



IARE
INSTITUTE OF
AERONAUTICAL ENGINEERING



26
YEARS
OF EXCELLENCE

OUTCOME BASED EDUCATION (OBE) PROCESS MANUAL (BT-23)

Electronics and Communication Engineering

2024 ADMITTED BATCH

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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 favour of students. OBE provides clear standards for observable and measurable outcomes.

National Board of Accreditation (NBA) is an authorised body for the accreditation of higher education institutions in India. NBA is also a full member of the Washington Accord. NBA accredited programmes 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 - 1 institutions can also claim the benefits as per the Washington Accord.

Tier - 2 Institutions consists of affiliated colleges of universities.

What is Outcome Based Education (OBE)?

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

Four levels of outcomes from OBE are:

1. Program Educational Objectives (PEOs)
2. Program Outcomes (POs)
3. Program Specific Outcomes (PSOs)
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 students' needs.

Comparison: OBE can be compared across the individual, class, batch, program and institute levels.

Involvement: Students are expected to do their own learning. Increased student's involvement allows them to feel responsible for their own learning, and they should learn more through this individual learning.

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

India, OBE and Accreditation:

From 13 June 2014, India has become the permanent signatory member of the Washington Accord. 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 only 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, 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

1.1 Vision and Mission of the Institution

Vision

To bring forth professionally competent and socially sensible engineers, capable of working across cultures meeting the global standards ethically.

Mission

To provide students with an extensive and exceptional education that prepares them to excel in their profession, guided by dynamic intellectual community and be able to face the technically complex world with creative leadership qualities.

Further, be instrumental in emanating new knowledge through innovative research that emboldens entrepreneurship and economic development for the benefit of wide spread community.

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 Institute of Aeronautical Engineering 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.

1.2 Vision and Mission of the Department

Vision

To produce professionally competent engineers, innovators and entrepreneurs capable of effectively addressing the technical challenges with social responsibility and professional ethics.

Mission

To provide an academic environment that will ensure high quality education, training and research by keeping students abreast of latest research and innovations in science and technology aimed at promoting employability, entrepreneurship, leadership qualities with ethics and research attitude.

M1: High quality academic education

To provide high-quality engineering education by creating a dynamic academic environment focused on imparting modern **technical knowledge, research skills, and industry-oriented practices, thereby developing technically competent, innovative, ethical, and professionally ready graduates.**

M2: Deliver extensive and holistic education

To provide exceptional and holistic education by integrating IARE's core values into teaching and learning processes, ensuring equal opportunities and student-centric development. To foster **communication skills, teamwork, critical thinking, social awareness, self-reflection, and personal initiative through innovative teaching methodologies and modern learning resources.**

M3: Develop creative and future-ready leaders

To equip students with the ability to face complex technical challenges through creative thinking and leadership qualities by incorporating future-oriented, **sustainable, and industry-relevant content. To bridge the gap between academia and professional practice by integrating current research findings, industrial needs, and global job market trends into curriculum design.**

M4: Develop entrepreneurship and societal development

To promote **entrepreneurship, innovation, and economic development by supporting start-ups, translational research, and enterprise-driven initiatives,** while instilling social responsibility to ensure students contribute positively to their communities and society.

2 Program Educational Objectives (PEOs)

Program Educational Objectives (PEOs) should be defined by the Head of the Department in consultation with the faculty members. PEOs are a promise by the department to the aspiring students about what they will achieve once they join the programme. PEO assessment is not made compulsory by

NBA as it is quite difficult to measure in 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 Behaviour. While writing the PEOs do not use the technical terms as it will be read by prospective students who wants to join the programme. Three to five PEOs are recommended.

Program Educational Objective – I: Success in Professional career:

To be excel in professional career, in applied research by acquiring the knowledge in the fundamentals of Electronics and Communication Engineering principles and professional skills through rigorous learning – teaching.

Program Educational Objective – II: Design/Development of Solutions:

To be in a position to analyze real life problems and design socially accepted and economically feasible solutions in the field of electronics & communication engineering or other allied engineering or other fields.

Program Educational Objective – III: Lifelong learning and Research:

To involve themselves in lifelong learning and professional development by pursuing higher education and participation in research and development activities to integrate engineering issues to broader social contexts.

Program Educational Objective – IV: Communication skills and Leadership:

To exhibit effective communication skills in their professional career, lead a team with good leadership traits and good interpersonal relationship with the members related to other engineering streams.

With a view to challenge ourselves and to nurture diverse capabilities for professional and intellectual growth for our students it is important for the department to define departmental objectives in generalized and broad format. Adherence to these objectives is proposed to be demonstrated through actions or achievements.

The department of Electrical and Electronics Engineering periodically reviews these objectives and as part of this review process, encourages comments from all interested parties including current students, alumni, prospective students, faculty, teaching assistants and members of related professional organizations, and colleagues from other educational institutions.

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, 6, 7, 8, 9, 10, 11	PO: 1, 2, 3, 4, 5, 6, 8, 9, 10, 11	PO: 1, 2, 3, 5, 6, 7, 8, 9, 10, 11	PO: 6, 7, 8, 9, 10, 11

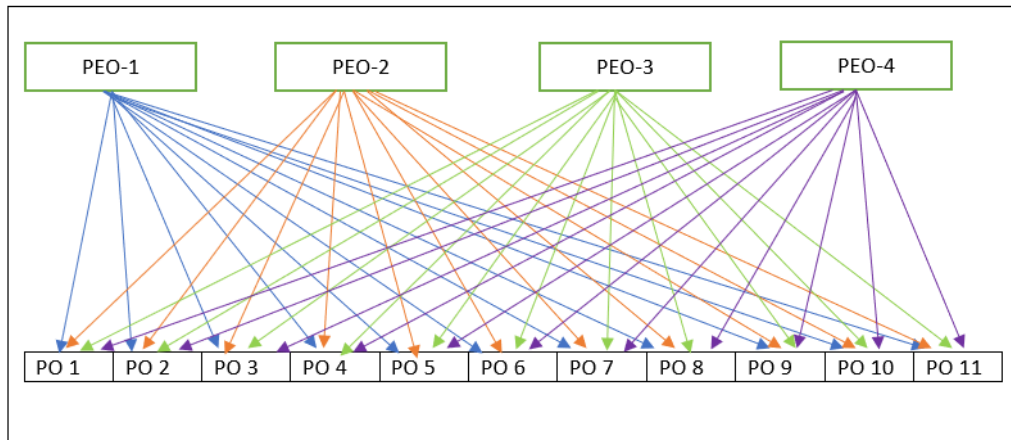


FIGURE 1: Correlation between the PEOs and the POs

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

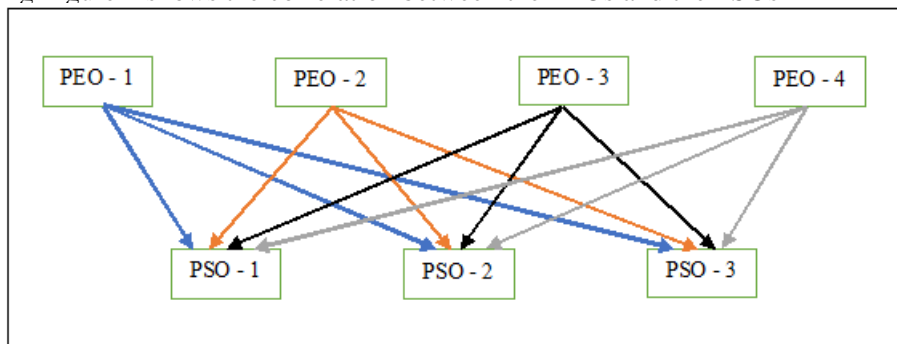


FIGURE 2: Correlation between the PEOs and the PSOs

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

3 Program Outcomes (POs)

A Program Learning Outcome is broad in scope and be able to do at the end of the programme. POs are to be in line with the graduate attributes as specified in the Washington Accord. POs are to be specific, measurable and achievable. NBA has defined 11 POs and you need not define those POs by yourself and it is common for all the institutions in India. In the syllabus book given to students, there should be clear mention of course objectives and course outcomes along with CO-PO course articulation matrix for all the courses.

