Inspect • List Motive • Simplify • Survey • Take part in • Test for Theme • Conclusion • Contrast	• Defend • Determine • Disprove • Estimate • Evaluate • Influence • Interpret • Judge • Justify Mark • Measure • Opinion • Perceive • Prioritize • Prove • Criteria • Criticize • Compare • Conclude	• Create • Design • Develop • Estimate • Formulate • Happen • Imagine • Improve • Makeup • Maximize • Minimize • Modify • Original • Originate • Plan • Predict • Propose • Solution

8. Guide lines for writing Course Outcome Statements:

Well-written course out comes involve the following parts:

1. Action verb
2. Subject content
3. Level of achievement as per BTL
4. Modes of performing task (if applicable)

8.1. Course Outcomes (COs)

A Course Outcome is a formal statement of what students are expected to learn in a course. When creating Course Outcomes, remember that the outcomes should clearly state what students will do or produce to determine and/or demonstrate their learning. Course learning outcome statements refer to specific knowledge, practical skills, areas of professional development, attitudes, higher-order thinking skills, etc., that faculty members expect students to develop, learn, or master during a course.

A well-formulated set of Course Outcomes will describe what a faculty member hopes to successfully accomplish in offering their particular course(s) to prospective students, or what specific skills, competencies, and knowledge the faculty member believes that students will have attained once the course is completed. The learning outcomes need to be concise descriptions of what learning is expected to take place by course completion.

8.2. Developing Course Outcomes

When creating course outcomes consider the following guidelines as you develop them either individually or as part of a multi-section group:

Limit the course outcomes to 5-6 statements for the entire course [more detailed outcomes can be developed for individual units, assignments, chapters, etc. if the instructor(s) wish (es)].

Focus on overarching knowledge and/or skills rather than small or trivial details.

Emphasize knowledge and skills that are central to the course topic and/or discipline.

Create statements that have a student focus rather than an instructor-centric approach.(Example:

Student-focused outcome: "Upon completion of this course, students will be able to list the names of the 28 states and 8 union territories."

Instructor-centric objective (to avoid): "One objective of this course is to teach the names of the 28 states and 8 union territories.").

Focus on the learning that results from the course rather than describing activities or lessons that are in the course.

Incorporate and/or reflect the institutional and departmental mission.

Include various ways for students to show success (e.g., outlining, describing, modelling, depicting, etc.) rather than using a single statement such as "At the end of the course, students will know" as the stem for each expected outcome statement.

When developing learning outcomes, here are the core questions to ask yourself:

- What do we want students in the course to learn?
- What do we want the students to be able to do?
- Are the outcomes observable, measurable, and able to be performed by the students?

Course outcome statements at the course level describe:

- What faculty members want students to know at the end of the course **AND**
- What faculty members want students to be able to do at the end of the course.

Course outcomes have three major characteristics:

- They specify an action by the students/learners that is **observable**.
- They specify an action by the students/learners that is **measurable**.
- They specify an action that is **done by the students/learners** rather than the faculty members.

Effectively developed expected learning outcome statements should possess all three of these characteristics.

When this is done, the expected learning outcomes for a course are designed so that they can be assessed. When stating expected learning outcomes, it is important to use **verbs that describe exactly what the student(s)/learner(s) will be able to do upon completion of the course**.

8.3. Relationship of Course Outcome to Program Outcome

Learning outcomes formula:

STUDENTS SHOULD BE ABLE TO + BEHAVIOR + RESULTING EVIDENCE

The Course Outcomes need to link to the Program Outcomes.

For example, you can use the following template to help you write an appropriate course level learning outcome.

"Upon completion of this course students will be able to (knowledge, concept, rule or skill you expect them to acquire) by (how will they apply the knowledge or skill/how will you assess the learning)."

8.4. Characteristics of Effective Course Outcomes

Well written course outcomes:

- Describe what you want your students to learning your course.
- Are aligned with program goals and objectives.
- Tell how you will know an instructional goal has been achieved.
- Use action words that specify definite, observable behaviors.
- Arrases able through one or more indicators (papers, quizzes, projects, presentations, journals, portfolios, etc.)
- Are realistic and achievable.
- Use simple language.

8.5. Examples of Effective Course Outcomes

After successful completion of the course, Students will be able to:

- Critically review the methodology of our search study published in a scholarly sociology journal.
- Design a website using HTML and JavaScript.
- Describe and present the contributions of women to American history.
- Recognize the works of major Re-naissance artists.
- Facilitating a group to achieve agreed – Up on goals.
- Determine and apply the appropriate statistical procedures to analyze the results of simple experiments.
- Develop an individual learning plan for a child with a learning disability.
- Produce a strategic plan for a small manufacturing business.
- Analyse a character's motivation and portray that character before an audience.
- Differentiate among five major approaches to literary analysis.
- List the major ethical issues one must consider when planning a human-subjects study.
- Locate and critically evaluate information on current political issues on the Web.
- List and describe the functions of the major components of the human nervous system.
- Correctly classify rock samples found in.
- Conduct a systems analysis of a group interaction.
- Demonstrate active listening skills when interviewing clients.
- Apply social psychological principles to suggest solutions to contemporary social problems.

A more detailed model for stating learning objectives requires at objectives have three parts: a condition, an observable behavior, and a standard.

The table below provides three examples.

S. No	Condition	Observable Behavior	Standard
1	Given a list of drugs	The student will be able to classify each item as amphetamine or barbiturate.	With atleast70%ac-curacy
2	Immediately following a fifteen-minute discussion on a topic.	The student will be able to summarize in writing the major issues being discussed.	Mentioning at least three of the five major topics.
3	Given an algebraic equation with one unknown.	The student will be able to correctly solve a simple linear equation.	With in a period of five minutes.

The following examples describe a course outcome that is not measurable as written, an explanation for why the course outcome is not considered measurable, and a suggested edit that improves the course outcome

Original course out-come	Evaluation of language used in this course outcome	Improved course outcome
Explore in depth the literature on an aspect of teaching strategies.	Exploration is not a measurable activity, but the quality of the product of exploration would be measurable with a suitable rubric.	Upon completion of this course, the students will be able to: write a paper based on an in-depth exploration of the literature on an aspect of teaching strategies.

Examples that are TOO general and VERY HARD to measure...

- ...will appreciate the benefits of learning a foreign language.
- ...will be able to access resources at the Institute library.
- ...will develop problem-solving skills.
- ...will have more confidence in their knowledge of the subject matter.
-

Examples that are still general and HARD to measure...

- ...will value knowing a second language as a communication tool.
- ...will develop and apply effective problem-solving skills that will enable one to adequately navigate through the proper resources within the institute library.
- ...will demonstrate the ability to resolve problems that occur in the field.

- ...will demonstrate critical thinking skills, such as problem-solving as it relates to social issues.

Examples that are SPECIFIC and relatively EASY to measure...

- ...will be able to read and demonstrate good comprehension of text in areas of the student's interest or professional field.
- ...will demonstrate the ability to apply basic research methods in psychology, including research design, data analysis, and interpretation.
- ...will be able to identify environmental problems, evaluate problem-solving strategies, and develop science-based solutions.
- ...will demonstrate the ability to evaluate, integrate, and apply appropriate information from various sources to create cohesive, persuasive arguments, and to propose design concepts.

An Introspection - Examine Your Own Course Outcomes

- If you have written statements of broad course goals, take a look at them. If you do not have a written list of course goals, reflect on your course and list the four to six most important student outcomes you want your course to produce.
- Look over your list and check the one most important student outcome. If you could only achieve one outcome, which one would it be?
- Look for your outcome on the list of key competencies or outcomes society is asking us to produce. Is it there? If not, is the reason a compelling one?
- Check each of your other "most important" outcomes against the list of outcomes. How many are on the list of key competencies?
- Take stock. What can you learn from this exercise about what you are trying to accomplish as a teacher? How clear and how important are your statements of outcomes for your use and for your students? Are they very specifically worded to avoid misunderstanding? Are they supporting important needs on the part of the students?

Write Your Course Outcomes!

One of the first steps you take in identifying the expected learning outcomes for your course is identifying the purpose of teaching the course. By clarifying and specifying the purpose of the course, you will be able to discover the main topics or themes related to students' learning. Once discovered, these themes will help you to outline the expected learning outcomes for the course. Ask yourself:

- What role does this course play within the program?

