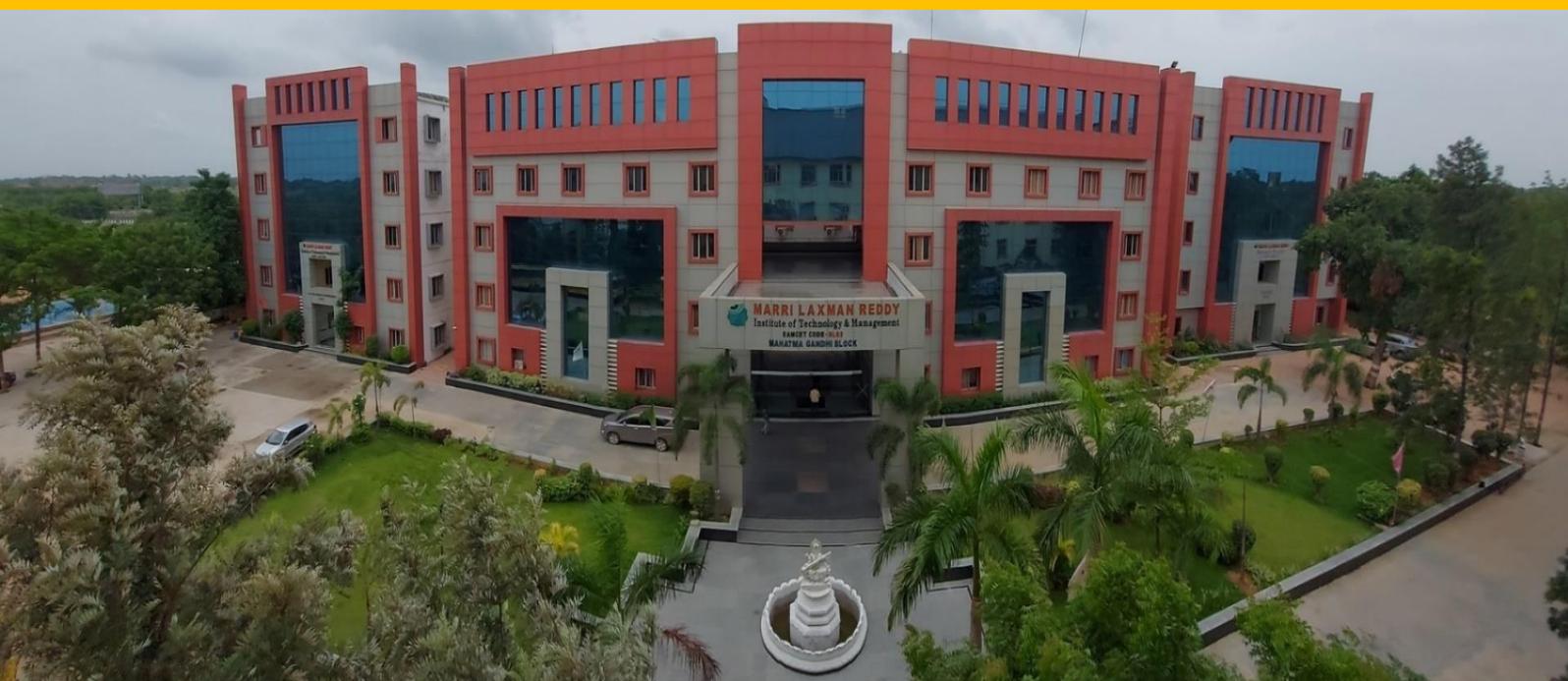# MLRITM

MARRI LAXMAN REDDY INSTITUTE OF TECHNOLOGY AND MANAGEMENT

Outcome Based Education (OBE) Manual

Department of Computer Science and Engineering(AIML)

Regulation: UGR22

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 programs and not the institutions.

Higher Education Institutions are classified into two categories by NBA

Tier – 1: Institutions consists of all IITs, NITs, Central Universities, State Universities and Autonomous Institutions. Tier –I 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 Stake holders 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 Specific Outcomes(PSOs)
3. Program Outcomes (POs)
4. 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 graduates 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 student's 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 education also 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 analysis help to find gaps and carryout continuous improvements in the education system of an Institute, which is very essential.

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

Vision

"To empower the students to be technologically adept, innovative, self-motivated and responsible global citizen possessing human values and contribute significantly towards high quality technical education by harmonizing innovation with sustainability."

Mission

M1: To offer high-quality education in the computing fields by providing an environment where the knowledge is gained and applied to participate in research, for bothstudents and faculty.

M2: To develop the problem solving skills in the students to be ready to deal with cutting-edge technologies of the industry.

M3: To make the students and faculty excel in their professional fields by inculcating the communication skills, leadership skills, team building skills with the organization of various co-curricular and extra-curricular programmes.

M4: To provide the students with theoretical and applied knowledge, and adopt an education approach that promotes lifelong learning and ethical growth.

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 stake holders.

A team of well qualified and experienced professionals ensure quality 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 therein is the notion 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 the 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 promote ties 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, trustworthiness, 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 PAQIC after taking feedback from all stake holders. PEOs are a 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 not ask 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 Behavior. 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.

Program Educational Objective - I: Graduates will possess strong theoretical and practical knowledge in Artificial Intelligence and Machine Learning, enabling them to solve complex real-world problems, pursue higher education, or excel in professional careers.
Program Educational Objective - II: Graduates will engage in innovative practices, cutting-edge research, and contribute to the advancement of AI and ML technologies through collaboration with industry and academia.
Program Educational Objective - III: Graduates will exhibit leadership qualities, effective communication, and teamwork skills, and will continuously upgrade their knowledge to adapt to evolving technological landscapes.
Program Educational Objective - IV: Graduates will leverage entrepreneurial skills and a sense of civic responsibility to create AI-driven solutions that benefit local and global communities.

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

The following Figure 1 shows the correlation between the PEOs and the POs
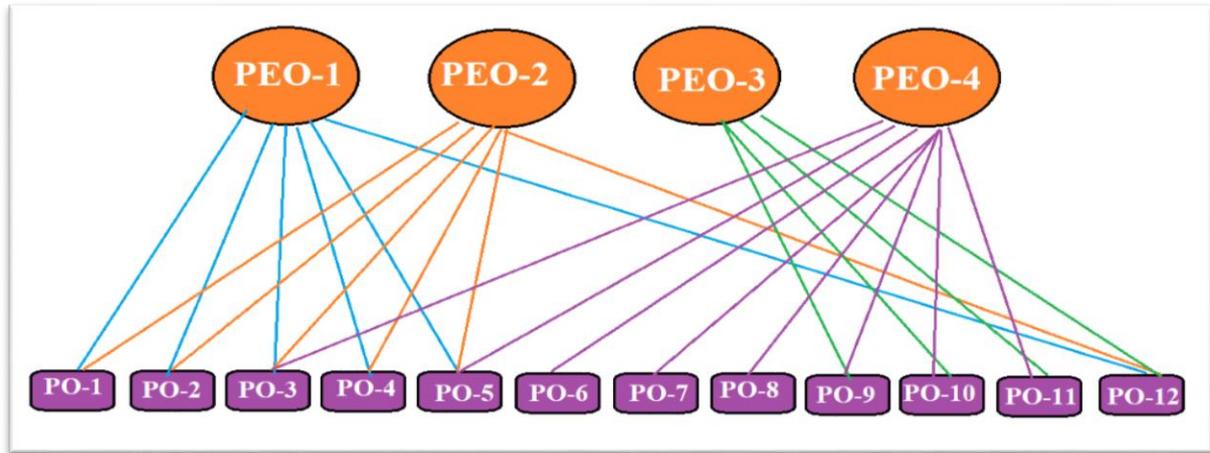
PEO-I	PEO-II	PEO-III	PEO-IV
PO:1,2,3,4,5,12	PO:1,2,3,4,5,12	PO:9,10,11,12	PO:3,5,6,7,8,9,10,11,12