B. Tech (ECE) - PROGRAM OUTCOMES (PO's)	
A graduate of the Electronics and Communication Engineering Program will demonstrate:	
PO1	Engineering knowledge: Apply knowledge of mathematics, science, and core engineering fundamentals to analyze and solve complex problems in electronics, communication systems, signal processing, VLSI, embedded systems, and its allied domains.
PO2	Problem analysis: Identify, formulate, and analyze complex engineering problems related to analog/digital circuits, communication networks, signals, systems, and semiconductor devices using principles of mathematics, natural sciences, and engineering fundamentals.
PO3	Design/development of solutions: Design and develop electronic circuits, communication systems, signal processing algorithms, VLSI architectures, and embedded solutions that meet specified technical, economic, environmental, and societal constraints.
PO4	Conduct investigations of complex problems: Use research-based knowledge and experimental methods to model, simulate, analyze, and interpret data related to Electronics and Communication Engineering problems using tools such as MATLAB, SPICE, HDL simulators, and communication test equipment to draw valid conclusions.

PO5	Modern tool usage: Select and apply appropriate modern engineering tools, software, and platforms such as simulation tools, Cadance tools, programming environments, and hardware platforms for analysis, design, validation, and implementation of Electronics and Communication Engineering systems, with awareness of their limitations.
PO6	The Engineer and the World: Apply contextual knowledge to assess societal, health, safety, legal, and ethical issues related to electronics and communication technologies such as wireless systems, IoT, automation, and information security and understand professional responsibilities.
PO7	Ethics: Apply ethical principles and commit to professional ethics, responsibilities, and norms of engineering practice in the design, development, deployment, and use of electronic and communication systems..
PO8	Individual and Team Work: Function effectively as an individual and as a member or leader of multidisciplinary teams in the development of electronics, communication, and embedded system projects.
PO9	Communication: Communicate effectively on complex engineering activities by preparing technical reports, design documents, research papers, and presentations, and by interacting clearly with engineers, clients, and society.
PO10	Project Management and Finance: Apply engineering and management principles to plan, execute, and manage electronics and communication engineering projects, considering cost, quality, timelines, and resource .
PO11	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 Electronics and Communication Engineering is given below.

B. Tech (ECE) - PROGRAM SPECIFIC OUTCOMES (PSO's)	
A graduate of the Electronics and Communication Engineering Program will demonstrate:	
PSO1	Build embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications.
PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.
PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

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) Success in Professional career	(2) Design/ De- velopment of Solutions	(3) Lifelong learning and Research	(4) Communica- -tion skills and Leadership
PO1	Apply knowledge of mathematics, science, and core engineering fundamentals to analyze and solve complex problems in electronics, communication systems, signal processing, VLSI, embedded systems, and its allied domains.	3	3	3	2
PO2	Identify, formulate, and analyze complex engineering problems related to analog/digital circuits, communication networks, signals, systems, and semiconductor devices using principles of mathematics, natural sciences, and engineering fundamentals.	3	3	2	2
PO3	Design and develop electronic circuits, communication systems, signal processing algorithms, VLSI architectures, and embedded solutions that meet specified technical, economic, environmental, and societal constraints.	3	3	2	2

PO4	Use research-based knowledge and experimental methods to model, simulate, analyze, and interpret data related to Electronics and Communication Engineering problems using tools such as MATLAB, SPICE, HDL simulators, and communication test equipment to draw valid conclusions.	3	3	2	2
PO5	Select and apply appropriate modern engineering tools, software, and platforms such as simulation tools, Cadance tools, programming environments, and hardware platforms for analysis, design, validation, and implementation of Electronics and Communication Engineering systems, with awareness of their limitations.	3	3	2	2
PO6	Apply contextual knowledge to assess societal, health, safety, legal, and ethical issues related to electronics and communication technologies such as wireless systems, IoT, automation, and information security and understand professional responsibilities.	2	3	3	3

PO7	Apply ethical principles and commit to professional ethics, responsibilities, and norms of engineering practice in the design, development, deployment, and use of electronic and communication systems.	2	2	3	3
PO8	Function effectively as an individual and as a member or leader of multidisciplinary teams in the development of electronics, communication, and embedded system projects.	2	2	3	3
PO9	Communicate effectively on complex engineering activities by preparing technical reports, design documents, research papers, and presentations, and by interacting clearly with engineers, clients, and society.	2	3	3	3
PO10	Apply engineering and management principles to plan, execute, and manage electronics and communication engineering projects, considering cost, quality, timelines, and resource .	2	3	3	3
PO11	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	3	3	3

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

PEO's → ↓ PO's		(1) Success in Professional career	(2) Design/ De- velopment of Solutions	(3) Lifelong learning and Research	(4) Communica- -tion skills and Leadership
PSO1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications..	2	3	3	2
PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	3	2	3	2
PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	2	2	2	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 programme exit questionnaire, alumni survey and employment survey.

7 Blooms Taxonomy

Bloom's taxonomy is considered as the global language for education. Bloom's Taxonomy is frequently used by teachers in writing the course outcomes as it provides a readymade structure and 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 a developing 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.



FIGURE 3: Revised version of Bloom's taxonomy

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

1. **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.

2. **Understand** –the ability to grasp the meaning of information (facts, definitions, concepts, etc.) that has been presented.
3. **Apply** –being able to use previously learned information in different situations or in problem solving.
4. **Analyze** –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.
5. **Evaluate** –being able to judge the value of information and/or sources of information based on personal values or opinions.
6. **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	Analyse	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
<ul style="list-style-type: none"> • Knowledge of terminologies • Knowledge of specific details and elements 	<ul style="list-style-type: none"> • Knowledge of classifications and categories • Knowledge of principles and generalizations • Knowledge of theories, models and structures 	<ul style="list-style-type: none"> • Knowledge of subject specific skills and algorithms • Knowledge of subject specific techniques and methods • Knowledge of criteria for determining when to use appropriate procedures 	<ul style="list-style-type: none"> • Strategic Knowledge • Knowledge about cognitive task, including appropriate contextual and conditional Knowledge • Self- Knowledge

Action Verbs for Course Outcomes

Lower Order of Thinking (LOT)			Higher Order of Thinking (HOT)			
Definitions	Remember	Understand	Apply	Analyse	Evaluate	Create
Bloom's Definition	Exhibit memory of previously learned material by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.	Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations.	Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria.	Compile information together in a different way by combining elements in a new pattern or proposing alternative solution.
Verbs	<ul style="list-style-type: none"> • Choose • Define • Find • How • Label • List • Match • Extend 	<ul style="list-style-type: none"> • Classify • Compare • Contrast • Demonstrate • Explain • Illustrate • Infer • Interpret 	<ul style="list-style-type: none"> • Apply • Build • Choose • Construct • Develop • Interview • Make use of • Model 	<ul style="list-style-type: none"> • Analyze • Assume • Categorize • Classify • Compare • Discover • Dissect • Distinguish 	<ul style="list-style-type: none"> • Agree • Appraise • Assess • Award • Choose • Criticize • Decide • Deduct • Importance 	<ul style="list-style-type: none"> • Adapt • Build • Solve • Choose • Combine • Invent • Compile • Compose • Construct

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 8-12 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
- Focus on 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 (basic e.g., “upon completion of this course students will be able to list the names of the 28 states and 8 union territories” versus “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 missions.
- Include various ways for students to show success (outlining, describing, modelling, depicting, etc.) rather than using a single statement such as “at the end of the course, students will know _____ “as the stem for each expected outcome statement.

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

- What do we want students in the course to learn?

- What do we want the students to be able to do?
- Are the outcomes observable, measurable and are they able to be performed by the students?

