NARASARAOPETA ENGINEERING COLLEGE

(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

OUTCOME BASED EDUCATION (OBE)





B.TECH (ME) – R20 REGULATION

NARASARAOPETA ENGINEERING COLLEGE
(AUTONOMOUS)

INSTITUTE VISION AND MISSION

VISION:

To emerge as a **Centre of excellence** in technical education with a blend of effective **student centric teaching learning** practices as well as **research** for the transformation of **lives and community**.

MISSION:

1. Provide the best class infrastructure to explore the field of engineering and research.
2. Build a passionate and a determined team of faculty with student centric teaching, imbibing experiential and innovative skills.
3. Imbibe lifelong learning skills, entrepreneurial skills and ethical values in students for addressing societal problems.

DEPARTMENT VISION AND MISSION

VISION:

To strive for making competent **Mechanical Engineering Professionals** to cater the real time needs of Industry and **Research** Organizations of high repute with **Entrepreneurial Skills and Ethical Values.**

MISSION:

M 1: To train the students with State of Art Infrastructure to make them industry ready professionals and to promote them for higher studies and research**.**

M 2: To employ committed faculty for developing competent mechanical engineering graduates to deal with complex problems.

M 3: To support the students in developing professionalism and make them socially committed mechanical engineers with morals and ethical values.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO 1: Demonstrate excellence in their professional careers by applying sound knowledge of mathematics, engineering fundamentals, and applied sciences to solve engineering problems effectively.

PEO 2: Demonstrate leadership qualities and team spirit in achieving goals.

PEO 3: Pursue higher studies to ace in research and develop as entrepreneurs.

PROGRAM OUTCOMES (POs):

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

I. The students will be able to apply knowledge of modern tools in manufacturing enabling to conquer the challenges of Modern Industry.

II. The students will be able to design various thermal engineering systems by applying the principles of thermal sciences.

III. The students will be able to design different mechanisms and machine components of transmission of power and automation in modern industry.

NARASARAOPETA ENGINEERING COLLEGE
(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

This Manual is a reference to help faculty, staff and stakeholders to understand the Outcome Based Education (OBE) system implemented at Narasaraopeta Engineering College. The manual serves as valuable guidelines for the faculty to develop an assessment plan in the process to measure the outcome of the students during their course of study and also after their graduation. The manual outlines the process involved in developing a constructive curriculum development and content delivery or teaching plan.

OUTCOME BASED EDUCATION (OBE)

Outcome-Based Education (OBE) model is being adopted at a fast pace at Engineering colleges in India at the moment. It is considered as a giant leap forward to improve technical education in India and help Indian Engineers compete with their global counterparts. Outcome Based Education (OBE) is an important demonstration Tool for student-centered instruction that focuses on measuring student performance through outcomes.



Quality assurance and improvement process is about determining whether the set educational objectives meet a general standard of quality. Emphasis of outcome-based education (OBE) system is on quantifying what the students are capable of doing and learning outcomes of the students is one of the key components. Course Outcomes are the statements indicating knowledge and skills the student is expected to acquire at the end of a course. Program outcomes represent the knowledge, skills and attitudes the students should have at the end of program. Program outcomes can be directly measured through course outcomes.

ABBREVIATIONS:

OBE	Outcome Based Education	BTL	Bloom's Taxonomy Level
LOT	Lower Order of Thinking	HOT	Higher Order of Thinking
PEO	Program Educational Objectives	PO	Program Outcome
CO	Course Outcome	PSO	Program Specific Outcome
CE	Course Exit Survey	HoD	Head of Department
PC	Program Coordinator	DAC	Department Advisory Committee
PAC	Program Assessment Committee	AY	Academic Year

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

Accreditation Serves To Notify:

- Parents and prospective students that a program has met minimum standards.
- Faculty, HOD, Principal of a program's strengths and weaknesses and of ways to improve the programme.
- Employers that graduates are prepared to begin professional practice
- The public that graduates are aware of societal considerations.

Purpose of accreditation is NOT TO:

- Find faults with the institution but to assess the status-ante of the performance.
- Denigrate the working style of the institution and its programs but to provide a feedback on their strengths and weaknesses.
- Demarcate the boundaries of quality but to offer a sensitizing process for continuous improvement in quality provisions.
- Select only institutions of national excellence but to provide benchmarks of excellence and identification of good practices.