- How is the course unique or different from other courses?
- Why should/do students take this course? What essential knowledge or skills should they gain from this experience?
- What knowledge or skills from this course will students need to have mastered to perform well in future classes or jobs?
- Why is this course important for students to take?

8.6.CO-PO Course Articulation Matrix (CAM) Mapping

A **Course Articulation Matrix** shows the educational relationship (Level of Learning achieved) between course outcomes and program outcomes for a course. This matrix strongly indicates whether the students are able to achieve the course learning objectives. The matrix can be used for any course and is a good way to evaluate a course syllabus.

Table 1 provides information about the action verbs used in the Program Outcomes (POs) and the nature of POs, stating whether the POs are technical or non-technical.

You need to understand the intention of each PO and the **Bloom's Taxonomy level** to which each of the section verbs in the POs correlates. Once you have understood the POs, you can write the **Course Outcomes (COs)** for a course and see to what extent each of those COs correlates with the POs.

TABLE9: Process for mapping the values for CO-PO Matrix

Experiential learning	Experiential learning	Experiential learning	Experiential learning	Experiential learning
Technical	PO1	Apply	L3	Bloom's L1 to L4for theory courses. Bloom's L1 to L5 for laboratory courses. Bloom's L1 to L6 for Project work, experiential learning
	PO2	Identify	L2	
		Formulate	L6	
		Review	L2	
	PO3	Design	L6	
		Develop	L3,L6	
	PO4	Analyze	L4	
		Interpret	L2,L3	
		Design	L6	
	PO5	Create	L6	
		Select	L1,L2,L6	
		Apply	L3	

Non-Technical	PO6	**Thumb Rule:**
	PO7	If Bloom's L1 Action Verb so far CO: Correlates with any of PO6 to PO12, then assign1.
	PO8	
	PO9	If Bloom's L2 to L3 Action Verb so far CO: Correlates with Any of PO6 to PO12, then assign2.
	PO10	
	PO11	If Bloom's L4 to L6 Action Verb so far CO: Correlates with any of PO6 to PO12, then assign 3
	PO12	

At the end, the Program Outcomes (POs) can be calculated using various descriptors that you may define. The mapping of Course Outcomes (COs) towards a PO is evaluated using descriptors such as High, Medium, Low, etc.

Observations:

1. The first five Program Outcomes (POs) are purely technical in nature, while the other POs are non-technical.
2. For theory courses, while writing the Course Outcomes (COs), you need to restrict yourself between Bloom's Level 1 to Level 4. However, if it is a programming course, restrict yourself between Bloom's Level 1 to Level 3, but for other courses, you can go up to Bloom's Level 4.
3. For laboratory courses, while composing COs, you need to restrict yourself between Bloom's Level 1 to Level 5.
4. Only for mini-projects and main projects, you may extend up to Bloom's Level 6 while composing COs.
5. For a given course, the course in-charge must involve all other professors who teach that course and ask them to come up with the CO-PO mapping. The course in-charge must take the average value of all these CO-PO mappings and finalize the values. Alternatively, the course in-charge can proceed with what the majority of faculty members prefer. Ensure that none of the professors handling the course discuss with each other while marking the CO-PO values.
6. If you want to match your COs with non-technical POs, correlate the action verbs used in the COs with the thumb rule given in the table and map the values. (This applies only for mapping COs to non-technical POs).

8.7. Tips for Assigning the values while mapping COs to POs.

1. Select action verbs for a Course Outcome (CO) from different Bloom's levels based on the importance of the particular CO for the given course.

2. Stick to a single action verb while composing COs, but you may use multiple action verbs if the need arises.
3. You need to justify the marking of values in the CO-PO articulation matrix. Use a combination of words found in the COs, POs, and your course syllabus for writing the justification. Restrict yourself to one or two lines.
4. Values for the CO-PO (technical POs in particular) matrix can be assigned by:
   (a) Judging the importance of the particular CO in relation to the POs. If the CO matches strongly with a particular PO criterion, assign 3; if it matches moderately, assign 2; if the match is low, assign 1; otherwise, mark with a "-" symbol.
   (b) If an action verb used in a CO appears at multiple Bloom's levels, then you need to judge which Bloom's level is the best fit for that action verb.

8.8. Method for Articulation

1. Identify the key competencies of POs/PSOs for each CO and create a corresponding mapping table by assigning marks in the corresponding cell. One importantobservation is that the first five POs are purely technical in nature, while the other POs are non-technical.
2. Justify each CO-PO/PSO mapping with a justification statement and recognize the number of vital features mentioned in the justification statement that match the given Key Attributes for Assessing Program Outcomes. Use a combination of words found in the COs, POs/PSOs, and your course syllabus for writing the justification.
3. Create a table listing the number of key competencies for CO-PO/PSO mapping with reference to the maximum given Key Attributes for Assessing Program Outcomes.
4. Create a table displaying the percentage of key competencies for CO-PO/PSO mapping with reference to the maximum given Key Attributes for Assessing Program Outcomes.
5. Finally, prepare a Course Articulation Matrix (CO-PO/PSO Mapping) with COs and POs and COs and PSOs on a scale of 0 to 3, where:
   - 0 = No correlation (marked as "-")
   - 1 = Low/slight correlation
   - 2 = Medium/moderate correlation
   - 3 = Substantial/high correlation
   -

The correlation is based on the following strategy:

Range (C%) Correlation Level

$0 \leq C \leq 5\%$ No correlation (0)

$5\% < C \leq 40\%$ Low/Slight correlation (1)

$40\% < C < 60\%$ Moderate correlation (2)

$60\% \leq C < 100\%$ Substantial/High correlation (3)

9. Key Competencies for Assessing Program Outcomes:

PO No.	NBA Statement / Vital Features	Key Components	No. of Key Components
PO1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge)**.	1. Application of scientific principles and methodologies. 2. Utilization of mathematical concepts in problem-solving. 3. Integration of knowledge from various engineering disciplines. **4.** Application of specialized engineering knowledge in complex engineering problems.	**4**
PO 2.	Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and Engineering sciences **(Problem Analysis).**	1. Recognizing and defining complex engineering problems or opportunities. 2. Structuring and abstracting the problem for systematic analysis. 3. Examining research literature 4. Investigating problems using data collection and relevant methodologies. 5. Applying mathematical, natural, and engineering sciences in problem-solving. 6. Ensuring accuracy and reliability through validation. 7. Planning and conducting experiments for problem analysis. 8. Implementing and testing solutions through experimentation. 9. Evaluating results to draw meaningful engineering conclusions. 10. Recording findings systematically for future reference and learning.	**10**

PO 3.	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations **(Design/Development of Solutions).**	1. Investigate and define a problem while identifying constraints, including environmental, sustainability, health, and safety considerations. 2. Understand customer and user needs while considering factors such as aesthetics. 3. Identify and manage cost drivers in engineering solutions. 4. Use creativity to develop innovative engineering solutions. 5. Ensure fitness for purpose across production, operation, maintenance, and disposal. 6. Manage the design process and evaluate outcomes for safety and risk assessment. 7. Understand the commercial and economic context of engineering processes. 8. Apply management techniques to achieve engineering objectives in a broader context. 9. Promote sustainable development through engineering activities. 10. Be aware of legal frameworks governing engineering activities, including personnel, health, safety, and environmental risks.	**10**
PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions **(Conduct Investigations of Complex Problems).**	1. Gain a deep understanding of materials, equipment, processes, and products through research to address engineering problems effectively. 2. Develop essential laboratory and workshop skills to carry out experimental investigations and gather reliable data. 3. Address complex problems in various engineering contexts, including operations, management, and technology development. 4. Leverage technical literature and reliable information sources	**10**

		5. Follow appropriate codes of practice and industry standards when analyzing and interpreting experimental data. 6. Ensure high-quality results by integrating various data sources and considering quality control during engineering investigations. 7. Draw valid conclusions by addressing technical uncertainties through sound reasoning and scientific principles. 8. Apply fundamental engineering principles to analyze and interpret key engineering processes and challenges. 9. Use analytical and modeling techniques to identify, classify, and describe the performance of engineering systems and components. **10.** Employ analytical software and quantitative methods efficiently and accurately.	
PO 5.	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations (**Modern Tool Usage).**	1. Develop engineering solutions using modern tools across various disciplines. 2. Identify appropriate prediction and modeling tools for diverse engineering applications. 3. Utilize IT tools in engineering analysis, design, and decision-making. **4.** Implement simulation tools in different engineering fields.	**4**
PO 6.	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).**	1. Understand the commercial and economic context of engineering processes. 2. Apply management strategies in engineering objectives within this context. 3. Promote sustainable development through engineering activities. 4. Recognize relevant legal requirements governing engineering practices, including health, safety, and environmental risks. **5.** Uphold high standards of professional and ethical conduct in engineering.	**5**