Course outcome statements on 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

The Course Outcomes need to link to the Program Outcomes.

Learning outcomes formula:

STUDENTS SHOULD BE ABLE TO + BEHAVIOR + RESULTING EVIDENCE

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 learn in your course.
- Are aligned with program goals and objectives.
- Tell how you will know an instructional goal has been achieved.
- Use action words that specify definite, observable behaviours.
- Are assessable 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 JavaScript.

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

A more detailed model for stating learning objectives requires that objectives have three parts: a condition, an observable behaviour, and a standard. The table below provides three examples.

S No	Condition	Observable Behaviour	Standard
1	Given a list of drugs	the student will be able to classify each item as amphetamine or barbiturate	with at least 70% 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 outcome	Evaluation of language used in this course outcome	Improved course outcome
Explore in depth the literature on an aspect of teaching strategies.	Exploration is not a measurable activity but the quality of the product of exploration would be measurable with a suitable rubric.	Upon completion of this course the students will be able to: write a paper based on an in-depth exploration of the literature on an aspect of teaching strategies.

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

- ... will appreciate the benefits of learning a foreign language.
- ... will be able to access resources at the Institute library.
- ... will develop problem-solving skills.
- ... will have more confidence in their knowledge of the subject matter. Examples that are still general and HARD to measure...
- ... will value knowing a second language as a communication tool.
- ... will develop and apply effective problem-solving skills that will enable one to adequately navigate through the proper resources within the institute library.
- ... will demonstrate the ability to resolve problems that occur in the field.
- ... will demonstrate critical thinking skills, such as problem solving as it relates to social issues.

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

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

An Introspection - Examine Your Own Course Outcomes

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

Write Your Course Outcomes!

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

- What role does this course play within the program?

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

8.6 CO-PO Course Articulation Matrix (CAM) Mapping

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.

The Table 1 gives information about the action verbs used in the POs and the nature of POs, stating whether the POs are technical or non-technical. You need to understand the intention of each POs and the Bloom's level to which each of these action verbs in the POs correlates to. Once you have understood the POs then you can write the COs for a course and see to what extent each of those CO's correlate with the POs.

TABLE 9: Process for mapping the values for CO-PO Matrix

Type	POs	Action Verb(s) in POs	Bloom's level(s) for POs	Bloom's level(s) for COs
Technical	PO1	Apply	L3	Bloom's L1 to L4 for theory courses. Bloom's L1 to L5 for laboratory courses. Bloom's L1 to L6 for project work, experiential learning
	PO2	Identify	L2	
		Formulate	L6	
		Review	L2	
	PO3	Design	L6	
		Develop	L3, L6	
	PO4	Analyse	L4	
		Interpret	L2, L3	
		Design	L6	
	PO5	Create	L6	
		Select	L1, L2, L6	
Apply		L3		
Non-Technical	PO6	Thumb Rule:		
	PO7	If Bloom's L1 Action Verbs of a CO: Correlates with any of PO6 to PO11, then assign 1.		
	PO8			
	PO9	If Bloom's L2 to L3 Action Verbs of a CO: Correlates with any of PO6 to PO11, then assign 2.		
	PO10			

TABLE 9: Process for mapping the values for CO-PO Matrix

Type	POs	Action Verb(s) in POs	Bloom's level(s) for POs	Bloom's level(s) for COs
	PO11	If Bloom's L4 to L6 Action Verbs of a CO: Correlates with any of PO6 to PO11, then assign 3		

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

Observations:

1. The first five POs are purely of technical in nature, while the other POs are non-technical.
2. For the theory courses, while writing the COs, you need to restrict yourself between Blooms Level 1 to Level 4. Again, if it is a programming course, restrict yourself between Blooms Level 1 to Level 3 but for the other courses, you can go up to Blooms Level 4.
3. For the laboratory courses, while composing COs, you need to restrict yourself between Blooms Level 1 to Level 5.
4. Only for Mini-project and Main project, you may extend up to Blooms Level 6 while composing COs.
5. For a given course, the course in-charge has to involve all the other Professors who teach that course and ask them to come up with the CO-PO mapping. The course in-charge has to take the average value of all of these CO-PO mappings and finalize the values or the course in-charge can go with what the majority of the faculty members prefer for. Ensure that none of the Professors who are handling the particular course discuss with each other while marking the CO-PO values.
6. If you want to match your COs with non-technical POs, then correlate the action verbs used in the course COs with the thumb rule given in the table and map the values. (Applies only for mapping COs to non-technical POs).

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

1. Select action verbs for a CO from different Bloom's levels based on the importance of the particular CO for the given course.
2. Stick on to single action verbs while composing COs but you may go for multiple action verbs if the need arises.
3. You need to justify for marking of the values in 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 to CO-PO (technical POs in particular) matrix can be assigned by
 - (a) Judging the importance of the particular CO in relation to the POs. If the CO matches strongly with a particular PO criterion then assign 3, if it matches moderately then assign 2 or if the match is low then assign 1 else mark with “ - ” symbol.

- (b) If an action verb used in a CO is repeated 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 to each CO and make a corresponding mapping table with assigning ✓ mark at the corresponding cell. One observation to be noted is that the first five POs are purely of 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 are matching with 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. Make a table with number of key competencies for CO – PO/PSO mapping with reference to the maximum given Key Attributes for Assessing Program Outcomes.
4. Make a table with percentage of key competencies for CO – PO/PSO mapping with reference to the maximum given Key Attributes for Assessing Program Outcomes.
5. Finally, Course Articulation Matrix (CO - PO / PSO Mapping) is prepared with COs and POs and COs and PSOs on the scale of 0 to 3, 0 being no correlation (marked with “ - ”), 1 being the low/slight correlation, 2 being medium/moderate correlation and 3 being substantial/high correlation based on the following strategy

$0-0 \leq C \leq 5\%$ - No correlation.

$1 - 5 < C \leq 40\%$ - Low / Slight.

$2 - 40\% < C < 60\%$ - Moderate

$3 - 60\% \leq C < 100\%$ - Substantial / High

9 Key Competencies for Assessing Program Outcomes:

PO	NBA statement / Vital features	No. of vital features
PO1	<p>Apply knowledge of mathematics, science, and core engineering fundamentals to analyze and solve complex problems in electronics, communication systems, signal processing, VLSI, embedded systems, and its allied domains (Engineering Knowledge). Knowledge, understanding and application of</p> <ol style="list-style-type: none"> 1. Scientific principles and methodology 2. Mathematical principles 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline 	3

PO	NBA statement / Vital features	No. of vital features
PO2	<p>Identify, formulate, and analyze complex engineering problems related to analog/digital circuits, communication networks, signals, systems, and semiconductor devices using principles of mathematics, natural sciences, and engineering fundamentals (Problem Analysis).</p> <ol style="list-style-type: none"> 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation 	3
PO3	<p>Design and develop electronic circuits, communication systems, signal processing algorithms, VLSI architectures, and embedded solutions that meet specified technical, economic, environmental, and societal constraints (Design / Development of Solutions).</p> <ol style="list-style-type: none"> 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk issues 	10

PO	NBA statement / Vital features	No. of vital features
PO4	<p>Use research-based knowledge and experimental methods to model, simulate, analyze, and interpret data related to Electronics and Communication Engineering problems using tools such as MATLAB, SPICE, HDL simulators, and communication test equipment to draw valid conclusions (Conduct Investigations of Complex Problems).</p> <ol style="list-style-type: none"> 1. Knowledge of characteristics of particular materials, equipment, processes, or product 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty. 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems. 	11
PO5	<p>Select and apply appropriate modern engineering tools, software, and platforms such as simulation tools, Cadance tools, programming environments, and hardware platforms for analysis, design, validation, and implementation of Electronics and Communication Engineering systems, with awareness of their limitations (Modern Tool Usage).</p> <ol style="list-style-type: none"> 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools. 	1