FIGURE1: Correlation between the PEOs and the POs

The following Figure2 shows the correlation between the PEOs and the PSOs

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

FIGURE2: Correlation between the PEOs and the PSOs

3. Program Out comes (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.
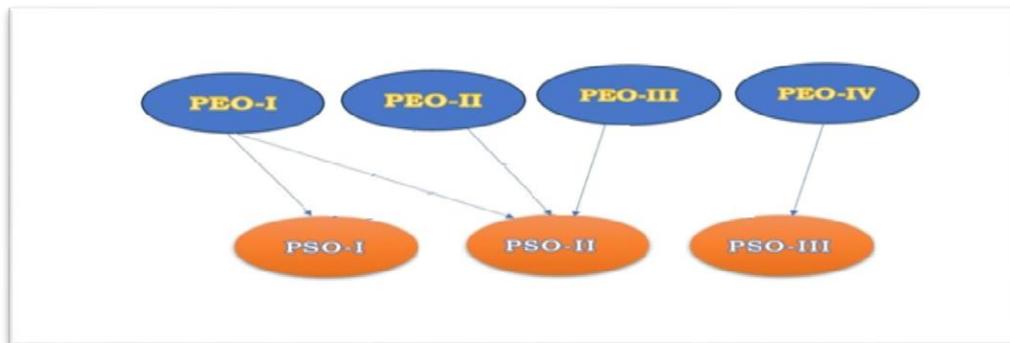
B. Tech (CSM) – PROGRAM OUTCOMES (PO's)	
A graduate of the Computer Science and Engineering(AIML) Program will be demonstrated:	
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering 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 Computer Science and Engineering(AIML) is given below.

B. Tech (CSM) – PROGRAM SPECIFIC OUTCOMES (PSO's)	
A graduate of the Computer Science and Engineering(AIML) Program will demonstrate:	
PSO1	Able to identify, analyze and solve the problems related to Artificial Intelligence and Machine Learning by applying the fundamental knowledge of Computer Science and Engineering.
PSO2	Able to use innovative tools and techniques to build project models in the areas related to Deep Learning, Machine learning, Artificial Intelligence.
PSO3	Able to apply their Artificial Intelligence and Machine Learning knowledge in interdisciplinary domains to address societal, environmental, health, safety challenges while aligning Sustainable development goals.

5. Relation between the Program Educational Objectives and the POs

Broad relationship between the program objectives and the program outcomes is given in the following Table below:

PEO's→ ↓PO's		(1) Professional Competence	(2) Innovation and Research Orientation	(3) Leadership and Lifelong Learning	(4) Entrepreneurial and Community Engagement
PO1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	3		
PO2	Identify, formulate, review research literature, and analyse complex engineering problems, reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	3		
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.	3	3		3
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.	3	3		

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.	3	3	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.		2		3
PO7	Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.		2		3
PO8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.			2	3
PO9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	2	2	3	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	2	3	2
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	3	3

		3	3	3	2
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.	3	3	3	2

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

PEO's→ ↓PSO's		(1) Professional Competence	(2) Innovation & Research	(3) Leadership & Lifelong Learning	(4) Entrepreneurial & Community Engagement
PSO1	Able to identify, analyze and solve the problems related to Artificial Intelligence and Machine Learning by applying the fundamental knowledge of Computer Science and Engineering.	3	2	1	2
PSO2	Able to use innovative tools and techniques to build project models in the areas related to Deep Learning, Machine learning, Artificial Intelligence.	3	3	2	2
PSO3	Able to apply their Artificial Intelligence and Machine Learning knowledge in interdisciplinary domains to address societal, environmental, health, safety challenges while aligning Sustainable development goals.	2	2	1	3

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 indirect.
- 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. Bloom's 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 incorporated into expected learning outcome statements. Recently, Anderson and Krathwohl (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.

FIGURE3: 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**	**Metacognitive**
• 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 • Knowledge about cognitive task, including gap propriate contextual and conditional Knowledge • Self-Knowledge

Action Verbs for Course Out comes

Lower Order of Thinking (LOT)			Higher Order of Thinking (HOT)		
Definitions	**Remem ber**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Bloom's Definition	Exhibit memory of previousl y learned material by recalling facts, terms, basic concepts, and answers.	Demonstrate understandin g off acts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and Stating main ideas.	Solve problem s to new situations by applying acquired knowledg e, facts, technique s 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	• Choos e • Define • Find • How • Label • List • Match • Extend	• Classify • Compare • Contrast • Demonstrate • Explain • Illustrate • Infer • Interpret	• Apply • Build • Choose • Constru ct • Develop • Intervie w • 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 • TestforTheme • 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. Guidelines for writing Course Outcome Statements:

Well-written course outcomes 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, modeling, 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 outcomesformula**:
>
> 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.
- A realigned 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 a research study published in a scholarly sociology journal.
- Design a web site using HTML and Java Script.
- Describe the contributions of women in American history.
- Recognize the works of major Re-naissance artists.
- Facilitating a group to achieve agreed – Up on goals.

- Determine 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.
- Analyseacharacter'smotivationandportraythatcharacterbeforeanaudience.
- 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 at least70% accuracy
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.	Within 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 those 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 those 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 those 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.

TABLE 9: 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 L4 for theory courses. Bloom'sL1toL5forlaboratory courses. Bloom'sL1toL6for 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:** If Bloom's L1 Action Verbs of a CO: Correlates with any of PO6 to PO12, then assign 1. If Bloom's L2 to L3 Action Verbs of a CO: Correlates with Any of PO6 to PO12, then assign 2. If Bloom's L4 to L6 Action Verbs of a CO: Correlates with any of PO6 to PO12, then assign3		
	PO7			
	PO8			
	PO9			
	PO10			
	PO11			
	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 PO s.