PO 7.	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).**	1. Understand the socio-economic effects of engineering solutions on society. 2. Recognize the political implications and responsibilities of engineering solutions. 3. Assess the environmental consequences of engineering practices and solutions. 4. Demonstrate the importance of sustainable development in engineering solutions.	**4**
PO 8.	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).**	1. Make informed decisions based on ethical principles, using professional codes of ethics to guide actions and evaluate the ethical aspects of practice. 2. Demonstrate a strong sense of trust and integrity, standing firm in one's values while acting responsibly and ethically. 3. Ensure fair treatment and equity in all professional activities, valuing diversity and respecting others' perspectives. 4. Adhere to the norms of engineering practice by committing to high ethical standards and demonstrating ethical behavior in all professional engagements.	**4**
PO9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).**	1. Work effectively as an individual, taking ownership of tasks and driving progress independently. 2. Demonstrate maturity by focusing on goal achievement, requiring minimal external motivation. 3. Approach vaguely defined problems with systematic problem-solving skills 4. Engage in teamwork during various activities, including hands-on labs and multidisciplinary projects. 5. Participate in diverse team settings, adjusting to different roles and projects. 6. Understand and apply principles of teamwork and project management	**10**

		7. Contribute to team dynamics by evaluating and reflecting on individual and group performance. 8. Foster teamwork and lasting relationships, contributing to both academic success and post-graduation professional networks. 9. Collaborate with individuals across all levels of an organization, demonstrating adaptability and interpersonal skills. **10.** Develop strong relationships through positive interactions, showcasing an ability to get along with others and work cohesively in teams.	
PO10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions **(Communication).**	1. Communicate complex engineering concepts clearly and concisely in written reports and design documentation. 2. Ensure high standards of grammar and punctuation in written communication, maintaining professionalism and clarity. 3. Properly reference sources in written communication, ensuring accuracy and academic integrity. **4.** Deliver oral presentations effectively, with appropriate speaking style **5.** Demonstrate a deep understanding of the subject matter, clearly communicating complex ideas during oral discussions and presentations.	**5**
PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments **(Project Management and Finance).**	1. Define the project scope clearly to ensure alignment with objectives and requirements. 2. Identify and prioritize critical success factors necessary for project completion and success. 3. Ensure the timely delivery of project outputs, meeting the predefined objectives and quality standards.	**10**

		4. Develop and organize a structured breakdown of tasks and activities to achieve project goals. 5. Create and manage schedules to ensure tasks are completed on time and milestones are met. 6. Develop and manage project budgets, ensuring that resources are used efficiently and within financial constraints. 7. Apply quality control measures to ensure that project deliverables meet the required standards. 8. Plan and allocate human resources effectively, ensuring the right skills and team dynamics. 9. Identify and manage stakeholders, ensuring their needs and expectations are addressed throughout the project. **10.** Develop a risk register and apply strategies to identify, assess, and mitigate project risks.	
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change **(Life - Long Learning).**	1. Pursue professional, Academic, Global certifications. 2. Begin and work towards advanced programs to further deepen knowledge in engineering and related areas. 3. Stay updated on industry trends and emerging technologies to remain relevant in the field. 4. Learn at least 2–3 new significant skills annually to ensure continuous growth and development. 5. Dedicate time for formal training for a standard duration of training each year. 6. Engage in ongoing self-improvement efforts to enhance both personal and professional growth. 7. Be adaptable to technological changes by actively pursuing new learning opportunities and challenges.	**8**

		8. Build a network with industry peers and professionals to stay informed and grow knowledge through collaboration	

10. Key Competencies for Assessing Program Specific Outcomes:

PSO1	Demonstrate the ability to plan, design, implement, and supervise civil engineering systems in various sectors	1. Understanding site selection, surveying, and project feasibility for infrastructure development. 2. Applying principles of structural analysis, material selection, and load considerations for safe and efficient construction. 3. Executing construction processes, project scheduling, and management techniques for timely completion. 4. Monitoring construction activities, ensuring adherence to standards, and implementing safety regulations. 5. Addressing challenges in transportation, water resources, geotechnical, and environmental engineering projects.	**5**
PSO2	Focus on safety, serviceability, and eco-friendly technologies while operating, maintaining, and rehabilitating civil engineering systems.	1. Understanding and implementing safety standards and regulations in civil engineering projects to ensure the well-being of users and workers. 2. Evaluating the performance of civil engineering systems to ensure they meet functional requirements and user needs throughout their lifecycle. 3. Incorporating sustainable practices and environmentally friendly materials in the design, construction, and maintenance of civil engineering systems. 4. Developing strategies for the effective operation, maintenance, and rehabilitation of existing civil engineering infrastructures to extend their service life. 5. Collaborating with professionals from various fields to integrate safety, serviceability, and sustainability	**5**

		considerations in civil engineering practices.	
PSO3	Utilize advanced civil engineering technologies to continue education, achieve entrepreneurial success, and explore various career options.	1. Understanding and applying modern tools and technologies in civil engineering. 2. Emphasizing the importance of lifelong learning through professional development courses, certifications. 3. Developing skills related to entrepreneurship, including project management, business planning, and innovation in civil engineering practices. 4. Awareness of various career paths within the civil engineering field.	**4**

11. Program Outcomes and Program Specific outcomes Attained through course modules:

Courses offered in Civil Engineering Curriculum (MLRS-R20) and POs/PSOs attained Through course modules for I, II, III, IV, V, VI, VII and VIII semesters.

Code	Subject	PO												PSO		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I B. Tech –I Semester																
2210001	Matrix Algebra and Calculus	√	√	√									√	√		
2210008	Applied Physics	√	√	√										√		
2210501	Programming for Problem Solving	√	√	√	√									√		
2210372	Engineering Workshop	√	√	√	√	√								√	√	
2210010	English for Skill Enhancement									√	√	√	√		√	√
2210175	Elements of Civil Engineering	√	√	√			√	√						√		
2210071	Applied Physics Laboratory	√	√	√	√	√								√	√	
2210571	Programming for Problem Solving Laboratory	√	√	√	√	√								√		

2210073	English Language and Communication Skills Laboratory									√	√	√	√		√	√
2210021	Environmental Science						√	√	√							
I B. Tech-II Semester																
2220002	Differential Equations and Vector Calculus	√	√	√									√	√		
2220009	Engineering Chemistry	√	√	√										√		
2220371	Engineering Drawing Practice	√	√	√	√									√		
2220122	Applied Mechanics	√	√	√	√									√		
2220123	Surveying	√	√	√	√	√							√	√	√	√
2220572	Data Structures Laboratory	√	√	√	√	√							√	√		
2220072	Engineering Chemistry Laboratory	√	√	√	√	√							√	√		
2220176	Surveying Laboratory - I	√	√	√	√	√	√						√	√	√	√
II B. Tech-I Semester																
2230124	Building Materials, Construction and Planning	√	√	√	√	√	√	√					√	√		√
2230125	Strength of Materials - I	√	√	√	√								√	√	√	√
2230126	Fluid Mechanics	√	√	√	√								√	√		√
2230016	Business Economics and Financial Analysis	√					√	√				√				
2230202	Basic Electrical and Electronics Engineering	√	√	√	√									√		
2230177	Surveying Laboratory - II	√	√	√	√	√	√						√	√	√	√

2230178	Strength of Materials Laboratory	√	√	√	√	√							√	√	√	√
2230272	Basic Electrical and Electronics Engineering Laboratory	√	√	√	√	√								√		
2230023	Constitution of India						√	√	√	√	√	√			√	
II B. Tech-II Semester																
2240127	Engineering Geology	√	√	√			√	√						√		
2240128	Strength of Materials - II	√	√	√	√								√	√		√
2240129	Hydraulics and Hydraulic Machinery	√	√	√	√								√	√		√
2240006	Probability and Statistics	√	√	√									√	√		
2240503	Python Programming	√	√	√	√								√	√		
2240179	Fluid Mechanics and Hydraulics Machinery Laboratory	√	√	√	√	√							√	√	1	√
2230180	Computer Aided Drafting Laboratory	√	√	√	√	√							√	√	√	√
2240573	Python Programming Laboratory	√	√	√	√								√	√	√	
2240191	Field based Project	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
2240022	Gender sensitization				√		√	√	√							
III B. Tech-I Semester																
2250130	Water Resources Engineering	√	√	√	√		√	√					√	√	√	√
2250131	Basic Structural Analysis	√	√	√	√								√	√	√	√
2250132	Design of Reinforced Concrete Elements	√	√	√	√								√	√	√	√
2250141	Concrete Technology	√	√	√	√		√						√	√	√	√