PO	NBA statement / Vital features	No. of vital features
PO6	<p>Apply contextual knowledge to assess societal, health, safety, legal, and ethical issues related to electronics and communication technologies such as wireless systems, IoT, automation, and information security and understand professional responsibilities(The Engineer and the World).</p> <ol style="list-style-type: none"> 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering 	5
PO7	<p>Apply ethical principles and commit to professional ethics, responsibilities, and norms of engineering practice in the design, development, deployment, and use of electronic and communication systems(Ethics).</p> <ol style="list-style-type: none"> 1. Comprises four components:ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity 	3

PO	NBA statement / Vital features	No. of vital features
PO8	<p>Function effectively as an individual and as a member or leader of multidisciplinary teams in the development of electronics, communication, and embedded system projects(Individual and Team Work.).</p> <ol style="list-style-type: none"> 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen - week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference. 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other’s performance, which is then reflected in the final grade. 9. Ability to work with all levels of people in an organization 10. Ability to get along with others 11. Demonstrated ability to work well with a team 12. Subjective evidence from senior students shows that the friendships and teamwork extend into the Junior years, and for some of those students, the friendships continue into the workplace after graduation. 	12
PO9	<p>Communicate effectively on complex engineering activities by preparing technical reports, design documents, research papers, and presentations, and by interacting clearly with engineers, clients, and society (Communication).”Students should demonstrate the ability to communicate effectively in writing / Orally.”</p> <ol style="list-style-type: none"> 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral) 	5

PO	NBA statement / Vital features	No. of vital features
PO10	<p>Apply engineering and management principles to plan, execute, and manage electronics and communication engineering projects, considering cost, quality, timelines, and resource (Project Management and Finance).</p> <ol style="list-style-type: none"> 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan 	12
PO11	<p>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).</p> <ol style="list-style-type: none"> 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year 	8

10 Key Competencies for Assessing Program Specific Outcomes:

PSO	NBA statement / Vital features	No. of vital features
PSO1	<p>Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications</p> <ol style="list-style-type: none"> 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System. 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct 	5
PSO2	<p>Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.</p> <ol style="list-style-type: none"> 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfaces for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment. 	11

PSO	NBA statement / Vital features	No. of vital features
PSO3	<p>Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.</p> <ol style="list-style-type: none"> 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3. Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment. 	7

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

Courses offered in Electronics and Communication Engineering Curriculum (IARE-BT23) and POs/PSOs attained through course modules for I, II, III, IV semesters.

Code	Subject	PO											PSO		
		1	2	3	4	5	6	7	8	9	10	11	1	2	3
I Semester B. Tech															
ACSD01	Object Oriented Programming	✓	✓	✓		✓				✓		✓	✓		✓
ACSD02	Object Oriented Programming with Java Laboratory	✓	✓	✓		✓	✓		✓				✓	✓	
ACSD03	Essentials of Innovation	✓	✓	✓	✓	✓			✓	✓		✓		✓	
AEED02	Electrical Circuits	✓	✓		✓									✓	✓
AEED04	Electrical Circuits Laboratory	✓	✓			✓				✓				✓	
AHSD01	Professional Communication	✓								✓			✓	✓	
AHSD02	Matrices and Calculus	✓	✓										✓	✓	
AHSD04	Professional Communication Laboratory	✓							✓	✓			✓		✓

Code	Subject	PO											PSO		
		1	2	3	4	5	6	7	8	9	10	11	1	2	3
AMED02	Manufacturing Practice	✓		✓		✓					✓		✓		
II Semester B. Tech															
ACSD05	Essentials of Problem Solving	✓	✓	✓		✓						✓	✓	✓	
ACSD06	Programming for Problem Solving Laboratory	✓	✓	✓		✓	✓		✓				✓	✓	✓
ACSD07	Mobile and Web Applications Development	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		
AHSD03	Engineering Chemistry	✓	✓				✓						✓	✓	✓
AHSD05	Engineering Chemistry Laboratory	✓	✓					✓						✓	
AHSD07	Applied Physics	✓	✓		✓									✓	
AHSD08	Differential Equations and Vector Calculus	✓	✓											✓	
AHSD09	Applied Physics Laboratory	✓	✓		✓								✓	✓	
AMED03	Engineering Graphics	✓					✓	✓	✓	✓			✓	✓	✓
III Semester B. Tech															
ACSD08	Data Structures	✓	✓	✓	✓	✓				✓		Y	✓		✓
ACSD11	Data Structures Laboratory	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓
AECD01	Electronic Devices and Circuits	✓	✓	✓						✓			✓	✓	✓
AECD02	Signals and Stochastic Process	✓	✓	✓	✓	✓		✓		✓	✓		✓		
AECD03	Digital System Design	✓	✓	✓	✓										✓
AECD06	Electronic Devices and Circuits Laboratory	✓	✓		✓				✓	✓				✓	
AECD07	Digital System Design Laboratory	✓	✓	✓		✓				✓	✓		✓		
AHSD12	Complex Analysis and Special Functions	✓	✓		✓								✓		
IV Semester B. Tech															

Code	Subject	PO											PSO		
		1	2	3	4	5	6	7	8	9	10	11	1	2	3
AECD08	Linear IC Applications	✓	✓	✓						✓	✓		✓		
AECD09	Analog Electronics	✓	✓	✓	✓	✓	✓				✓		✓		✓
AECD10	Communication Systems	✓	✓	✓											✓
AECD11	Electromagnetic Waves and Transmission Lines	✓	✓	✓	✓	✓	✓				✓	✓	✓		
AECD12	System Simulation and Modeling	✓	✓	✓	✓	✓		✓		✓	✓				✓
AECD14	Analog Electronics Laboratory	✓	✓	✓	✓	✓		✓	✓						
AECD15	Communication Systems Laboratory		✓		✓			✓	✓						
AECD16	Linear IC Applications Laboratory	✓	✓	✓						✓	✓		✓		

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) Alternate Assessment Tools (AAT)
- iii) Semester end examination (SEE)
- iv) Laboratory and project work
- v) Course exit survey
- vi) Program exit survey
- vii) Alumni survey
- viii) Employer survey
- ix) Course expert committee
- x) Program Assessment and Quality Improvement Committee (PAQIC)
- xi) Department Advisory Board (DAB)
- xii) Faculty meetings
- xiii) Professional societies

The above assessment indicators are detailed below.

12.1 Continuous Internal Assessment (CIA)

Two Continuous Internal Examinations (CIEs) are conducted for all courses by the department. All students must participate in this evaluation process. These evaluations are critically reviewed by HOD

and senior faculty and the essence is communicated to the faculty concerned to analyze, improve and practice so as to improve the performance of the student.

12.2 Alternate Assessment Tools (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table.

12.3 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 (DAC) and to the principal for taking necessary actions to better the course for subsequent semesters.

12.4 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.

12.5 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 DAC meetings.

12.6 Programme Exit Survey

The programme exit questionnaire form is to be filled by all the students leaving the institution. The questionnaire is designed in such a way to gather information from the students regarding the program educational objectives, solicit about program experiences, carrier choices, as well as any suggestions and comments for the improvement of the program. The opinions expressed in exit interview forms are reviewed by the DAC for implementation purposes.

12.7 Alumni Survey

The survey asks former students of the department about the status of their employment and further education, perceptions of institutional emphasis, estimated gains in knowledge and skills, involvement as a sunder graduate student, and continuing involvement with Institute of Aeronautical Engineering. This survey is administered every three years. The data obtained will be analyzed and used in continuous improvement.

12.8 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 e is also to

identify gaps in technical and vocational skills, need for required training practices to fill these gaps and criteria for hiring new employees. These employer surveys are reviewed by the College Academic Council (CAC) to affect the present curriculum to suit the requirement so the employer.

12.9 Course Expert Committee

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

12.10 Programme Assessment and Quality Improvement Committee (PAQIC)

PAC Monitors the achievements of Program Outcomes (POs), Program Specific Outcomes (PSOs) and Program Educational Objectives (PEOs). It will evaluate the program effectiveness and proposes the necessary changes. It also prepares the periodic reports on program activities, progress, status or other special reports for management. It also motivates the faculty and students towards attending workshops, developing projects, working models, paper publications and engaging in research activities.