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 PO s. 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 important observation 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
$0 \leq C \leq 10\%$	No correlation (0)
$10\% < C < 40\%$	Low/Slight correlation (1)
$40\% \leq C < 60\%$	Moderate correlation (2)
$60\% \leq C \leq 100\%$	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. **Scientific Principles:** Application of scientific principles and methodologies. 2. **Mathematical Principles:** Utilization of mathematical concepts in problem-solving. 3. **Interdisciplinary Integration:** Integration of knowledge from various engineering disciplines. 4. **Engineering Specialization:** Application of specialized engineering knowledge in complex engineering problems.	4

PO2	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. **Identity:** Recognizing and defining complex engineering problems or opportunities. 2. **Formulate:** Structuring and abstracting the problem for systematic analysis. 3. **Review:** Examining research literature 4. **Analyze:** Investigating problems using data collection and relevant methodologies. 5. **First Principles:** Applying mathematical, natural, and engineering sciences in problem-solving. 6. **Substantiated Conclusions:** Ensuring accuracy and reliability through validation. 7. **Experimental Design:** Planning and conducting experiments for problem analysis. 8. **Solution Development:** Implementing and testing solutions through experimentation. 9. **Interpretation:** Evaluating results to draw meaningful engineering conclusions. 10. **Documentation:** Recording findings systematically for future reference and learning.	**10**

| PO3 | 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. **Design:** Investigate and define a problem while identifying constraints, including environmental, sustainability, health, and safety considerations.
2. **Solutions:** Understand customer and user needs while considering factors such as aesthetics.
3. **System Components:** Identify and manage cost drivers in engineering solutions.
4. **Processes:** Use creativity to develop innovative engineering solutions.
5. **Specified Needs:** Ensure fitness for purpose across production, operation, maintenance, and disposal.
6. **Public Health & Safety:** Manage the design process and evaluate outcomes for safety and risk assessment.
7. **Cultural Considerations:** Understand the commercial and economic context of engineering processes.
8. **Societal Considerations:** Apply management techniques to achieve engineering objectives in a broader context.
9. **Environmental Considerations:** Promote sustainable development through engineering activities.
10. **Appropriate Considerations:** Be aware of legal frameworks governing engineering activities, including personnel, health, safety, and environmental risks. | **10** |

| 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 (**Conduct Investigations of ComplexProblems).** | 1. **Research-Based Knowledge:** Gain a deep understanding of materials, equipment, processes, and products through research to address engineering problems effectively.
2. **Research Methods:** Develop essential laboratory and workshop skills to carry out experimental investigations and gather reliable data.
3. **Design of Experiments:** Address complex problems in various engineering contexts, including operations, management, and technology development.
4. **Analysis:** Leverage technical literature and reliable information sources.
5. **Interpretation of Data:** Follow appropriate codes of practice and industry standards when analyzing and interpreting experimental data.
6. **Synthesis:** Ensure high-quality results by integrating various data sources and considering quality control during engineering investigations.
7. **Valid Conclusions:** Draw valid conclusions by addressing technical uncertainties through sound reasoning and scientific principles.
8. **Engineering Principles:** Apply fundamental engineering principles to analyze and interpret key engineering processes and challenges.
9. **Modelling Techniques:** Use analytical and modeling techniques to identify, classify, and describe the performance of engineering systems and components.
10. **Quantitative Methods:** Employ analytical software and quantitative methods efficiently and accurately. | 10 |

PO5	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. **Create:** Develop engineering solutions using modern tools across various disciplines. 2. **Select:** Identify appropriate prediction and modeling tools for diverse engineering applications. 3. **Apply:** Utilize IT tools in engineering analysis, design, and decision-making. 4. **Techniques:** Implementsimulation tools in different engineering fields.	4
PO6	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. **Contextual Knowledge:** Understand the commercial and economic context of engineering processes. 2. **Management Techniques:** Apply management strategies in engineering objectives within this context. 3. **Sustainable Development:** Promote sustainable development through engineering activities. 4. **Legal Awareness:** Recognize relevant legal requirements governing engineering practices, including health, safety, and environmental risks. 5. **Professional Ethics:** Uphold high standards of professional and ethical conduct in engineering.	5

PO7	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. **Socio-Economic Impact:** Understand the socio-economic effects of engineering solutions on society. 2. **Political Impact:** Recognize the political implications and responsibilities of engineering solutions. 3. **Environmental Impact:** Assess the environmental consequences of engineering practices and solutions. 4. **Sustainability:** Demonstrate the importance of sustainable development in engineering solutions.	**4**
PO8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).**	1. **Ethical Judgement:** Make informed decisions based on ethical principles, using professional codes of ethics to guide actions and evaluate the ethical aspects of practice. 2. **Integrity:** Demonstrate a strong sense of trust and integrity, standing firm in one's values while acting responsibly and ethically. 3. **Fairness and Equity:** Ensure fair treatment and equity in all professional activities, valuing diversity and respecting others' perspectives. 4. **Professional Responsibility:** 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. **Independence:** Work effectively as an individual, taking ownership of tasks and driving progress independently.
2. **Maturity:** Demonstrate maturity by focusing on goal achievement, requiring minimal external motivation.
3. **Self-Direction:** Approach vaguely defined problems with systematic problem-solving skills to find solutions.
4. **Team Collaboration:** Engage in teamwork during various activities, including hands-on labs and multidisciplinary projects.
5. **Adaptability:** Participate in diverse team settings, adjusting to different roles and projects such as mini projects and design tasks.
6. **Project Management:** Understand and apply principles of teamwork and project management to effectively complete assignments and projects.
7. **Peer Evaluation:** Contribute to team dynamics by evaluating and reflecting on individual and group performance.
8. **Building Relationships:** Foster teamwork and lasting relationships, contributing to both academic success and post-graduation professional networks.
9. **Organizational Integratio**n: Collaborate with individuals across all levels of an organization, demonstrating adaptability and interpersonal skills.
10. **Effective Communication:** Develop strong relationships through positive interactions, showcasing an ability to get along with others and work cohesively in teams. | 10 |

| 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. **Clarity:** Communicate complex engineering concepts clearly and concisely in written reports and design documentation.
2. **Grammar and Punctuation:** Ensure high standards of grammar and punctuation in written communication, maintaining professionalism and clarity.
3. **References:** Properly reference sources in written communication, ensuring accuracy and academic integrity.
4. **Speaking Style:** Deliver oral presentations effectively, with appropriate speaking style to engage the audience and convey technical information clearly.
5. **Subject Matter**: 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 multi-disciplinary Environments (**Project Management and Finance**). | 1. **Scope Definition:** Define the project scope clearly to ensure alignment with objectives and requirements.
2. **Critical Success Factors:** Identify and prioritize critical success factors necessary for project completion and success.
3. **Deliverables:** Ensure the timely delivery of project outputs, meeting thepredefined objectives and quality standards.
4. **Work Breakdown Structure:** Develop and organize a structured breakdown of tasks and activities to achieve project goals.
5. **Scheduling:** Create and manage schedules to ensure tasks are completed on time and milestones are met.
6. **Budget Management:** Develop and manage project budgets, ensuring that resources are used efficiently and within financial constraints.
7. **Quality Assurance**: Apply quality control measures to ensure that project deliverables meet the required standards.
8. **Human Resources Planning:** Plan and allocate human resources effectively, ensuring the right skills and team dynamics.
9. **Stakeholder Management:** Identify and manage stakeholders, ensuring their needs and expectations are addressed throughout the project.
10. **Risk Management:** Develop a risk register and apply strategies to identify, assess, and mitigate project risks. | 10 |

| 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. **Professional Certificate:** Pursue professional, Academic, Global certifications.
2. **Advanced Education:** Begin and work towards advanced programs to further deepen knowledge.
3. **Continuous Learning:** Stay updated on industry trends and emerging technologies to remain relevant in the field.
4. **Skill Acquisition:** Learn at least 2–3 new significant skills annually to ensure continuous growth and development.
5. **Training Commitment:** Dedicate time for formal training for a standard duration of training each year.
6. **Personal Development:** Engage in ongoing self-improvement efforts to enhance both personal and professional growth.
7. **Adaptability:** Be adaptable to technological changes by actively pursuing new learning opportunities and challenges.
8. **Networking:** Build a network with industry peers and professionals to stay informed and grow knowledge through collaboration | 8 |