2230504	Data Analytics	√	√	√	√		√	√	√	√	√	√	√	√	√	√
2250181	Concrete Technology Laboratory	√	√	√	√	√							√	√	√	√
2250182	Computer Aided Design and Detailing Laboratory	√	√	√	√	√							√	√	√	√
2250183	Design and Drawing of Irrigation Structures	√	√	√	√			√	√				√	√	√	√
2250192	Internship *	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
III B. Tech-II Semester																
2260133	Design of Steel Structures	√	√	√	√								√	√	√	√
2260134	Soil Mechanics	√	√	√	√		√						√	√	√	√
2260017	Fundamentals of Management															
2260146	Prestressed Concrete	√	√	√	√					√			√	√	√	√
2250406	Utilization of Electrical Energy	√	√	√	√											
2260011	Advanced English Communication Skills Laboratory									√	√	√	√		√	√
2260184	Soil Mechanics Laboratory	√	√	√	√	√	√						√	√		
2260185	Civil Engineering Software Laboratory	√			√	√							√	√		
2260193	Industrial Oriented Mini Project	√	√	√	√	√						√	√	√	√	√
2260024	Intellectual Property Rights						√	√	√	√	√	√			√	
IV B. Tech-I Semester																
2270135	Environmental Engineering	√	√	√	√		√	√					√	√	√	√
2270136	Estimation, Costing and Project Management	√	√	√	√		√					√	√	√	√	√

2270137	Transportation Engineering	√	√	√	√		√						√	√	√	√
2270151	Watershed Management	√	√	√			√	√					√	√	√	
2280164	Remote Sensing and GIS	√	√				√	√					√	√		√
2270186	Environmental Engineering Laboratory	√	√		√								√	√		
2270187	Transportation Engineering Laboratory	√	√	√	√	√	√						√	√	√	√
2270194	Project Stage – I	√	√	√	√	√	√	√	√	√		√	√	√	√	√
IV B. Tech-II Semester																
2280153	Railway, Airport and Harbour Engineering	√	√	√	√		√						√	√	√	√
2280160	Environmental Impact Assessment	√	√	√			√	√	√					√	√	
2260407	Alternative Energy sources	√	√	√			√	√						√		√
2280195	Technical Seminar	√	√	√	√	√	√	√	√	√		√	√	√	√	√
2280196	Project Stage - II	√	√	√	√	√	√	√	√	√		√	√	√	√	√

12. Methods for measuring Learning Outcomes and Value Addition:

There are many different ways to assess student learning. In this section, we present the different type of assessment approaches available and the different frameworks to interpret the results.

i) Continuous Internal Assessment (CIA).
ii) Semester end examination(SEE)
iii) Laboratory and project work
iv) Course exit survey
v) Program exit survey
vi) Alumni survey
vii) Employer survey
viii) Course expert committee
ix) Department Advisory Board
x) Faculty meetings

The above assessment indicators are detailed below.

12.1. Continuous Internal Assessment (CIA)

Two Continuous Internal Examinations (CIEs) are conducted for all courses by the department. All students must participate in this evaluation process. These evaluations are critically reviewed by HOD and senior faculty and the essence is communicated to the faculty concerned to analyze, improve and practice so as to improve the performance of the student.

12.2. Semester End Examination (SEE)

The semester end examination is conducted for all the courses in the department. Before the Semester end examinations course reviews are conducted, feedback taken from students and remedial measures will be taken up such that the student gets benefited before going for end exams. The positive and negative comments made by the students about the course are recorded and submitted to the departmental academic council and to the principal for taking necessary actions to better the course for subsequent semesters.

12.3. Laboratory and Project Works

The laboratory work is continuously monitored and assessed to suit the present demands of the industry. Students are advised and guided to do project works giving solutions to research/industrial problems to the extent possible by the capabilities and limitations of the student. The results of the assessment of the individual projects and laboratory work can easily be conflated in order to provide the students with periodic reviews of the overall progress and to produce terminal marks and grading.

12.4. Course End Surveys

Students are encouraged to fill-out a brief survey on the fulfillment of course objectives. The data is reviewed by the concerned course faculty and the results are kept open forth entire faculty. Based on this, alterations or changes to the course objectives are undertaken by thorough discussions in faculty and meetings.

12.5. Programme Exit Survey

The Program Exit Questionnaire is to be completed by all students leaving the institution. The questionnaire is designed to gather information from students regarding program educational objectives, overall program experiences, career choices, and any suggestions or comments for program improvement. The opinions expressed in the exit interview forms are reviewed by the Department Advisory Committee (DAC) for potential implementation.

12.6. Alumni Survey

The survey gathers insights from former students of the department regarding their employment status, further education, perceptions of institutional emphasis, estimated gains in knowledge and skills, undergraduate involvement, and continued engagement with Marri Laxman Reddy Institute of Technology and Management. This survey is

conducted every three years, and the collected data is analyzed for continuous improvement.

12.7. Employer Survey

The main purpose of this employer questionnaire is to know employers' views about the skills they require of employees compared to the skills actually possessed by them. The purpose is also to identify gaps in technical and vocational skills, determine the need for required training practices to fill these gaps, and establish criteria for hiring new employees. These employer surveys are reviewed by the College Academic Council (CAC) to modify the present curriculum to suit the requirements of the employer.

12.8. Course Expert Committee

The course expert team is responsible in exercising the central domain of expertise in developing and renewing the curriculum and assessing its quality and effectiveness to the highest of professional standards. Inform the Academic Committee the 'day-to-day' matters as are relevant to the offered courses. This committee will consider the student and staff feedback on the efficient and effective development of the relevant courses. The committee also review the course full stack content developed by the respective course coordinator.

12.9. Department Advisory Board

The Departmental Advisory Board (DAB) plays an important role in the development of the department. The department-level Advisory Board is established to provide guidance and direction for the qualitative growth of the department. The board interacts and maintains liaison with key stakeholders.
The DAB will monitor the progress of the program and develop or recommend new or revised goals and objectives for the program. Additionally, the DAB will review and analyse the gaps between the curriculum and industry requirements, providing necessary feedback or advice to improve the curriculum

12.10. Faculty Meetings

The DAC meets bi-annually for every academic year to review the strategic planning and modification of PEOs. Faculty meetings are conducted atleast once in fortnight for ensuring the implementation of DAC's suggestions and guidelines. All these proceedings are recorded and kept for the availability of all faculties.

12.11. Professional Societies

The importance of professional societies like Society of Automotive Engineers (SAE), American Society of Mechanical Engineers (ASME) American Welding Society(AWS), American Society of Heating, Refrigerating and Air-Conditioning Engineers(ASHRAE) etc., are explained to the students and they are encouraged to become members of the above to carry out their continuous search for knowledge. Student and faculty chapters of the above societies are constituted for a better technical and entrepreneurial environment. These professional societies promote excellence in instruction, research, public service and practice.

13. CO-Assessment processes and tools:

Course outcomes are evaluated based on two approaches namely direct and indirect assessment methods. The direct assessment methods are based on the Continuous Internal Assessment (CIA) and Semester End Examination (SEE) where as the indirect assessment methods are based on the course end survey and program exit survey provided by the students, Alumni and Employer.

The weightage in CO attainment of Direct and Indirect assessments are illustrated in Table.

Assessment Method	Assessment Tool	Weightage in CO attainment
Direct Assessment	Continuous Internal Assessment (CIE & Assignment)	80%
	Semester End Examination	
Indirect Assessment	Course End Survey	20%

13.1. Direct Assessment:

Direct assessment methods are based on the student's knowledge and performance in various assessments and examinations. These assessment methods provide evidence that a student has command over a specific course, content, or skill. Additionally, they demonstrate that the student's work exhibits specific qualities such as creativity, analysis, or synthesis.

The various direct assessment tools used to assess the impact of the delivery of course content is listed in the table.

- Continuous internal examination, semester end examinations, Assignment (includes assignment, 5 minutes videos, seminars etc.) are used for CO calculation.
- The attainment values are calculated for individual courses and are formulated and summed for assessing the POs.
- Performance in Assignment is indicative of the student's communication skills.