12.11 Department Advisory Board (DAB)

Departmental Advisory Board plays an important role in the development of the department. Department level Advisory Board will be established for providing guidance and direction for qualitative growth of the department. The Board interacts and maintains liaison with key stakeholders. DAB will Monitor the progress of the program and develop or recommend the new or revised goals and objectives for the program. Also, the DAB will review and analyze the gaps between curriculum and Industry requirement and gives necessary feedback or advices to be taken to improve the curriculum.

12.12 Faculty Meetings

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

12.13 Professional Societies

The importance of professional societies like IEEE, IETE, ISTE, IE (I) etc., are explained to the students and they are encouraged to become members of the above to carry out their continuous search for knowledge. Student and faculty chapters of the above societies are constituted for a better technical and entrepreneurial environment. These professional societies promote excellence in instruction, research, public service and practice.

13 CO - Assessment processes and tools:

Course outcomes are evaluated based on two approaches namely direct and indirect assessment methods. The direct assessment methods are based on the Continuous Internal Assessment (CIA) and Semester End Examination (SEE) whereas 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 & AAT)	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 the various assessments and examinations. These assessment methods provide evidence that a student has command over a specific course, content, or skill, or that the students work demonstrates a specific quality such as creativity, analysis, or synthesis.

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

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

S No	Courses	Components	Frequency	Max. Marks	Evidence
1	Core / Elective	Continuous Internal Examination	Twice in a semester	20	Answer script
		Alternative Assessment Tools (AAT)	Twice in a semester	20	Video / Quiz / assignment
		Semester End Examination	Once in a semester	60	Answer script
2	Laboratory	Conduction of experiment	Once in a week	4	Work sheets
		Observation	Once in a week	4	Work sheets
		Result	Once in a week	4	Work sheets
		Record	Once in a week	4	Work sheets
		Viva	Once in a week	4	Work sheets
		Internal laboratory assessment	Once in a semester	10	Answer script
		Laboratory Report/Project and Presentation	Once in a semester	10	Answer script
Semester End Examination	Once in a semester	60	Answer script		
3	Project Work	Presentation	Twice in a semester	40	Presentation
		Semester End Examination	Once in a semester	60	Thesis report
4	Comprehensive Examination	Written examination (objective type)	Once in a semester	50	Online assessment
		Oral examination	Once in a Semester	50	Viva

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 Indirect assessment

Tools	Process	Frequency
Course end survey	<ul style="list-style-type: none">• 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 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 Program Articulation Matrix are considered for calculation of direct attainment of PO/PSOs.

14.1 PO Direct Attainment is calculated using the following rubric:

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

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

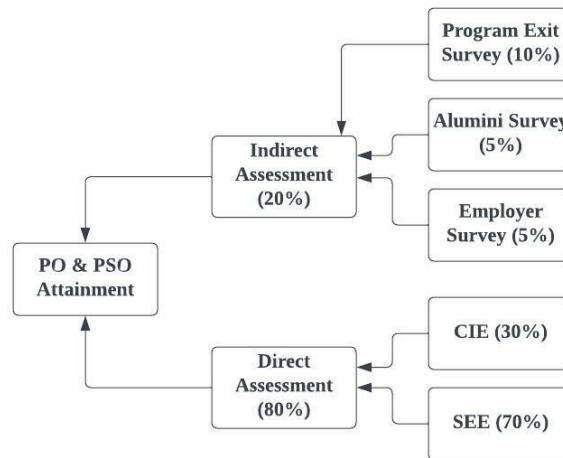


FIGURE 4: Evaluation process of POs/PSOs attainment

15 Course Description:

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

The “Course Description” contains the following contents:

- Course Overview
- Prerequisite(s)
- Marks Distribution
- Content delivery / Instructional methodologies
- Evaluation Methodology
- Course Objectives
- Course Outcomes
- Program Outcomes
- Program Specific Outcomes
- How Program Outcomes are assessed
- How Program Specific Outcomes are assessed
- Mapping of each CO with PO(s), PSO(s)
- Justification for CO – PO / PSO mapping- direct
- Total count of key competencies for CO – PO/ PSO mapping
- Percentage of key competencies for CO – PO/ PSO
- Course articulation matrix (PO / PSO mapping)
- Assessment methodology-direct

- Assessment methodology-indirect
- Syllabus
- List of Text Books / References / Websites
- Course Plan



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	Object Oriented Programming
Course Code	ACSE01
Course Start	First Semester
Course Type	Core
Regulation	IARE - BT 23
Prerequisite Courses	-
Department	Electronics and Communication Engineering
Number of Credits	3 Credit hours
Academic Year	2024-25
Method(s) of Instruction	Theory and laboratory
Course Administrator	Name: Dr. M Lakshmi Prasad EmpID: IARE10862 Designation: Professor of Computer Science and Engineering Email ID: m.lakshmprasad@iare.ac.in
Course Coordinator	Name: Dr. B. Surekha Reddy EmpID: IARE10795 Designation: Assistant Professor of Electronics and Communication and Engineering Email ID: b.surekhareddy@iare.ac.in
Prior Learning Assessment and Recognition (PLAR)	-
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=1678
Course Description	<p>This course introduces the principles of Object-Oriented Programming (OOP) and its role in solving complex problems effectively. It provides a solid foundation in object-oriented concepts such as abstraction, encapsulation, inheritance, polymorphism, and collaboration. The course also extends into file handling, exception management, and concurrent execution, preparing students to design, develop, and manage robust real-world applications.</p> <p>Course includes laboratory component for lab-based exercises. Key notions of object-oriented programming with a view for efficiency, maintainability, and code-reuse, are emphasized.</p>
	The Java programming language will be used to demonstrate the concepts discussed in lecture, and students will demonstrate these skills by solving real-world problems in the Java language.

Course Objectives	<p>The students will try to learn:</p> <ol style="list-style-type: none"> The fundamental concepts and principles of object-oriented programming in high-level programming languages. The advanced concepts for developing well-structured and efficient programs that involve complex data structures, numerical computations, or domain-specific operations. The design and implementation of features such as inheritance, polymorphism, and encapsulation for tackling complex problems and creating well-organized, modular, and maintainable code. The usage of input/output interfaces to transmit and receive data to solve real-time computing problems.
Text and Reference Books	<p>Text Books</p> <ol style="list-style-type: none"> Matt Weisfeld, <i>The Object-Oriented Thought Process</i>, Addison Wesley Object Technology Series, 4th Edition, 2013. Grady Booch, <i>Object-Oriented Analysis and Design with Applications</i>, Addison-Wesley Professional, 3rd Edition, 2007. Craig Larman, <i>Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development</i>, Addison-Wesley Professional, 3rd Edition, 2004. <p>Reference Books</p> <ol style="list-style-type: none"> Timothy Budd, <i>Introduction to object-oriented programming</i>, Addison Wesley Object Technology Series, 3rd Edition, 2002. Gaston C. Hillar, <i>Learning Object-Oriented Programming</i>, Packt Publishing, 2015. Kingsley Sage, <i>Concise Guide to Object-Oriented Programming</i>, Springer International Publishing, 1st Edition, 2019. Rudolf Pecinovsky, <i>OOP - Learn Object Oriented Thinking and Programming</i>, Tomas Bruckner, 2013.
Learning Resources	<p>Course full stack is made available in IARE learning management portal – Akansha, which includes lecture notes, tutorial question bank, definition and terminology, tech-talk topics, assignments, Model question papers (2 sets), complex engineering problem solving statements, power point presentations (PPTs) and ELRV lecture recordings at:</p> <ol style="list-style-type: none"> https://www.youtube.com/watch?v=ef5irlN2JxU https://www.youtube.com/watch?v=J7RKLvqNX5c&pp=0gcJCbIJAYcqIYzv
Supplemental Materials	<p>Readings, Videos, and Links</p> <ol style="list-style-type: none"> https://docs.oracle.com/javase/tutorial/java/concepts/ https://www.w3schools.com/cpp/ https://www.edx.org/learn/object-oriented-programming https://www.geeksforgeeks.org/introduction-of-object-oriented-programming/
Learning and Teaching Strategies	<p>Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course.</p> <p>There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.</p>