10. Key Competencies for Assessing Program Specific Outcomes:

PSO	NBA statement/Vital features	No. of vital features
PSO1	Able to identify, analyze and solve the problems related to Artificial Intelligence and Machine Learning by applying the fundamental knowledge of Computer Science and Engineering. 1. Problem Identification & Formulation Skills 2. Strong Foundation in Core CSE Concepts 3. Model Development & Algorithmic Implementation 4. Analytical Thinking & Performance Evaluation	4
PSO2	Able to use innovative tools and techniques to build project models in the areas related to Deep Learning, Machine learning, Artificial Intelligence. 1. Proficiency in AI/ML/DL Tools and Frameworks 2. Model Design and Implementation Skills 3. Innovation and Research-Oriented Thinking 4. Project Development and Deployment Competency	4
PSO3	Able to apply their Artificial Intelligence and Machine Learning knowledge in interdisciplinary domains to address societal, environmental, health, safety challenges while aligning Sustainable development goals. 1. Interdisciplinary Application Skills 2. Sustainable Solution Design Competency 3. Ethical and Responsible AI Awareness 4. Societal Impact Analysis and Problem-Solving Skills	4

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

Courses offered in Computer Science and Engineering Curriculum (MLRS-R22) 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
IB. Tech – I Semester																
2210001	Matrix Algebra and Calculus	✔	✔	✔	✔								✔	✔	✔	
2210008	Applied Physics	✔	✔	✔			✔	✔								
2210501	Programming for Problem Solving	✔	✔	✔	✔	✔	✔						✔	✔	✔	
2210372	Engineering Workshop	✔		✔			✔									✔
2210009	Communicative English						✔		✔	✔	✔	✔	✔			
2210518	Elements of Computer Science and Engineering	✔	✔	✔	✔									✔	✔	
2210071	Applied Physics Laboratory	✔	✔	✔			✔	✔				✔				
2210074	Communicative English Lab					✔	✔	✔	✔	✔	✔					
2210571	Programming for Problem Solving Lab	✔	✔	✔	✔	✔							✔	✔	✔	
2210021	Environmental Science						✔	✔	✔	✔						
IB. Tech- II Semester																
2220002	Differential Equations and Vector Calculus	✔	✔	✔	✔		✔							✔	✔	
2220009	Engineering Chemistry	✔		✔	✔			✔				✔				
2220502	Data Structures	✔	✔	✔	✔		✔						✔	✔	✔	
2220201	Basic Electrical Engineering	✔	✔	✔	✔		✔									✔
2220401	Basic Electronic Devices and Circuits	✔	✔	✔	✔		✔									✔

Code	Subject	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
2220271	Basic Electrical Engineering Laboratory	✔	✔	✔	✔							✔			✔	
2220371	Engineering Drawing Practice	✔	✔	✔	✔							✔			✔	
2220071	Applied Physics Lab	✔	✔	✔	✔		✔									
2220572	Data Structures Lab	✔	✔	✔	✔	✔						✔		✔	✔	
2220575	IT work shop	✔	✔	✔	✔	✔					✔	✔				

Code	Subject	PO												PSO		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
IIB.Tech- I Semester																
2230507	Discrete Mathematics	✔	✔	✔	✔	✔						✔	✔	✔		
2230509	Operating Systems	✔	✔	✔	✔		✔					✔	✔	✔	✔	
2230506	Software Engineering	✔	✔	✔	✔		✔				✔	✔	✔			✔
2230005	Mathematical and Statistical Foundations	✔	✔	✔	✔							✔	✔	✔	✔	
2230510	OOPS Through JAVA	✔	✔	✔		✔							✔	✔	✔	✔
2230583	Skill Development Course (Node JS/ React JS/Django)	✔	✔	✔	✔	✔	✔					✔	✔	✔	✔	
2230577	Operating systems Lab	✔	✔	✔	✔	✔	✔							✔		
2230576	OOPS Through JAVA Lab	✔	✔	✔	✔	✔				✔		✔		✔	✔	
2230022	Gender Sensitization							✔	✔	✔	✔		✔			
IIB.Tech- II Semester																
2240516	Artificial Intelligence	✔	✔	✔	✔		✔					✔	✔	✔	✔	
2240504	Database Management Systems	✔		✔	✔	✔		✔				✔	✔		✔		✔
2246201	Computer System Architecture	✔	✔	✔	✔									✔		
2246702	Automata & Language Processors	✔	✔	✔	✔		✔									
2240503	Python Programming	✔	✔	✔	✔					✔		✔	✔	✔	✔	

Code	Subject	1	2	3	4	5	6	7	8	9	10	11	12	PSO 1	PSO 2	PSO 3
2240584	Skill Development Course- Data Visualization (Power BI)	✔	✔	✔	✔	✔				✔		✔	✔	✔	✔	✔
2240574	Database Management Systems Lab	✔	✔	✔	✔	✔				✔	✔			✔	✔	✔
2240573	Python Programming Lab	✔	✔	✔	✔	✔								✔		✔
2240591	Field Based Project	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2240023	Constitution of India						✔		✔	✔	✔		✔			

Code	Subject	**PO**												**PSO**		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
III B.Tech- I Semester																
2250512	Computer Networks	✔	✔	✔	✔		✔					✔	✔			
2250511	Design and Analysis of Algorithms	✔	✔	✔	✔		✔					✔	✔			
2250514	Machine learning	✔	✔	✔	✔		✔							✔	✔	✔
2250513	Devops	✔	✔	✔	✔									✔		✔
2250101	Air and Noise Pollution Control	✔	✔	✔			✔		✔			✔				
2250578	Computer Networks Lab	✔	✔	✔	✔	✔								✔	✔	
2250580	Machine learning Lab	✔	✔	✔	✔	✔								✔	✔	✔
2250074	Advanced English Communication skills Lab								✔	✔	✔	✔				
2250592	Internship	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2250024	Intellectual Property Rights								✔	✔	✔	✔	✔			
III B.Tech- II Semester																
2260016	Business Economics and Financial Analysis						✔			✔	✔	✔	✔			
2260543	Soft Computing	✔	✔		✔	✔						✔		✔	✔	
2260524	Web Technologies	✔	✔	✔	✔	✔						✔		✔	✔	
2260546	Data Science	✔	✔	✔	✔		✔					✔		✔		✔
2260102	Remote Sensing &GIS						✔	✔	✔	✔			✔			
2260587	Web Technology Lab	✔	✔	✔	✔	✔	✔					✔		✔	✔	
2266673	Soft Computing Lab	✔	✔	✔	✔	✔	✔							✔	✔	

Code	Subject	1	2	3	4	5	6	7	8	9	10	11	12	PSO 1	PSO 2	PSO 3
2260585	Skill Development Course (UI design-Flutter)	✔	✔	✔	✔	✔	✔				✔		✔	✔	✔	
2260593	Industry Oriented Mini Project	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔

Code	Subject	PO												PSO		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
IV B. Tech - I Semester																
2270017	Fundamentals of management						✔	✔	✔		✔	✔	✔			
2270551	Deep Learning	✔	✔	✔	✔		✔						✔	✔	✔	
2270555	Expert systems	✔	✔	✔	✔	✔	✔			✔			✔	✔	✔	
2270550	Distributed Systems	✔	✔	✔	✔									✔	✔	
2270103	Disaster Management						✔	✔			✔		✔			✔
2276671	Deep Learning Lab	✔	✔	✔	✔	✔	✔			✔		✔	✔	✔	✔	✔
2276672	Expert Systems Lab	✔	✔	✔	✔	✔	✔			✔	✔		✔	✔	✔	
2270594	Project stage-I	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
IVB. Tech- II Semester																
2280558	Cloud Computing	✔	✔	✔	✔							✔	✔			
2280557	Cyber Crime Investigation & Digital Forensics	✔	✔	✔	✔		✔					✔				✔
2280561	Block chain Technology	✔					✔	✔	✔	✔		✔				
2280595	Technical Seminar	✔	✔	✔			✔		✔	✔	✔	✔	✔	✔		
2280596	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 types of assessment approaches available and the different frame works to interpret the results.