S.No	Courses	Components	Frequency	Max. Marks	Evidence
1		Continuous Internal Examination	Twice in a semester	30	Answer script
		Assignment	Twice in a semester	5	Video/Quiz/ assignment

	Core/ Elective	Semester End Examination	Once in a semester	75	Answer script
2	Laboratory	Conduction of experiment	Once in a week	10	Record
		Observation	Once in a week	5	Worksheets
		Result	Once in a week	5	Worksheets
		Record	Once in a week	5	Worksheets
		Viva	Once in a week	5	Worksheets
		Internal laboratory assessment	Once in a semester	10	Answer script
		Semester End Examination	Once in a semester	60	Answer script
3	Project Work	Presentation	Twice In a semester	40	Presentation
		Semester End Examination	Once in a semester	60	Thesis report

13.2. Indirect Assessment:

Course End Survey- In this survey, questionnaires are prepared based on the level of understanding of the course and the questions are mapped to Course Outcomes. The tools and processes used in indirect assessment are shown in Table.

TABLE15: Tools used in Indirect assessment

Tools	Process	Frequency
Course end survey	• Taken for every course at the end of the semester • Gives an overall view that helps to assess the extent of coverage/compliance of COs • Helps the faculty to improve upon the various teaching methodologies	Once in a semester

Direct Tools: (Measurable in terms of marks and w.r.t.CO) Assessment done by faculty at department level.

Indirect Tools: (Non measurable (surveys) in terms of marks and w.r.t. CO) Assessment done at institute level.

14. PO/PSO-Assessment tools and Processes

The institute has the following methods for assessing the attainment of POs/PSOs.

1. Direct method
2. Indirect method

The attainment levels of course outcomes help in computing the PO/PSO based upon the mapping done.

TABLE16: Attainment of PO/PSOs

	Assessment	Tools	Weight
POs/PSOs Attainment	Direct Assessment	CO attainment of courses	80%
	Indirect Assessment	Program exit survey	20%
		Alumni survey	
		Employer survey	

The CO values of both theory and laboratory courses, with appropriate weightage as per CO-PO mapping, as per the Program Articulation Matrix, are considered for the calculation of direct attainment of PO/PSOs.

14.1. PO Direct Attainment is calculated using the following rubric:

PO Direct Attainment = (Strength of CO-PO) * CO attainment / Sum of CO-PO strength.

The below figure represents the evaluation process of POs/PSOs attainment through course outcome attainment.

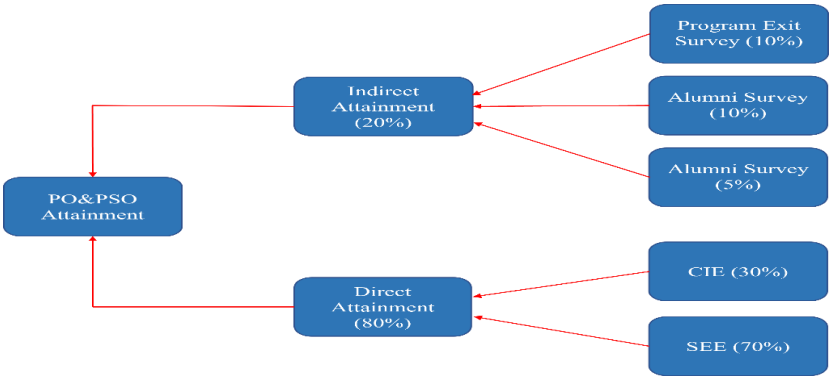


FIGURE4: Evaluation process of POs/PSO sattainment

15. Course Description:

The “Course Description” provides general information regarding the topics and content addressed in the course. A sample course description is given in Annexure – A for reference.

The “Course Description” contains the following contents:

- Course Overview
- Prerequisite(s)
- Marks Distribution
- Content Delivery / Instructional Methodologies
- Evaluation Methodology
- Course Objectives
- Course Outcomes
- Program Outcomes
- Program Specific Outcomes
- How Program Outcomes are Assessed
- How Program Specific Outcomes are Assessed
- Mapping of each CO with PO(s), PSO(s)
- Justification for CO–PO/PSO Mapping - Direct
- Total Count of Key Competencies for CO–PO/PSO Mapping
- Percentage of Key Competencies for CO–PO/PSO
- Course Articulation Matrix (PO/PSO Mapping)
- Assessment Methodology - Direct
- Assessment Methodology - Indirect
- Syllabus
- List of Textbooks / References / Websites

15.1 Course Descriptor:

MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)
Accredited by NAAC with 'A' Grade & Recognized Under Section2(f) & 12(B)of the UGC act,1956

BUILDING MATERIALS,CONSTRUCTIONAND PLANNING
COURSE DESCRIPTOR

1	Department	CIVIL ENGINEERING							
2	Course Name	Building materials ,construction and planning							
3	Course Code	2230124							
4	Year/Semester	II/I							
5	Regulation	MLRS-R22							
7	Structure of the course	Theory				Practical			
		Lecture	Tutorials	Practical	Credit	L	T	P	C
		3	0	0	3	0	0	0	0
8	Type of course	BS	HS	ES	PC	PE	OE	CC	MC
		×	×	×	√	×	×	×	×
9	Course Offered	Odd Semester	√	Even Semester	×				
10	Total lecture, tutorial and practical hours for this course Offered (16 weeks of teaching per semester)								
	Lectures: 58 Hours	Tutorials: 0	Practical: 0 hours						
11	Course Coordinator	Mrs.B. LAVANYA							
12	Date Approved by BOS	14-11-2022							
13	Course Webpage	www.mlritm.ac.in/							
14	Prerequisites/ Co-requisites	Level	Course Code	Semester	Prerequisites				
		UG	2210175	I-I	Elements of civil engineering				

15. Course Overview:

This course covers the fundamental principles and practices of building materials and construction planning. Students will learn about the properties, applications, and selection

criteria for various building materials, as well as the planning and management techniques necessary for successful construction projects. This course is designed for students in construction management, architecture, engineering, and related fields, as well as professionals in the construction industry who want to improve their knowledge and skills in building materials and construction planning.

16. Course Objectives:

The students will try to learn:

CE 214.1: To learn various construction materials for constructing a building
CE 214.2: To know the process involved to manufacture of cement, tests on cement, grades of concrete, tests on concrete, NDT, admixtures used for concrete
CE 214.3: To understand different building components
CE 214.4: To understand Plumbing services using different materials.
CE 214.5: To know the types of form work, utilisation, preparation of mortars for finishing work
CE 214.6:To learn Bye laws to construct a building

17. Course Outcomes:

After successful completion ofthe course, students should be able to:

CO1	**Describe** the different types and properties of stones, bricks, timber, and modern materials used in construction.
CO2	**Discuss** the manufacturing processes and chemical composition of various cements and their application in concrete, along with the role of admixtures.
CO3	**Assess** the various components of buildings such as lintels, arches, roofs, and foundations, as well as key building services like plumbing, ventilation, and fire protection systems.
CO4	**Utilize** knowledge of structural systems, formwork types, and mortar preparation methods in construction practices
CO5	**Justify** building plans based on the principles of building planning and classification, ensuring adherence to relevant bylaws and regulations.

18. Course Learning Outcome (CLOs):

Sno	Topic Name	CLO No	Course Learning Outcome	Course Outcome	Blooms Level
1	Stones,	CLO 1	Predict the properties of building stones and its classification	CO1	Understand
2	Bricks	CLO 2	Understand the composition, types and concept of various methods of manufacture of bricks	CO1	Understand
3	Timber	CLO 3	Understand timber and other modern materials	CO1	Understand

			which are used for constructions.		
4	Cement, concrete	CLO 4	Predict the properties of cement and concrete its classifications.	CO2	Understand
5	Admixtures	CLO 5	Understand the importance of mineral and chemical admixtures.	CO2	Understand
6	Building components	CLO 6	Know the various components of buildings and its purposes.	**CO3**	Understand
7	Building services	CLO 7	Understand the importance of building services.	CO3	Understand
8	Structuralsystems and Form work	CLO 8	Understand the structural system	CO4	Understand
9	Mortars and finishers	CLO 9	Understand purpose of mortars and finishers	CO4	Understand
10	Stairs and Building planning	CLO 10	Understand the different types of stairs.	CO5	Understand

19. Employability Skills:

Technical expertise: Fluid Mechanics Engineers are experts in the study and application of fluid dynamics principles. They analyze the behavior of liquids and gases in various engineering systems, from designing efficient pipelines to optimizing aerodynamics in aircraft. Their work impacts industries such as aerospace, energy, environmental engineering, and more.
Problem-solving and analytical thinking: The ability to break down complex fluid dynamics problems, identify the relevant physical processes, and develop appropriate computational models and solution strategies is essential.
Systems thinking: study, harness, and exploit fluid mechanics to develop and test formal and computational techniques, to better understand the natural world, and to attempt to improve the human condition.
Communication and collaboration: Fluid mechanics is closely related to other fields, such as thermodynamics, structural mechanics, and material science. Collaboration across these disciplines is necessary to ensure that all aspects of a project are considered.
Environmental ethics and sustainability: In fluid mechanics, sustainability often focuses on designing systems that minimize energy consumption. For example, optimizing the design of pumps, turbines, and HVAC systems can lead to significant energy savings, reducing the environmental impact. Fluid systems are designed to use resources efficiently. This includes reducing water usage in hydraulic systems or designing irrigation systems that minimize waste.