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 48, Tutorial hours: 8, Scheduled revision session hours: 2, Guided independent study hours: 15, Homework / Programming assignment hours: 10, Course project/ Preparation for complex problem solving hours: 15)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	48	01	48
TLA 2	Tutorials	08	01	08
TLA 3	Case Study			
TLA 4	Problem Solving			
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions	02	01	02
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			15
TLA 8	Independent private study			
TLA 9	Laboratory Exercises	0	0	0
TLA 10	Homework assignments / Programming assignments			10
TLA 11	Placement / work based learning or Specific practical training	0	0	0
TLA 12	Presentation / Seminar Preparation			
TLA 13	Course Project / Preparation for Complex Problem Solving			15
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
Total study hours				90
Expected total study hours				90

SECTION 3A: Course Outcomes**After successfully completing this course, the student will be able to:**

Outcome Number	Course Outcomes	Learning Domain
CO 1	Identify appropriate programming approaches to manage complexity.	Understand
CO 2	Design modular, reusable, and adaptable software systems.	Analyze
CO 3	Apply structured problem-solving techniques to build reliable and maintainable applications.	Apply
CO 4	Demonstrate the ability to handle data, manage errors, and ensure smooth program execution.	Apply
CO 5	Develop applications that are efficient, scalable, and suitable for real-world scenarios.	Evaluate
CO 6	Develop contemporary solutions to software design problems using object-oriented principles.	Create

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	16.67
Apply	33.32
Analyse	16.67
Evaluate	16.67
Create	16.67

SECTION 4: Content and Context of Object Oriented Programming

CO 1	Identify appropriate programming approaches to manage complexity.
	<p>Help learners understand various programming paradigms and their use in managing software complexity. Introduce structured, procedural, and object-oriented programming approaches, with an emphasis on how each handles modularity, readability, and scalability. Explore how programming methodologies influence design and maintenance decisions..</p> <p>Students should be able to:</p> <ul style="list-style-type: none">• Identify different programming paradigms and when to apply them.• Understand the trade-offs between structured and object-oriented programming.• Recognize the role of abstraction in reducing code complexity.• Match real-world problems to suitable programming models.• Distinguish between top-down and bottom-up design strategies.
CO 2	Design modular, reusable, and adaptable software systems.
	<p>Enable students to design software that follows modularity principles, supports code reuse, and adapts to changes. Emphasize concepts like separation of concerns, code refactoring, and interface design. Teach the importance of loosely coupled, highly cohesive modules that can evolve independently.</p> <p>Students should be able to:</p> <ul style="list-style-type: none">• Apply modular design techniques in program structure.• Build reusable functions, classes, and components.• Use interfaces and design patterns to promote adaptability.• Refactor code to improve readability and maintainability.• Design for future extension without modifying existing code.
CO 3	Apply structured problem-solving techniques to build reliable and maintainable applications.
	<p>Focus on structured analysis, problem decomposition, and algorithm design. Teach learners how to approach programming systematically — from understanding requirements to designing stepwise solutions. Emphasize traceability, documentation, and coding standards to ensure maintainability.</p> <p>Students should be able to:</p> <ul style="list-style-type: none">• Break complex problems into manageable subproblems.• Use flowcharts, pseudocode, and UML diagrams for planning.• Implement step-by-step solutions using control structures.• Apply testing and debugging techniques systematically.• Write clean, well-documented, and maintainable code.

CO 4	<p>Demonstrate the ability to handle data, manage errors, and ensure smooth program execution.</p>
	<p>This outcome reinforces the principles of different data types, structures, and input/output operations. Emphasize robust programming practices, including error detection, exception handling, and validation techniques to ensure fault-tolerant and stable execution.</p> <p>Key abilities:</p> <ul style="list-style-type: none"> • Handle various data formats and perform input/output operations. • Implement error-checking and exception-handling mechanisms. • Use control flow structures to manage execution logic. • Debug runtime issues and prevent application crashes. • Ensure predictable and safe program behavior under edge cases.
CO 5	<p>Develop applications that are efficient, scalable, and suitable for real-world scenarios.</p>
	<p>Prepare learners to create programs that meet performance and scalability needs in real-world contexts. Discuss efficiency in terms of algorithm complexity and memory usage. Introduce basic principles of scalable software design, and how to profile and optimize applications.</p> <p>Learners must:</p> <ul style="list-style-type: none"> • Write optimized code with attention to time and space complexity. • Choose appropriate data structures and algorithms for a given task. • Evaluate performance trade-offs in implementation decisions. • Apply coding practices that allow applications to grow in scale. • Build user-centric applications suitable for real-world deployment.
CO 6	<p>Develop contemporary solutions to software design problems using object-oriented principles.</p>
	<p>This is the capstone outcome, where students apply all OOP concepts to solve real-world problems. They must use inheritance, polymorphism, and abstraction to build flexible and extensible designs.</p> <p>Students should be able to:</p> <ul style="list-style-type: none"> • Implement class hierarchies using single, multiple, and multilevel inheritance. • Use virtual functions and abstract classes to design polymorphic behavior. • Resolve issues like method overriding, ambiguity in multiple inheritance, and constructor execution order. • Demonstrate static vs dynamic polymorphism. • Solve software problems using real-world modeling with OOP concepts.

SECTION 5: Complex Engineering Problem Solving

Programs, complex problem solving and programming projects

There is one piece of assessed coursework, involving a mixture of theoretical work and programming. We encourage to use the object oriented programming concepts in different languages — although they can use a single language, depending on the level of their ability. Programming assignments are a mandatory part of the course. Homework programs will concentrate on implementing fundamental programming concepts and techniques. Projects will be large scale programs implementing the concepts discussed in class. Programming Projects will be worth significantly more points than homework programs. All programs are individual assignments.

Programming exams/hack-a-thons will also be conducted. Student are required to complete these tasks during the class period with no assistance.

Object-Oriented Programming for Scalable Software Design: In addition to algorithmic thinking, learners will focus on applying object-oriented principles to build modular, maintainable, and scalable software systems. Students will explore real-world problem domains through object modeling and class design, emphasizing the binding of data and behavior using classes and objects. Core concepts such as encapsulation, inheritance, polymorphism, and abstraction will be reinforced through iterative development of software components. Learners will be expected to create class hierarchies, manage access control through visibility specifiers, overload operators and functions, and apply dynamic polymorphism using virtual functions and abstract classes. Projects will challenge students to solve larger engineering problems where these concepts can be used to manage complexity and improve code reuse. This approach prepares learners to design systems that are not only functionally correct but also extensible, modular, and aligned with industry-standard practices in software engineering.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
AAT: 1 - 1	Tech-Talk	Week – 2 / 5	05
AAT: 1 - 2	Hack-a-thon	Week – 4 / 7	05
AAT: 2 - 1	Complex Engineering Problem Solving	Week – 9 / 12	05
AAT: 2 - 2	Hack-a-thon	Week – 12 / 15	05
CIE - 1	2 hours - Answer 4 out of 5 questions	Week - 9	10
CIE - 2	2 hours - Answer 4 out of 5 questions	Week - 17	10
SEE	3 hours - Answer 1 from each module	Week - 18	60
Total Marks			100
Department's Late Submission Policy:			
1. 1 – 24 hours: 25% of the mark will be deducted			
2. > 24 hours: Not accepted			
SECTION 6B: Assessment Methods – Indirect			
Course End Survey (End Semester OBE Feedback)			

SECTION 7: Engineering Competencies (ECs) Focused

EC Number	Attributes	Profiles	()
EC 1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	
EC 2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	
EC 3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	
EC 4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC 5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC 6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC 7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC 8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	
EC 9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC 10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	

EC 11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	
EC 12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 8: Employability Skills

Example: Communication skills / Programming skills / Project based skills



Studying Object Oriented Programming helps the students with a wide range of employability skills that are highly valued in industries.