    I. Continuous Internal Assessment (CIA).
   II. Semester end examination (SEE)
  III. Laboratory and project work
  IV. Course end 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)

The framework for Continuous Internal Assessment (CIA) for the Undergraduate (UG) courses includes Continuous Internal Examinations (CIEs), assignments, PPT/poster presentations, case studies, and viva voce. All these are mandatory and designed in a systematic way to assess the understanding of concepts, analytical and problem-solving skills, communication skills, and overall subject competency in accordance with the principles of Outcome-Based Education (OBE).

The assessment performance is formally evaluated to ensure consistency, transparency, and achievement of Course Outcomes (COs) and Program Outcomes (POs). Constructive feedback is given to the students to enable continuous improvement and improve the teaching-learning process, thereby improving overall performance and achievement of outcomes.

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 their overall progress and to produce terminal marks and grading.

12.4. Course Exit 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 for the

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 Board (DAB) 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 year, and the collected data is analyzed for continuous improvement.

12.7. Employer Survey

The main purpose of this employer questionnaire is to know employer's 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 reviews 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 DAB meets bi-annually for every academic year to review the strategic planning and modification of PEOs. Faculty meetings are conducted at least once in a month for ensuring the implementation of PAQIC'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 CSI (Computer Society of India), ACM (Association for Computing Machinery),TASK(Telangana Academy of kill and Knowledge)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& PPT/Poster Presentation/Viva-Voce/Case Study)	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, CAT (includes PPT, poster presentation etc) are used for CO calculation.
- The attainment values are calculated for individual courses and are formulated and summed for assessing the PO s.
- Performance in Assignment is indicative of the student's communication skills.

S. No	Courses	Components	Frequency	Max. Marks	Evidence
1	Core/ Elective	Continuous Internal Assessment	Twice in a semester	30	Answer script
		Assignment	One Assignment per unit.	5	Assignment
		Viva-Voce / PPT/ Poster Presentation/ Case Study etc.	Twice in a semester	5	PPT, Poster Presentation etc
		Semester End Examination	Once in a semester	60	Answer script
2	Laboratory	Day-to-Day Evaluation	Once in a week	10	Work sheets
		Viva-Voce	Once in a week	10	Work sheets
		Certificate/ Open ended experiment	Once in a semester	10	Certificate/ Work sheet
		Internal laboratory assessment	Twice 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
4	Technical Seminar	Presentation	Twice in a semester	100	Seminar 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.

TABLE 15: Tools used in In-direct 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.

TABLE 16: Attainment of PO / PSOs

	Assessment	Tools	Weight
POs/PSOs Attainment	Direct Assessment	CO attainment of courses	80%
	Indirect Assessment	Student 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.

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.
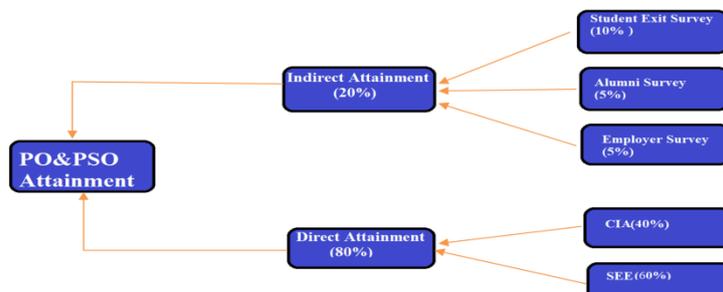

FIGURE 4: Evaluation process of POs / PSOs attainment

15.   Course Descriptor:

The "Course Descriptor" 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 Descriptor" contains the following contents:

- Course Overview
- Prerequisite(s)
- Marks Distribution
- Course Objectives
- Course Outcomes
- Content Delivery / Instructional Methodologies
- Syllabus
- List of Textbooks / References / Websites
- Evaluation Methodology
- 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
- Mapping with Sustainability development goals

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

OOPS THROUGH JAVA

1	Department	COMPUTER SCIENCE AND ENGINEERING (AI &ML)							
2	Course Name	OOPS Through JAVA							
3	Course Code	2230510							
4	Year/Semester	II/I							
5	Regulation	MLRS-R22							
	Structure of the course	Theory				Practical			
		Lecture	Tutorials	Practical	Credit	L	T	P	C
		3	0	0	3	0	0	2	1
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: 48 Hours		Tutorials: 0 hours		Practical: 32 hours			
11	Course Coordinator	G ASHA BHAVANI							
12	Date Approved by BOS	30-07-2022							
13	Course Webpage	www.mlritm.ac.in/							
14	Prerequisites/ Co-requisites	Level	Course Code		Semester		Prerequisites		
		UG	2210501		I-I		Programming for Problem Solving		

15. Course Overview:

Java was first released by Sun Microsystems in 1995 and has evolved to become one of the most widely used programming languages and computing platforms in the world. It is a class-based, object-oriented language designed to have as few implementation dependencies as possible, making it a versatile choice for developers across various domains. Java is a high-

level programming language known for its portability across platforms, from mainframe data centers to smartphones.

Its philosophy, "Write Once, Run Anywhere" (WORA), highlights its cross-platform capabilities, enabling Java applications to run easily on any device that has the Java Virtual Machine (JVM) installed. This unique feature has made Java very important for many web and mobile applications, enterprise-level solutions, and even in the world of big data and IoT (Internet of Things).

16. Course Objectives:

The students will try to learn:

- To understand the basic concepts and fundamentals of platform independent object oriented language.

- To learn how to extend Java classes with inheritance and dynamic binding.

- To learn how to use exception handling and multithreading in Java applications.

- To understand how to design GUI components with the Java AWT.

17. Course Outcomes:

After successful completion of the course, students should be able to:

CO1	Apply object-oriented programming principles for developing basic Java applications using control statements, arrays, and string handling.
CO2	Design Java classes using constructors, method overloading, recursion, inheritance hierarchies, packages, and interfaces for developing structured and reusable programs.
CO3	Develop robust and reliable Java applications by implementing exception handling mechanisms and multithreading concepts including synchronization and inter-thread communication..
CO4	Utilize Java Collections Framework for managing data efficiently for real-world problem-solving.
CO5	Design interactive graphical user interface (GUI) applications using AWT and Swing components and implement event-driven programming using delegation event model.