20. Content Delivery / Instructional Methodologies:

√	 PowerPointPresentation	√	 Chalk&Talk	√	 CAT(Assignments/Tech	✓	 MOOC

					Talk/Concep t video etc.)		
√	 ALP	√	 Seminars	x	 MiniProject	√	 Videos

21. Evaluation Methodology:

Theperformanceofastudentina coursewill be evaluated for 100 marks each, with 40 marks allotted for CIE (ContinuousInternalEvaluation)and60marksfor SEE(SemesterEnd-Examination). In CIE, for theory subjects, during a semester, there shall be two mid-term examinations. EachMid-Term examination consists of two parts i) **Part – A** for 10 marks, ii) **Part – B** for 20 marks with a totaldurationof2hours asfollows:

MidTermExaminationfor40marks:

a. Part-A:Objective/quiz/shortanswer typepaperfor 10marks.
b. Part-B:Descriptivepaperfor20marks.

The average of two midterm examinations shall be taken as the final marks for mid term examinations.

The semester end examinations (SEE), will be conducted for 60 marks consisting of two parts viz.i) **Part-A**for10marks,ii)**Part-B**for50marks.

a. Part-A is a compulsory question which consists of ten sub-questions from all units carryingequalmarks.0
b. Part-B consists of five questions (numbered from 2 to 6) carrying 10 marks each. Each ofthese questions is from each unit and may contain sub-questions.For each question therewill be an "either" "or" choice, which means that there will be two questions from each unitandthestudentshouldanswereitherofthetwoquestions.
c. ThedurationofSemesterEndExaminationis3hours.

Table 1: Outline for Continues Internal Evaluation (CIE-I and CIE-II) and SEE

Activities	CIE-I	CIE-II	Average of CIE	SEE	Total Marks
Continues Internal Evaluation (CIE)	20 Marks	20 Marks			Average of CIE + SEE
Objective / quiz / short answer Questions	10 Marks	10 Marks			

CAT(Assignment/Tech Talk/PPT/Concept video etc.)	10 Marks	10 Marks			
Total Marks	**40 Marks**	**40 Marks**	**40 Marks**	**60 Marks**	**100 Marks**

22. Course content - Number of modules: Five:

MODULE 1	**Stones and Bricks, Tiles**: Building stones – classifications and quarrying – properties – structural requirements – dressing. Stone masonry – types; Bricks – Composition of Brick earth – manufacture and structural requirements, Fly ash, Ceramics. Brick masonry – types – bonds. **Timber and Other modern materials**: Wood - structure – types and properties – seasoning – defects; alternate materials for Timber – GI / fibre – reinforced glass bricks, steel &aluminum, Plastics. Geomembranes and Geotextiles for earth reinforcement	No. of theory classes : 14
MODULE 2	**Cement, Concrete and Admixtures**: Cements – Grade of cements - Ingredients of cement – Types and properties of cement - Manufacture – Chemical composition – Hydration - field & lab tests on cement. Concrete – Types – Properties – Various test on concrete. Admixtures – mineral & chemical admixtures – uses	No. of theory classes : 12
MODULE 3	**Building Components**: Lintels, Arches, walls, stair cases, floors – types of floors, roofs -types of roofs – Damp Proof Course ; Joinery – doors – windows – types. foundations – types. **Building Services**: Plumbing Services: Water Distribution, Sanitary – Lines & Fittings; Ventilations: Functional requirements systems of ventilations. Air-conditioning - Essentials and Types; Acoustics – characteristic – absorption – Acoustic design; Fire protection – Fire Harzards – Classification of fire resistant materials and constructions.	No. of theory classes : 15
MODULE 4	**Structural Systems**: Load Bearing Structure - Framed Structure - Load transfer mechanism. **Form work: Types**: Requirements – Standards – Scaffolding – Design; Shoring, Underpinning. **Mortars and Finishers**: Lime and Cement Mortars - Preparation of mortar Plastering, Pointing, Painting, Claddings – Types – Tiles.	No. of theory classes : 12
MODULE 5	**Stairs and Building Planning:** Stairs – Types – Requirement of good stairs - Principles of Building Planning, Classification of buildings and Building by laws.	No. of theory classes : 5

TEXT BOOKS:

1. Building Materials and Construction by Arora &Bindra, Dhanpat Roy Publications.

2. Building Construction by B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain - Laxmi Publications (P) ltd., New Delhi.

REFERENCE BOOKS:

1. Building Materials and Construction by G C Sahu, Joygopal Jena McGraw hill Pvt Ltd 2015.

2. Building Materials by Duggal, New Age International.

3. Building Materials by P. C. Varghese, PHI Publications.

4. Building Construction by PC Varghese PHI Publications.

5. Construction Technology – Vol – I & II by R. Chubby, Longman UK.

6. Alternate Building Materials and Technology by Jagadish, Venkatarama Reddy and others; New Age Publications

ELECTRONIC RESOURCES:

https://nptel.ac.in/courses/105102088
https://www.classcentral.com/course/swayam-building-materials-and-composites-19810

https://www.youtube.com/watch?v=uoS6XKFznBE&list=PLUg-KBWu0QYmEf5BW19QPiZQy1V5suyXa

23. COURSE PLAN:

S. No.	Topics to be covered	Cos	Reference
1	Introduction, Building stones, Classification of stones	CO1	T1,R1,R5
2	Quarrying of stones, Properties of good building stones	CO1	T1,R1,R5
3	Structural requirements of a good building stone	CO1	T1,R1,R5
4	Surface tension, capillarity	CO1	T1,R1,R5
5	Dressing of stones and bricks, Composition of brick earth	CO1	T1,R1,R5
6	Manufacture and structural requirements of a good brick earth	CO1	T1,R1,R5
7	Fly ash, Ceramic, Timber, Aluminum, Glass	CO1	T1,R1,R5
8	Paints, Plastics, Introduction of wood, Wood structure,	CO1	T1,R1,R5
9	Introduction of wood, Wood structure,	CO1	T1,R1,R5
10	Types and properties of wood, Seasoning of wood	CO1	T1,R1,R5
11	Defects of wood, Alternate materials for Timber	CO1	T1,R1,R5
12	GI sheets, fiber, Reinforced glass bricks	CO1	T1,R1,R5
13	Active Learning (collaborative learning)	CO1	T1,R1,R5
14	Unit Test – 1	CO2	T1,R1,R5
15	Introduction of cement	CO2	T1,R1,R5
16	Ingredients of cement, Manufacturing process	CO2	T1,R1,R5
17	Chemical composition	CO2	T1,R1,R5
18	Hydration	CO2	T1,R1,R5
19	Field and lab tests of cement	CO2	T1,R1,R5