Employability Skills:

- Problem-solving skills for designing efficient solutions.
- Logical and analytical thinking for data organization.
- Proficiency in programming languages like C / C++ / Java / Python.
- Optimization skills for time and space complexity.
- Knowledge of scalable and robust system design.
- Teamwork and collaboration in software development.
- Adaptability to learn and apply advanced data structures.

Project Management:

- Planning and organizing project timelines and tasks.
- Allocating resources efficiently.
- Collaborating and communicating with team members.
- Identifying and mitigating project risks.
- Testing and validating system performance

SECTION 9: Relevance to Sustainability goals		
SDG Goals	Correlation with SDG	
4 	Quality Education: This subject will prepare students for modern technological challenges, improving educational tools, and promoting skills essential for global development.	
8 	Decent Work and Economic Growth: Prepares students for careers in technology-driven industries, boosting employability and fostering innovation in the digital economy.	
9 	Industry, Innovation, and Infrastructure: Supports the development of efficient algorithms and systems crucial for advancing technological infrastructure and innovation.	
11 	Sustainable Cities and Communities: Sustainable Cities and Communities: Enables the creation of smart city technologies (e.g., optimized traffic systems, resource management) using graph and tree structures.	
17 	Partnerships for the Goals: Facilitates collaboration in data-driven research and global educational initiatives through scalable and efficient data processing.	

SECTION 10A: Mapping between COs and POs / PSO's														
COURSE OUTCOMES	Prgram Outcomes (PO's)											PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	✓	-	-	-	✓	-	-	-	-	✓	-	-	✓	-
CO 2	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	✓	-
CO 3	✓	-	✓	-	✓	-	-	-	-	-	-	-	✓	-
CO 4	✓	-	✓	-	✓	-	-	-	-	✓	-	✓	✓	-
CO 5	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	-
CO 6	✓	✓	✓	-	✓	-	-	-	-	✓	-	✓	✓	-

SECTION 10B: Indicators of Attainment with COs to POs and PSO's														
COURSE OUTCOMES	Percentage of Indicators of Attainments (IA) with POs and PSO's													
	Prgram Outcomes (PO's)											PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	67	-	-	-	82	-	-	-	-	71	-	-	90	-
CO 2	67	67	67	-	82	-	-	-	-	71	-	-	90	-
CO 3	67	-	67	-	82	-	-	-	-	-	-	-	90	-
CO 4	67	-	67	-	82	-	-	-	-	71	-	53	90	-

SECTION 10B: Indicators of Attainment with COs to POs and PSOs														
COURSE	Percentage of Indicators of Attainments (IA) with POs and PSOs													
	Prgram Outcomes (PO's)											PSO'S		
OUTCOMES	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 5	67	67	67	-	82	-	-	-	-	-	-	-	90	-
CO 6	67	67	67	-	82	-	-	-	-	71	-	53	90	-

SECTION 10C: Course Articulation Matrix of COs to POs														
0 No Contribution (0-5%)		1 Low ($\geq 5 - < 40\%$)					2 Moderate ($\geq 40 - < 60\%$)					3 High ($\geq 60\%$)		
COURSE	Prgram Outcomes (PO's)											PSO'S		
OUTCOMES	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	-	-	-	3	-	-	-	-	3	-	-	3	-
CO 2	3	3	3	-	3	-	-	-	-	3	-	-	3	-
CO 3	3	-	3	-	3	-	-	-	-	-	-	-	3	-
CO 4	3	-	3	-	3	-	-	-	-	3	-	2	3	-
CO 5	3	3	3	-	3	-	-	-	-	-	-	-	3	-
CO 6	3	3	3	-	3	-	-	-	-	3	-	2	3	-
Total	18	9	15	-	18	-	-	-	-	12	-	4	18	-
Average	3	3	3	-	3	-	-	-	-	3	-	2	3	-

Outcomes		WKS and indicators for attainment and justification for mapping(students will be able to)																								IA'S							
		WK 1		WK 2			WK 3			WK 4			WK 5			WK 6			WK 7			WK 8			WK 9								
CO's	PO's	a	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	d	e	f		
CO 1	PO 1	•	•	•	•	•	•	•	•																								10
	PO 5	•	•	•	•	•	•	•	•																								10
	PO 10	•	•	•	•	•	•	•	•																								5
	PSO 1	•	•	•	•	•	•	•	•																								8
CO 2	PO 1	•	•	•	•	•	•	•	•																								10
	PO 2	•	•	•	•	•	•	•	•																								10
	PO 3	•	•	•	•	•	•	•	•																								4
	PO 5	•	•	•	•	•	•	•	•																								4
	PO 10	•	•	•	•	•	•	•	•																								5
	PSO 1	•	•	•	•	•	•	•	•																								8
CO 3	PO 1	•	•	•	•	•	•	•	•																								10
	PO 3	•	•	•	•	•	•	•	•																								4
	PO 5	•	•	•	•	•	•	•	•																								4
	PSO 1	•	•	•	•	•	•	•	•																								8
CO 4	PO 1	•	•	•	•	•	•	•	•																								10
	PO 3	•	•	•	•	•	•	•	•																								10
	PO 5	•	•	•	•	•	•	•	•																								4
	PO 10	•	•	•	•	•	•	•	•																								5
	PSO 1	•	•	•	•	•	•	•	•																								8
CO 5	PO 1	•	•	•	•	•	•	•	•																								10
	PO 2	•	•	•	•	•	•	•	•																								10
	PO 3	•	•	•	•	•	•	•	•																								4
	PO 5	•	•	•	•	•	•	•	•																								4
	PSO 3	•	•	•	•	•	•	•	•																								8

SECTION 10D: Level of Contribution of the COs to POs and PSOs

Number	Programme Outcomes	Proficiency Assessed by	(Contribution Level (from 1 to 3))
PO 1	Apply knowledge of mathematics, science, and core engineering fundamentals to analyze and solve complex problems in electronics, communication systems, signal processing, VLSI, embedded systems, and its allied domains(WK1 to WK4.)	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	3
PO 2	Identify, formulate, and analyze complex engineering problems related to analog/digital circuits, communication networks, signals, systems, and semiconductor devices using principles of mathematics, natural sciences, and engineering fundamentals. (WK1 to WK4).	CIE / SEE / AAT:1 – 2 Hack-a-thon	3
PO 3	Design and develop electronic circuits, communication systems, signal processing algorithms, VLSI architectures, and embedded solutions that meet specified technical, economic, environmental, and societal constraints. (WK5)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	3
PO 4	Use research-based knowledge and experimental methods to model, simulate, analyze, and interpret data related to Electronics and Communication Engineering problems using tools such as MATLAB, SPICE, HDL simulators, and communication test equipment to draw valid conclusions. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	3
PO 5	Select and apply appropriate modern engineering tools, software, and platforms such as simulation tools, Cadance tools, programming environments, and hardware platforms for analysis, design, validation, and implementation of Electronics and Communication Engineering systems, with awareness of their limitations. (WK2 and WK6).	CIE / SEE / AAT:2 – 2 Hack-a-thon	3
PO 6	Apply contextual knowledge to assess societal, health, safety, legal, and ethical issues related to electronics and communication technologies such as wireless systems, IoT, automation, and information security and understand professional responsibilities. (WK1, WK5, and WK7)	CIE / SEE / AAT:2 – 2 Hack-a-thon	3
PO 10	Apply engineering and management principles to plan, execute, and manage electronics and communication engineering projects, considering cost, quality, timelines, and resource . (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	3
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications..	AAT: 1 – 1 Tech-Talk	2

PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	2	
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	AAT: 2 – 1 Complex Engineering Problem Solving	2

SECTION 11: Course Content	
MODULE I	Object-oriented concepts
	<p>Complex systems: definition, characteristics, and five attributes (hierarchy, abstraction, emergence, encapsulation, modularity).</p> <p>Evolution of problem-solving: procedural vs. object-oriented thinking.</p> <p>Objects as fundamental building blocks: state, behavior, and identity.</p> <p>Benefits of OOP in managing complexity, Applications of OOP in real-world systems.</p>
MODULE II	Abstraction, Encapsulation and Object Collaboration
	<p>Abstraction: forms of abstraction (procedural, data, control), abstraction layers, mechanisms.</p> <p>Encapsulation: information hiding, boundary definition, modularity.</p> <p>Objects and message passing: collaboration through responsibilities.</p> <p>Relationships: association, aggregation, composition, dependency.</p>
MODULE III	Inheritance and Generalization
	<p>Classification and taxonomy in object-oriented programming, Concepts of generalization and specialization.</p> <p>Types of inheritance: single, multiple, and hierarchical (conceptual).</p> <p>Challenges in multiple inheritance: ambiguity and the diamond problem (conceptual). Importance of generalization for adaptability and method reuse.</p>
MODULE IV	Polymorphism and Interfaces
	<p>Polymorphism: static vs dynamic polymorphism, Abstract classes, abstract operations, late binding, and dynamic dispatch.</p> <p>Interfaces as behavioral contracts, difference between interfaces and abstract classes (conceptual), Multiple realizations of interfaces (role-based modeling).</p>
MODULE V	File structures, Exception handling, Concurrent execution
	<p>Working with Files: Files, need for file handling, types, modes, operations and error handling.</p> <p>Exception handling: Detecting problems during execution and responding gracefully, preventing failures from crashing the system and ensuring smooth execution.</p> <p>Concurrent execution: Allowing multiple tasks to run simultaneously within a system, co-ordinating tasks to avoid conflicts when sharing resources.</p>

SECTION 12: Tentative Schedule of Instructions		
Week Number	Topics	Duration (Hours)
1	1.1 Introduction to OOP 1.2 Complex systems: definition, characteristics 1.3 Introduction to OOP five attributes	3
2	2.1 Hierarchy, abstraction and emergence 2.2 Encapsulation and modularity 2.3 Evolution of problem-solving	3
3	3.1 Procedural Programming 3.2 Object-oriented thinking 3.3 Objects as fundamental building blocks	3
4	4.1 State, behavior, and identity 4.2 Benefits of OOP in managing complexity 4.3 Applications of OOP in real-world systems	3
5	5.1 Forms of abstraction (procedural) 5.2 Forms of abstraction (data) 5.3 Forms of abstraction (control)	3
6	6.1 Abstraction layers 6.2 Abstraction mechanisms 6.3 Encapsulation - information hiding	3
7	7.1 Encapsulation - Boundary definition 7.2 Encapsulation - modularity 7.3 Objects and message passing: collaboration through responsibilities	3
8	8.1 Relationships: association, aggregation 8.2 Relationships: composition, dependency 8.3 Classification and taxonomy in object-oriented programming	3
CONTINUOUS INTERNAL EXAMINATION (CIE- I)		
9	9.1 Concepts of generalization and specialization 9.2 Types of inheritance 9.3 Single and multiple inheritance	3
10	10.1 Hierarchical (conceptual) inheritance 10.2 Challenges in multiple inheritance: ambiguity and the diamond problem (conceptual) 10.3 Importance of generalization for adaptability and method reuse	3
11	11.1 Polymorphism and Interfaces 11.2 Static vs dynamic polymorphism 11.3 Abstract classes	3
12	12.1 Abstract operations 12.2 Late binding and dynamic dispatch 12.3 Interfaces as behavioral contracts	3
13	13.1 Difference between interfaces and abstract classes (conceptual) 13.2 Multiple realizations of interfaces (role-based modeling)	3

SECTION 12: Tentative Schedule of Instructions		
Week Number	Topics	Duration (Hours)
	13.3 File Structures	
14	14.1 Need for file handling 14.2 File types and modes 14.3 File operations and error handling	3
15	15.1 Exception handling 15.2 Detecting problems during execution 15.3 Responding gracefully in exception handling	3
16	16.1 Preventing failures from crashing the system and ensuring smooth execution 16.2 Concurrent execution - Allowing multiple tasks to run simultaneously within a system 16.3 Co-ordinating tasks to avoid conflicts when sharing resources	3
Total		48

SECTION 13: Specific Goals for the Course

The following table shows the knowledge and skills covered by the unit outcomes:

Knowledge	Skills
<p>Learners should understand:</p> <ul style="list-style-type: none"> • the principles of object-oriented programming such as encapsulation, abstraction, inheritance, and polymorphism • how object-oriented programming differs from procedural programming • the process of designing classes, objects, and their interactions in real-world scenarios • the role and use of access specifiers (public, private, protected) • the concept and use of constructors and destructors, including different types (default, parameterized, copy, dynamic) • the importance of function and operator overloading • the use of inheritance to promote code reuse and polymorphic behavior • the concept of virtual functions and pure virtual functions for achieving dynamic polymorphism 	<p>Learners can:</p> <ul style="list-style-type: none"> • model real-world problems using class and object representations • design and implement classes with appropriate attributes and methods • define and use constructors and destructors effectively in class design • apply access specifiers correctly to control data access and protection • write programs that implement function and operator overloading • use single, multiple, and multilevel inheritance to extend class functionality • override base class methods and resolve ambiguity in multiple inheritance using virtual base classes • apply dynamic polymorphism through virtual functions and abstract classes • manage input/output using streams for console and file operations

Administrative Information

SECTION 14: History of changes

Regulations	Description of change	BOS Date
BT 23	<p>This course was introduced in BT23 regulation. With this course the student is able:</p> <ul style="list-style-type: none"> • To transition learners from procedural to object-oriented thinking • To prepare students for real-world software development using object models • To enable scalable and reusable code through class-based design • To promote modular programming practices for better code management • To equip students with practical coding experience using Java — a widely used and industry-relevant programming language • To bridge the gap between theoretical programming principles and applied software engineering 	28.08.2023

BT 25	Incorporated the following modifications in BT 25 regulations: <ul style="list-style-type: none">• Many C++-specific topics like constructors/destructors, operator overloading, friend functions, console I/O, access specifiers, and memory allocation.• More conceptual topics such as complex system attributes, abstraction layers, object collaboration (message passing, relationships), generalization/specialization, interfaces, exception handling, and concurrent execution are added.• File handling is integrated with exception handling and concurrency rather than console I/O.	29.08.2025
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Course Outline Approvals	
Course Coordinator	Head of the Department
Name:	Name:
Signature:	Signature:
Date:	Date:
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on date in meetings IARE - OBTL – COD /104/24	
Dean of Outcome Based Teaching and Learning	Dean of Academics
Name:	Name:
Signature:	Signature:
Date:	Date:

Check List		
Section	Description	Please tick
1	General Information about the Course	✓
2	Notional Study Time	✓
3	A. Course Outcomes	✓
	B. Cognitive Levels	✓
4	Content and Context of the Course	✓
5	Complex Engineering Problem Solving	✓
6	A. Assessment Methods – Direct	✓
	B. Assessment Methods – Indirect	✓
7	Content Delivery / Instructional Methodologies	✓
8	Engineering Competencies (ECs) Focused	✓
9	Employability Skills	✓
10	Relevance to Sustainability goals	✓
11	A. Mapping between COs and POs / PSOs	✓
	B. Indicators of Attainment with COs to POs and PSOs	✓
	C. Course Articulation Matrix of COs to POs	
	D. Level of Contribution of the COs to POs and PSOs	✓
12	Syllabus	✓
13	Tentative Schedule of Instructions	✓
14	Specific Goals for the Course	✓
15	History of Changes	✓