18. Course Learning Outcome (CLOs):

Sno	Topic Name	CLO No	Course Learning Outcome	Course Outcome	Blooms Level
1	Object Oriented Methodology	CLO 1	Understand Object Oriented Methodology	CO1	Understand

2	Principles of OOPS	CLO 2	Understand basic OOPs principles	CO1	Understand
3	Object oriented thinking	CLO 3	Apply Object oriented knowledge on real world scenarios	CO1	Apply
4	Introduction to JAVA	CLO 4	Understand basic java datatypes, variables, operators, control statements	CO1	Understand
5	Classes	CLO 5	Implement class for creating objects (a particular data structure), including their states (attributes) and behaviours (methods).	CO2	Apply
6	Inheritance	CLO 6	Understanding the concept of inheritance is an essential part of OOPs	CO2	Understand
7	Packages	CLO 7	Create user-defined packages	CO2	Create
8	Interfaces	CLO 8	Understand the concept of interfaces which supports multiple inheritance	CO2	Understand
9	Exception handling	CLO 9	Understands the concept of Exception handling and create user-defined Exceptions	CO3	Create
10	Multithreading	CLO 10	Apply the concept of multi threading to achieve multitasking	CO3	Apply
11	String Handling	CLO 11	Apply the methods of String handling	CO4	Apply
12	Collections Framework	CLO 12	Analyze different types of collections.	CO4	Analyze
13	JDBC	CLO13	Establish connection from Java application to databases	CO4	Apply

14	Event Handling	CLO 14	Understand the mechanism that controls the event and decides what should happen if an event occurs.	CO5	Understand
15	AWT	CLO 15	develop GUI (Graphical User Interface) or window-based applications using AWT	CO5	Create

19. Employability Skills:

Example: Communication skills / Programming skills / Project based skills /
Java offers a rich set of libraries for DSA, including data structures like ArrayLists, LinkedLists and HashMaps which can make your work easier. Getting a strong hold in Java can help you in the longer run of working as a software developer in big MNCs where they still use JAVA for their backend.

20. Content Delivery / Instructional Methodologies:

✓	Power Point Presentation	✓	Chalk & Talk	✓	Assignments	✓	MOOC
✓	ALP	✓	Seminars	X	Mini Project	✓	Videos

21. Evaluation Methodology:

The performance of a student in a course will be evaluated for 100 marks each, with 40 marks allotted for CIA (Continuous Internal Assessment) and 60 marks for SEE (Semester End-Examination). In CIA, for theory subjects, during a semester, there shall be two mid-term examinations. Each Mid-Term examination consists of two parts i) **Part – A** for 10 marks, ii) **Part – B** for 20 marks with a total duration of 2 hours as follows:

Mid Term Examination for 30 marks:

        a. Part - A: Objective / quiz / short answer type paper for 10 marks.
        b. Part - B: Descriptive paper for 20 marks.

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

The semester end examinations (SEE), will be conducted for 60 marks consisting of two parts viz. i) **Part- A** for 10 marks, ii) **Part - B** for 50 marks.

        a. Part-A is a compulsory question which consists of ten sub-questions from all

units carrying equal marks.

b. Part-B consists of five questions (numbered from 2 to 6) carrying 10 marks each. Each of these questions is from each unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.

c. The duration of Semester End Examination is 3 hours.

Table 1: Outline for Continues Internal Assessment (CIA-I and CIA-II) and SEE

Activities	CIA-I	CIA-II	Average of CIA	SEE	Total Marks
Continues Internal Evaluation (CIE)	30 Marks	30 Marks			
Assignment	5 Marks	5 Marks			
Viva-Voce / PPT / Poster Presentation / Case Study	5 Marks	5 Marks			Average of CIA + SEE
Total Marks	**40 Marks**	**40 Marks**	**40 Marks**	**60 Marks**	**100 Marks**

22. Course content - Number of modules: Five:

MODULE 1	**Object Oriented Methodology:** Introduction, Advantages and Disadvantages of Procedure Oriented Languages, what is Object Oriented? What is Object Oriented Development? Object Oriented Themes, Benefits and Application of OOPS. **Principles of OOPS:** OOPS Paradigm, Objects, Classes and Methods, Abstraction, Encapsulation, Inheritance, Polymorphism, Dynamic Binding, Message Passing. **Object oriented thinking:** A way of viewing world – Agents, responsibility, messages, methods, Classes and instances, class hierarchies – inheritance, method binding, overriding and exceptions. **Introduction to JAVA:** History of Java, Java buzzwords, data types, variables, scope and life time of variables, Type conversion and casting, arrays, operators, Operator Precedence, control statements.	No. of Lectures: 11
MODULE 2	**Classes:** Class fundamentals, Declaring Objects, methods, Constructors, this keyword, garbage collection, Overloading methods and constructors, Recursion. **Inheritance, Packages and Interfaces:** Inheritance basics, Using super, Creating a multilevel hierarchy, method overriding, Dynamic method dispatch, abstract classes, Using final with inheritance, Defining a package, Finding package and class path, Access protection, importing packages, Defining an interface, implementing interface, applying interfaces,	No. of Lectures:9
	variables in interface and extending interfaces.	

MODULE 3	**Exception handling and Multithreading:** Exception types, uncaught exceptions, using try and catch, Multiple catch classes, nested try statements, throw, throws and finally. Java's built-in exceptions, chained exceptions, creating own exception sub classes. Java thread model, thread priorities, synchronization, messaging, thread class and runnable interface, creating thread, creating multiple threads, thread priorities, synchronizing threads, interthread communication, thread life cycle.	No. of Lectures: 9
MODULE 4	**Java String Handling:** String Constructors, Special string operations, Character Extraction, String Comparisons, Modifying a string, String Buffer. **Collections Framework:** Overview, Collection Interfaces, Collection Classes, Accessing a collection via Iterator, Working with Maps, Generics	No. of Lectures: 9
MODULE 5	**Event Handling :** Events, Event sources, Event Listeners, Event classes, Event listener interface, Handling mouse and keyboard events, Adapter classes, The AWT class hierarchy, AWT controls- labels, buttons, scrollbars, text field, check box, check box groups, choices, handling lists, dialogs, Menubar, layout manager- Flow, Border, Grid, Card	No. of Lectures: 9

TEXTBOOKS:

1. Java The complete reference, 12th edition, Herbert Schildt, McGraw Hill Education (India) Pvt. Ltd.

REFERENCE BOOKS:

1. An Introduction to programming and OO design using Java, J. Nino and F.A. Hosch, John Wiley & sons

2. Introduction to Java programming, Y. Daniel Liang, Pearson Education.

3. Object Oriented Programming through Java, P. Radha Krishna, University Press.

4. Programming in Java, S. Malhotra, S. Chudhary, 2nd edition, Oxford Univ. Press.

5. Java Programming and Object-oriented Application Development, R. A. Johnson, Cengage Learning.

22. ELECTRONIC RESOURCES:

1. https://www.w3schools.com/java/java_intro.asp
2. https://www.geeksforgeeks.org/java/
3. https://www.programiz.com/java-programming
4. javatpoint.com/java-tutorial
5. https://en.wikipedia.org/wiki/Java_(programming_language)
6. https://www.coursera.org/specializations/java-programming
7. https://aws.amazon.com/what-is/java/
8. https://onlinecourses.nptel.ac.in/noc22_cs47/preview
9. https://onlinecourses.swayam2.ac.in/aic20_sp13/preview
10. https://www.simplilearn.com/tutorials/java-tutorial/java-programming