20	Concrete types	CO2	T1,R1,R5
21	Mineral admixtures	CO2	T1,R1,R5
22	Chemical admixtures	CO2	T1,R1,R5
23	Uses of admixtures	CO2	T1,R1,R5
24	Active Learning (collaborative learning)	CO2	T1,R1,R5
25	Unit Test-2	CO2	T1,R1,R5
26	Introduction on building components, Lintels, Arches	CO3	T1,R1,R5
27	Walls, vaults, Stair cases	CO3	T1,R1,R5
28	Types of floors, Types of roofs – Flat, Curved, Trussed	CO3	T1,R1,R5
29	Foundations, types of foundations	CO3	T1,R1,R5
30	Damp proof course, Joinery, Doors, Windows, Materials & types	CO3	T1,R1,R5
31	Building services - Plumbing services: Water distribution, Sanitary - lines & fittings	CO3	T1,R1,R5
32	Ventilations - Functional requirements systems of ventilations	CO3	T1,R1,R5
33	Air conditioning - Essentials and types, Acoustics - Characteristics of acoustic materials, Acoustics design	CO3	T1,R1,R5
34	Fire protection, Fire hazards	CO3	T1,R1,R5
35	Classification of fire resistant materials and construction	CO3	T1,R1,R5
36	Active learning	CO3	T1,R1,R5
37	Unit test 3	CO3	T1,R1,R5
38	Structural systems Load bearing structure	CO4	T1,R1,R5
39	Framed structures,load transfer mechanism	CO4	T1,R1,R5
40	Form work types scaffolding design	CO4	T1,R1,R5
41	Introduction, Mortars, masonry and Finishing's Mortars, Lime and Cement mortars	CO4	T1,R1,R5
42	Finishers – Plastering, Pointing, painting, Claddings, types, Tiles, ACP	CO4	T1,R1,R5
43	Active learning	CO4	T1,R1,R5
44	Unit test 4	CO4	T1,R1,R5
45	Stairs and types	CO5	T1,R1,R5
46	Requirement of good stairs	CO5	T1,R1,R5
47	Principles of building planning	CO5	T1,R1,R5

48	Classification of builings and building by laws	CO5	T1,R1,R5
49	unit test 5		

24. PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES:

S No	Program Outcomes
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

S No	Program Outcomes
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
Program Specific Outcomes	
PSO1	Demonstrate the ability to plan, design, implement, and supervise civil engineering systems in various sectors
PSO2	Focus on safety, serviceability, and eco-friendly technologies while operating, maintaining, and rehabilitating civil engineering systems.
PSO3	Utilize advanced civil engineering technologies to continue education, achieve entrepreneurial success, and explore various career options.

25. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals,	3	CAT Modules , internal and External Examinations

	and an engineering specialization to the solution of complex engineering problems.		
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CAT Modules , internal and External Examinations
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3	CAT Modules , internal and External Examinations
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	CAT Modules , internal and External Examinations
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.		CAT Modules , internal and External Examinations
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.		CAT Modules , internal and External Examinations
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.		CAT Modules , internal and External Examinations
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.		CAT Modules , internal and External Examinations
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.		CAT Modules , internal and External Examinations
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear		CAT Modules , internal and External Examinations

	instructions.		
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.		CAT Modules , internal and External Examinations
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	3	CAT Modules , internal and External Examinations

26. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO1	Demonstrate the ability to plan, design, implement, and supervise civil engineering systems in various sectors	3	CAT Modules , internal and External Examinations
PSO2	Focus on safety, serviceability, and eco-friendly technologies while operating, maintaining, and rehabilitating civil engineering systems.	3	CAT Modules , internal and External Examinations
PSO3	Utilize advanced civil engineering technologies to continue education, achieve entrepreneurial success, and explore various career options.	3	CAT Modules , internal and External Examinations

3 = High; 2 = Medium; 1 = Low

27. MAPPING OF EACH CO WITH PO(s), PSO(s):

	PROGRAM OUTCOMES												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1,2,3	3,4,5,6,7,8,9,10				1,3,5						1,2,3,6,7	1,2,5		2,3,4
CE 417.2	1,2,3	3,4,5,6,7,8,9,10				1,3,5	3					1,2,3,6,7	1,2,5		2,3,4
CE 417.3	1,2,3	3,4,5,6,7,8,9,10	1,2,5	1,3,8		1,3,5	3,4					1,2,3,6,7	1,2,5		2,3,4
CE 417.4	1,2,3	3,4,5,6,7,8,9,10	1,2,5	1,3,8		1,3,5	3,4					1,2,3,6,7	1,2,5		2,3,4
CE 417.5	1,2,3	3,4,5,6,7,8,9,10	1,2,5	1,3,8		1,3,5	3,4					1,2,3,6,7	1,2,5		2,3,4

28. JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:0

PO No.	NBA Statement / Vital Features	Key Components	No. of Key Components
PO1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems (Engineering Knowledge).	1. Application of scientific principles and methodologies. 2. Utilization of mathematical concepts in problem-solving. 3. Integration of knowledge from various engineering disciplines. 4. Application of specialized engineering knowledge in complex engineering problems.	4
PO 2.	Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and Engineering sciences (Problem Analysis).	1. Recognizing and defining complex engineering problems or opportunities. 2. Structuring and abstracting the problem for systematic analysis. 3. Examining research literature 4. Investigating problems using data collection and relevant methodologies. 5. Applying mathematical, natural, and engineering sciences in problem-solving. 6. Ensuring accuracy and reliability through validation. 7. Planning and conducting experiments for problem analysis. 8. Implementing and testing solutions through experimentation. 9. Evaluating results to draw meaningful engineering conclusions. 10. Recording findings systematically for future reference and learning.	10
PO 3.	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (Design/Development of Solutions).	1. Investigate and define a problem while identifying constraints, including environmental, sustainability, health, and safety considerations. 2. Understand customer and user needs while considering factors such as aesthetics. 3. Identify and manage cost drivers in engineering solutions. 4. Use creativity to develop innovative engineering solutions. 5. Ensure fitness for purpose across production, operation, maintenance, and disposal. 6. Manage the design process and evaluate outcomes for safety and risk assessment. 7. Understand the commercial and economic context of engineering processes. 8. Apply management techniques to achieve engineering objectives in a broader context.	10

		9. Promote sustainable development through engineering activities. 10. Be aware of legal frameworks governing engineering activities, including personnel, health, safety, and environmental risks.	
PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (Conduct Investigations of Complex Problems).	1. Gain a deep understanding of materials, equipment, processes, and products through research to address engineering problems effectively. 2. Develop essential laboratory and workshop skills to carry out experimental investigations and gather reliable data. 3. Address complex problems in various engineering contexts, including operations, management, and technology development. 4. Leverage technical literature and reliable information sources 5. Follow appropriate codes of practice and industry standards when analyzing and interpreting experimental data. 6. Ensure high-quality results by integrating various data sources and considering quality control during engineering investigations. 7. Draw valid conclusions by addressing technical uncertainties through sound reasoning and scientific principles. 8. Apply fundamental engineering principles to analyze and interpret key engineering processes and challenges. 9. Use analytical and modeling techniques to identify, classify, and describe the performance of engineering systems and components. 10. Employ analytical software and quantitative methods efficiently and accurately.	10

PO 5.	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations (Modern Tool Usage).	1. Develop engineering solutions using modern tools across various disciplines. 2. Identify appropriate prediction and modeling tools for diverse engineering applications. 3. Utilize IT tools in engineering analysis, design, and decision-making. 4. Implement simulation tools in different engineering fields.	4
PO 6.	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (The Engineer and Society).	1. Understand the commercial and economic context of engineering processes. 2. Apply management strategies in engineering objectives within this context. 3. Promote sustainable development through engineering activities. 4. Recognize relevant legal requirements governing engineering practices, including health, safety, and environmental risks. 5. Uphold high standards of professional and ethical conduct in engineering.	5
PO 7.	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (Environment and Sustainability).	1. Understand the socio-economic effects of engineering solutions on society. 2. Recognize the political implications and responsibilities of engineering solutions. 3. Assess the environmental consequences of engineering practices and solutions. 4. Demonstrate the importance of sustainable development in engineering solutions.	4
PO 8.	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (Ethics).	1. Make informed decisions based on ethical principles, using professional codes of ethics to guide actions and evaluate the ethical aspects of practice. 2. Demonstrate a strong sense of trust and integrity, standing firm in one's values while acting responsibly and ethically. 3. Ensure fair treatment and equity in all professional activities, valuing diversity and respecting others' perspectives. 4. Adhere to the norms of engineering practice by committing to high ethical standards and demonstrating ethical behavior in all professional engagements.	4
PO9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (Individual and Teamwork).	1. Work effectively as an individual, taking ownership of tasks and driving progress independently. 2. Demonstrate maturity by focusing on goal achievement, requiring minimal external motivation. 3. Approach vaguely defined problems with systematic problem-solving skills	10