23. COURSE PLAN:

S. No.	Topics to be covered	Cos	Reference
1	Discussion on Outcome Based Education, CO, POs and PSOs	-	-
2	Introduction to Object Oriented Methodology	CO1	T11.1
3	Advantages and Disadvantages of Procedure oriented lang.	CO1	T11.2
4	Object Oriented Development &Themes	CO1	T11.2
5	Benefits and Applications of OOPS	CO1	T11.2
6	Principles of OOPS,OOPS Paradigm	CO1	T1 1.3
7	Objects, classes and Methods,Abstraction,encapsulation	CO1	T1 1.3
8	Object Oriented Thinking –ALP	CO1	T1 1.3
9	Agents, Responsibility, messages, classes, class hierarchies	CO1	T1 1.4
10	Introduction to Java,History of Java,Java Buzzwords	CO1	T1 1.5
11	Datatypes, variables ,Type Conversion and casting ,arrays	CO1	T1 2.1
12	Operators, precedence of Operators, control structures	CO1	T1 2.2
13	Introduction to Classes, objects	CO2	T1 3.1
14	Methods ,Constructors	CO2	T1 3.2
15	this ,Garbage collection ,Overloading methods & Recursion	CO2	T1 3.3
16	Introduction to Inheritance ,Multilevel hierarchy	CO2	T1 3.3
17	Using Super, final &Dynamic Dispatch ,abstract classes	CO2	T1 3.4
18	Defining packages, classpath, importing packages	CO2	T1 3.4
19	Defining interfaces, implementing interfaces-ALP	CO2	T1 4.1
20	Applying interfaces	CO2	T1 4.2
21	Varibale in interface and extending interfaces	CO2	T1 4.3

22	Module Built-in Functions, Packages, Related modules.	CO2	T1 4.4
23	Introduction to Exception Handling ,Exception types	CO3	T1 5.1
2	Uncaught Exceptions	CO3	T1 5.2
25	Using try and catch ,multiple catch classes	CO3	T1 5.3
26	Nested try, throw, throws and finally	CO3	T1 5.3
27	Java built-in Exceptions, chained Exceptions	CO3	T1 5.4
28	Creating own exceptions-ALP	CO3	T1 5.5
29	Java thread model, thread priorities, synchronization	CO3	T1 6.1
30	Creating threads ,multiple threads	CO3	T1 6.2
31	Interthread communication	CO3	T1 6.3
32	Thread Life Cycle	CO3	T1 6.4
33	String Constructors ,Special string Operations	CO4	T1 7.1
34	Character Extraction & String Comparisons	CO4	T1 7.2
35	Modify String ,String Buffer	CO4	T1 7.3
36	Overview of Collections	CO4	T1 8.1
37	Collection Interfaces, Collection classes	CO4	T1 8.2
38	Accessing a Collection via Iterator	CO4	T1 8.2
39	Working with Maps-ALP	CO4	T1 8.3
40	Generics	CO4	T1 8.4
41	Events, Event Sources, Event Listeners	CO5	T1 10.1
42	Event classes, Event Listener Interface	CO5	T1 10.2
43	Handling Mouse and Keyboard events	CO5	T1 10.3
44	Adapter classes, AWT class hierarchy	CO5	T1 10.4
45	AWT Controls-labels, buttons-ALP	CO5	T1 10.4
46	Checkbox groups, choices	CO5	T1 11.1
47	Handling lists, dialogs, menubars	CO5	T1 11.2
48	Layoutmangers-flow, Border, Grid	CO5	T1 11.3

24. PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES:

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and engg. specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.
PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4: Conduct investigations of complex problems: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5: 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.
PO 6: 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.
PO 7: 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.
PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.
PO 10: Communication: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.
PO 11: 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. Manage projects in multidisciplinary environments.
PO 12: 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
PSO 1: Able to identify, analyze and solve the problems related to Artificial Intelligence and Machine Learning by applying the fundamental knowledge of Computer Science and Engineering.
1. Problem Identification & Formulation Skills
2. Strong Foundation in Core CSE Concepts
3. Model Development & Algorithmic Implementation.
4. Analytical Thinking & Performance Evaluation
PSO 2: Able to use innovative tools and techniques to build project models in the areas related to Deep Learning, Machine learning, Artificial Intelligence.
1. Proficiency in AI/ML/DL Tools and Frameworks
2. Model Design and Implementation Skills
3. Innovation and Research-Oriented Thinking.
4. Project Development and Deployment Competency
PSO 3: Able to apply their Artificial Intelligence and Machine Learning knowledge in interdisciplinary domains to address societal, environmental, health, safety challenges while aligning Sustainable development goals.
1. Interdisciplinary Application Skills.
2. Sustainable Solution Design Competency.
3. Ethical and Responsible AI Awareness.
4. Societal Impact Analysis and Problem-Solving Skills.

25. HOW PROGRAM OUTCOMES ARE ASSESSED:

	Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and engg. specialization to the solution of complex engineering problems.		3	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /
PO 2	**Problem analysis:** Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.		10	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /

PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.	10	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	11	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /
PO 5	**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.	1	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /
PO 6	**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.	5	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /
PO 7	**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.	3	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.	12	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /
PO 10	**Communication:** Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.	5	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /

PO 11	**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. Manage projects in multidisciplinary environments.	12	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /
PO 12	**Life-Long Learning:** Recognize the need for and have the preparation and ability to engagein independent and life-long learning in the broadcast context of technological change.	8	Short term courses

6. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

	Program Outcomes	Strength	Proficiency Assessed by
PSO1	**Able to identify, analyze and solve the problems related to Artificial Intelligence and Machine Learning by applying the fundamental knowledge of Computer Science and Engineering.** 1. Problem Identification & Formulation Skills 2. Strong Foundation in Core CSE Concepts. 3. Model Development & Algorithmic Implementation. 4. Analytical Thinking & Performance Evaluation.	3	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /
PSO2	**Able to identify, analyze and solve the problems related to Artificial Intelligence and Machine Learning by applying the fundamental knowledge of Computer Science and Engineering.** 1. Proficiency in AI/ML/DL Tools and Frameworks. 2. Model Design and Implementation Skills. 3. Innovation and Research-Oriented Thinking. 4. Project Development and Deployment Competency.	3	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /
PSO3	**Able to apply their Artificial Intelligence and Machine Learning knowledge in interdisciplinary domains to address societal, environmental, health, safety challenges while aligning Sustainable development goals.** 1. Interdisciplinary Application Skills.	3	CIE/ PPT/ Objective / quiz /SEE/ Assignments/ Viva-Voce /

2. Sustainable Solution Design Competency.
3. Ethical and Responsible AI Awareness.
4. Societal Impact Analysis and Problem-Solving Skills.