		4. Engage in teamwork during various activities, including hands-on labs and multidisciplinary projects. 5. Participate in diverse team settings, adjusting to different roles and projects. 6. Understand and apply principles of teamwork and project management 7. Contribute to team dynamics by evaluating and reflecting on individual and group performance. 8. Foster teamwork and lasting relationships, contributing to both academic success and post-graduation professional networks. 9. Collaborate with individuals across all levels of an organization, demonstrating adaptability and interpersonal skills. 10. Develop strong relationships through positive interactions, showcasing an ability to get along with others and work cohesively in teams.	
PO10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (Communication).	1. Communicate complex engineering concepts clearly and concisely in written reports and design documentation. 2. Ensure high standards of grammar and punctuation in written communication, maintaining professionalism and clarity. 3. Properly reference sources in written communication, ensuring accuracy and academic integrity. 4. Deliver oral presentations effectively, with appropriate speaking style 5. Demonstrate a deep understanding of the subject matter, clearly communicating complex ideas during oral discussions and presentations.	5
PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (Project Management and Finance).	1. Define the project scope clearly to ensure alignment with objectives and requirements. 2. Identify and prioritize critical success factors necessary for project completion and success. 3. Ensure the timely delivery of project outputs, meeting the predefined objectives and quality standards. 4. Develop and organize a structured breakdown of tasks and activities to achieve project goals. 5. Create and manage schedules to ensure tasks are completed on time and milestones are met. 6. Develop and manage project budgets, ensuring that resources are used efficiently and within financial constraints. 7. Apply quality control measures to ensure that project deliverables meet the required standards.	10

		8. Plan and allocate human resources effectively, ensuring the right skills and team dynamics. 9. Identify and manage stakeholders, ensuring their needs and expectations are addressed throughout the project. 10. Develop a risk register and apply strategies to identify, assess, and mitigate project risks.	
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (Life - Long Learning).	1. Pursue professional, Academic, Global certifications. 2. Begin and work towards advanced programs to further deepen knowledge in engineering and related areas. 3. Stay updated on industry trends and emerging technologies to remain relevant in the field. 4. Learn at least 2–3 new significant skills annually to ensure continuous growth and development. 5. Dedicate time for formal training for a standard duration of training each year. 6. Engage in ongoing self-improvement efforts to enhance both personal and professional growth. 7. Be adaptable to technological changes by actively pursuing new learning opportunities and challenges. 8. Build a network with industry peers and professionals to stay informed and grow knowledge through collaboration	8
PSO1	Demonstrate the ability to plan, design, implement, and supervise civil engineering systems in various sectors	1. Understanding site selection, surveying, and project feasibility for infrastructure development. 2. Applying principles of structural analysis, material selection, and load considerations for safe and efficient construction. 3. Executing construction processes, project scheduling, and management techniques for timely completion. 4. Monitoring construction activities, ensuring adherence to standards, and implementing safety regulations. 5. Addressing challenges in transportation, water resources, geotechnical, and environmental engineering projects.	5
PSO2	Focus on safety, serviceability, and eco-friendly technologies while operating, maintaining, and rehabilitating civil engineering systems.	1. Understanding and implementing safety standards and regulations in civil engineering projects to ensure the well-being of users and workers. 2. Evaluating the performance of civil engineering systems to ensure they meet functional requirements and user needs throughout their lifecycle. 3. Incorporating sustainable practices and environmentally friendly materials in the design, construction, and maintenance of civil engineering systems. 4. Developing strategies for the effective operation, maintenance, and rehabilitation of existing civil engineering infrastructures to extend their service life.	5

		5. Collaborating with professionals from various fields to integrate safety, serviceability, and sustainability considerations in civil engineering practices.	
PSO3	Utilize advanced civil engineering technologies to continue education, achieve entrepreneurial success, and explore various career options.	1. Understanding and applying modern tools and technologies in civil engineering. 2. Emphasizing the importance of lifelong learning through professional development courses, certifications. 3. Developing skills related to entrepreneurship, including project management, business planning, and innovation in civil engineering practices. 4. Awareness of various career paths within the civil engineering field.	4

29. TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

	PROGRAM OUTCOMES												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	8				3						5	3		3
CO2	3	8				3	1					5	3		3
CO3	3	8	3	3		3	2					5	3		3
CO4	3	8	3	3		3	2					5	3		3
CO5	3	8	3	3		3	2					5	3		3

30. PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO/ PSO):

Program outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO 1	PSO 2	PSO 3
No.Key Components	4	10	10	10	4	5	4	4	10	5	10	8	5	5	4
CO1	**75**	**80**	**0**	**0**	**0**	**60**	**0**	**0**	**0**	**0**	**0**	**63**	**60**	**0**	**75**
CO2	**75**	**80**	**0**	**0**	**0**	**60**	**25**	**0**	**0**	**0**	**0**	**63**	**60**	**0**	**75**
CO3	**75**	**80**	**30**	**30**	**0**	**60**	**50**	**0**	**0**	**0**	**0**	**63**	**60**	**0**	**75**
CO4	**75**	**80**	**30**	**30**	**0**	**60**	**50**	**0**	**0**	**0**	**0**	**63**	**60**	**0**	**75**
CO5	**75**	**80**	**30**	**30**	**0**	**60**	**50**	**0**	**0**	**0**	**0**	**63**	**60**	**0**	**75**

31. COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S, CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - 0≤ C≤ 5% – No correlation, 2 - 40 % <C < 60% –Moderate

1-5 <C≤ 40% – Low/ Slight 3 - 60% ≤ C < 100% – Substantial /High

Program outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO 1	PSO 2	PSO 3
CO1	3	3	0	0	0	3	0	0	0	0	0	3	3	0	3
CO2	3	3	0	0	0	3	1	0	0	0	0	3	3	0	3
CO3	3	3	1	1	0	3	2	0	0	0	0	3	3	0	3
CO4	3	3	1	1	0	3	2	0	0	0	0	3	3	0	3
CO5	3	3	1	1	0	3	2	0	0	0	0	3	3	0	3
Average	3	3	0.6	0.6	0	3	1.4	0	0	0	0	3	3	0	3

32. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	√	SEE	√	Seminars	√
Objective / quiz	√	Viva-Voce/PPT	√	MOOCS	√
Assignments	√	Project	-		

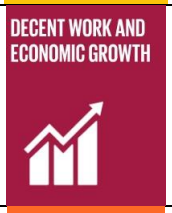
33. ASSESSMENT METHODOLOGY INDIRECT:

✓	Course End Survey (CES)

34. RELEVANCE TO SUSTAINABILITY GOALS:

Python, as a versatile and powerful programming language, can play a significant role in advancing various SDGs.

x	1		
x	2		
✓	3		BMCP emphasizes the importance of preventive healthcare, health promotion, and access to quality healthcare services for all. It advocates for addressing social determinants of health, such as poverty, education, and living conditions, which directly impact individual and community well-being. Furthermore, BMCP highlights the significance of mental health, ensuring that emotional and psychological well-being are prioritized alongside physical health.

✓	4		BMCP underscores the role of education in promoting healthier behaviors, improving health literacy, and enabling informed decision-making regarding health practices. Quality education empowers individuals with the knowledge and skills to prevent diseases, manage health conditions, and access healthcare services more effectively. Additionally, it contributes to reducing health inequalities by addressing social determinants of health such as income, occupation, and access to resources.
x	5		
✓	6		.BMCP highlights that access to safe drinking water, proper sanitation, and effective hygiene practices are essential for reducing the burden of waterborne diseases such as cholera, diarrhea, and typhoid, which disproportionately affect vulnerable populations. The journal also explores the importance of improving infrastructure and policies to ensure equitable access to clean water and sanitation, particularly in low-income regions. By addressing these challenges, BMCP emphasizes the role of sanitation in reducing health disparities and preventing the spread of infectious diseases.
x	7		
✓	8		
✓	9		
x	10		

✓	11		
✓	12		
✓	13		
x	14		
✓	15		BMCP emphasizes that the degradation of land, deforestation, and loss of biodiversity have profound effects on public health by increasing exposure to zoonotic diseases, reducing the availability of natural resources, and contributing to climate change. The journal advocates for the protection of terrestrial ecosystems, as healthy ecosystems provide essential services such as clean air, water, food, and natural medicines, all of which are critical for human survival. BMCP also explores the intersection of environmental health and human health, highlighting how the conservation of biodiversity and sustainable land management practices can mitigate public health risks and promote resilience against environmental challenges.
x	16		
✓	17		Fluid mechanics research often involves collaboration across disciplines and industries, as well as international partnerships for large-scale projects such as water management systems and climate modeling.

Signature of Course Coordinator **HOD**