3 = High; 2 = Medium; 1 = Low

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

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

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

Course Outcoes (COs)	POs / PSOs	Justification for mapping (Students will be able to)	No. of key competencies
CO 1	PO 1	1. Mathematical principles 2. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	**2**
	PO2	1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Experimental design	**4**
	PO3	Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues;	**1**
	PO5	Computer software/simulation packages/diagnostic equipment/technical library resources / Literature search tools.	**1**
	PO12	1. Personal continuing education efforts 2. Ongoing learning – stays up with industry trends/ new technology 3. Continued personal development	**3**

	PSO1	1. Problem Identification & Formulation Skills 2. Strong Foundation in Core CSE Concepts. 3. Model Development & Algorithmic Implementation. 4. Analytical Thinking & Performance Evaluation.	**4**
	PSO2	1. Proficiency in AI/ML/DL Tools and Frameworks. 2. Model Design and Implementation Skills. 3. Innovation and Research-Oriented Thinking.	**3**
	PSO3	1. Interdisciplinary Application Skills. 2. Sustainable Solution Design Competency.	**2**
CO 2	PO1	1. Mathematical principles 2. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	**2**
	PO2	1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Experimental design	**4**
	PO3	Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues;	**1**
	PO5	Computer software/simulation packages/diagnostic equipment/technical library resources / Literature search tools.	**1**
	PO12	1. Personal continuing education efforts 2. Ongoing learning – stays up with industry trends/ new technology 3. Continued personal development	**3**
	PSO1	1. Problem Identification & Formulation Skills 2. Strong Foundation in Core CSE Concepts. 3. Model Development & Algorithmic Implementation. 4. Analytical Thinking & Performance Evaluation	**4**
	PSO2	1. Proficiency in AI/ML/DL Tools and Frameworks. 2. Model Design and Implementation Skills. 3. Innovation and Research-Oriented Thinking.	**3**

CO 3	PO 1	1. Mathematical principles 2. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	2
	PO2	1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Experimental design	4
	PO3	Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues;	1
	PO5	Computer software/simulation packages/diagnostic equipment/technical library resources / Literature search tools.	1
	PO12	1. Personal continuing education efforts 2. Ongoing learning – stays up with industry trends/ new technology 3. Continued personal development	3
	PSO1	1. Problem Identification & Formulation Skills 2. Strong Foundation in Core CSE Concepts. 3. Model Development & Algorithmic Implementation. 4. Analytical Thinking & Performance Evaluation	4
	PSO2	1. Proficiency in AI/ML/DL Tools and Frameworks. 2. Model Design and Implementation Skills. 3. Innovation and Research-Oriented Thinking.	3
	PSO3	1. Interdisciplinary Application Skills. 2. Sustainable Solution Design Competency	2
CO 4	PO1	1. Mathematical principles 2. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	2
	PO2	1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Experimental design	4
	PO3	Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues;	1
	PO5	Computer software/simulation packages/diagnostic equipment/technical library resources / Literature search tools.	1
	PO12	1. Personal continuing education efforts 2. Ongoing learning – stays up with industry trends/ new technology 3. Continued personal development	3

	PSO1	1. Problem Identification & Formulation Skills 2. Strong Foundation in Core CSE Concepts. 3. Model Development & Algorithmic Implementation. 4. Analytical Thinking & Performance Evaluation.	**4**
	PSO2	1. Proficiency in AI/ML/DL Tools and Frameworks. 2. Model Design and Implementation Skills. 3. Innovation and Research-Oriented Thinking.	**3**
CO 5	PO1	1. Mathematical principles 2. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	**2**
	PO2	1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction **4.** Experimental design	**4**
	PO3	Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues;	**1**
	PO5	Computer software/simulation packages/diagnostic equipment/technical library resources / Literature search tools.	**1**
	PO12	1. Personal continuing education efforts 2. Ongoing learning – stays up with industry trends/ new technology 3. Continued personal development	**3**
	PSO1	1. Problem Identification & Formulation Skills 2. Strong Foundation in Core CSE Concepts. 3. Model Development & Algorithmic Implementation. 4. Analytical Thinking & Performance Evaluation.	**4**
	PSO2	1. Proficiency in AI/ML/DL Tools and Frameworks. 2. Model Design and Implementation Skills. 3. Innovation and Research-Oriented Thinking.	**3**
	PSO3	1. Interdisciplinary Application Skills. 2. Sustainable Solution Design Competency	**2**

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

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

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

Course Outcomes	PROGRAM OUTCOMES												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	66.6	40.0	10.0	-	100.0	-	-	-	-	-	-	37.5	100.0	75	50
CO2	66.6	40.0	10.0	-	100.0	-	-	-	-	-	-	37.5	100.0	50	-
CO3	66.6	40.0	10.0	-	100.0	-	-	-	-	-	-	37.5	100.0	75	50
CO4	66.6	40.0	10.0	-	100.0	-	-	-	-	-	-	37.5	100.0	75	-
CO5	66.6	40.0	10.0	-	100.0	-	-	-	-	-	-	37.5	100.0	75	50

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≤ 10% – No correlation,   2 - 40 % <C < 60% –Moderate

1- 10<C≤ 40% – Low/ Slight   3 - 60% ≤ C < 100% – Substantial /High

Course Outcomes	PROGRAM OUTCOMES												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	-	3	-	-	-	-	-	-	1	3	3	2
CO2	3	2	1	-	3	-	-	-	-	-	-	1	3	2	-
CO3	3	2	1	-	3	-	-	-	-	-	-	1	3	3	2
CO4	3	2	1	-	3	-	-	-	-	-	-	1	3	3	-
CO5	3	2	1	-	3	-	-	-	-	-	-	1	3	3	2
Total	15	10	5	-	15	-	-	-	-	-	-	5	15	14	6
Average	3	2	1	-	3	-	-	-	-	-	-	1	3	2.8	2

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:

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

x	1	**NO POVERTY**	
✓	2	**ZERO HUNGER**	**Zero hunger: Java** programming can be applied in agriculture to optimize resource use, predict crop yields, and manage supply chains, contributing to food security and sustainable agriculture practices.
✓	3	**GOOD HEALTH AND WELL-BEING**	**Good Health and well-being:** Java is extensively used in bioinformatics, medical imaging, and other healthcare applications, supporting advancements in medical research and improving healthcare delivery.
✓	4	**QUALITY EDUCATION**	**Quality Education: Java** is an accessible language for teaching programming and computational thinking, which are critical skills in the digital age. This can help bridge educational gaps and promote lifelong learning.
x	5	**GENDER EQUALITY**	
x	6	**CLEAN WATER AND SANITATION**	
✓	7	**AFFORDABLE AND CLEAN ENERGY**	**Affordable and clean Energy:** Java is useful in modeling and optimizing energy systems, analyzing energy consumption patterns, and promoting the use of renewable energy sources.
x	8	**DECENT WORK AND ECONOMIC GROWTH**	

✓	9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	Java is widely used for data analysis, allowing researchers to analyze large datasets related to health, education, and infrastructure. This can lead to better decision-making and resource allocation.
x	10	REDUCED INEQUALITIES	
x	11	SUSTAINABLE CITIES AND COMMUNITIES	
x	12	RESPONSIBLE CONSUMPTION AND PRODUCTION	
✓	13	CLIMATE ACTION	**Climate Action**: Java can be used to develop tools for environmental monitoring, such as tracking climate change indicators, analyzing biodiversity data, or monitoring ocean health. This supports efforts in climate action and environmental conservation.
x	14	LIFE BELOW WATER	
x	15	LIFE ON LAND	
x	16	PEACE, JUSTICE AND STRONG INSTITUTIONS	
x	17	PARTNERSHIPS FOR THE GOALS	
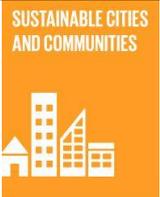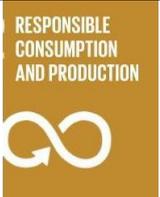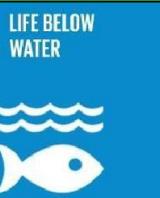
Signature of Course Coordinator   **HOD**

Name & Designation

G.Asha Bhavani

(Assistant Professor)