Benefits of Accreditation:

- Facilitates continuous Quality Improvement.
- Demonstrates accountability to the public.
- Improves staff morale.
- Recognizes the achievements/innovations.
- Facilitates information sharing.
- Priority in getting financial assistance helps the Institution to know its strengths, weaknesses and opportunities.
- Initiates Institutions into innovative and modern methods of pedagogy
- Promotes intra and inter-Institutional interactions

Pre 2013 Scenario:

- Educational quality measurements focused on inputs, activities and outputs, such as resources used, classes taught, articles published, placements and graduate enrolments
- Such performance indicators provide no measurement of the degree to which Institutions of higher learning actually develop the knowledge and skills of their students.
- These measurements are ill-suited to inform governments, students and the general public about teaching and learning quality
- In the absence of comparable learning outcomes assessment across institutions, ratings and rankings are widely used as proxies for relative educational quality.
- NBA criteria were mainly input-process-output related and there were no direct measures of quality of learning.

WASHINGTON ACCORD:

It recognizes the substantial equivalency of programs accredited by those bodies and recommends that graduates of programs accredited by any of the signatory bodies be recognized by the other bodies as having met the academic requirements for entry to the practice of engineering. The induction of India in the Washington Accord in 2014 with the permanent signatory status of The National Board of Accreditation (NBA) is considered a big leap forward for the higher education system in India. It means that an Engineering graduate from India can be employed in any one of the other countries who have signed the accord. For Indian Engineering Institutions to get accredited by NBA according to the pacts of the accord, it is compulsory that engineering institutions follow the Outcome Based Education (OBE) model. So, for an Engineering Institution to be accredited by NBA it should compulsorily follow the OBE model. Similarly, NAAC is also now following the same path and OBE is benchmarked as a standard for accreditation.

What are Outcomes?

- An outcome of an education is what the student should be able to do at the end of a program/ course/ instructional unit.
- Outcome-based education is an approach to education in which decisions about the curriculum are driven by the exit learning outcomes that the students should display at the end of the program/ course.
- Outcomes are the abilities the students acquire at the end of the program
- In outcome-based education, "product defines process".
- It is the results-oriented thinking and is the opposite of input-based education where the emphasis is on the educational process and where we are happy to accept whatever is the result.
- Outcome-based education is not simply producing outcomes for an existing curriculum.

A learning outcomes answers the question:

"What is it that your students should be able to do at the end of the hour/lecture that they could not do before?". It provides a clear guidance for the planning and development of the teaching process, including the design and organization of materials, the selection of the most appropriate teaching methods, as well as providing a measure for quality assurance (Biggs, 2003).

Some important aspects of the Outcome Based Education:

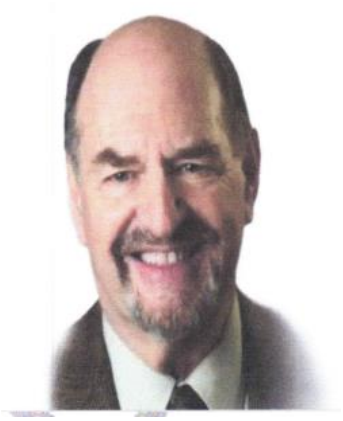
1. **Course:** It is defined as a theory, practical or theory cum practical subject studied in a semester. For example Engineering Mathematics
2. **Course Outcome (CO):** Course outcomes are statements that describe significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. Generally three or more course outcomes may be specified for each course based on its weightage.
3. **Program:** It is defined as the specialization or discipline of a Degree. It is the interconnected arrangement of courses, co-curricular and extracurricular activities to accomplish predetermined objectives leading to the awarding of a degree. For Example: B.E., Marine Engineering.
4. **Program Outcomes (POs):** Program outcomes are narrower statements that describe what students are expected to be able to do by the time of graduation. POs are expected to be aligned closely with Graduate Attributes.
5. **Program Educational Objectives (PEOs):** The Program Educational Objectives of a program are the statements that describe the expected achievements of graduates in their career, and also in particular, what the graduates are expected to perform and achieve during the first few years after graduation.
6. **Program Specific Outcomes (PSO):** Program Specific Outcomes are what the students should be able to do at the time of graduation with reference to a specific discipline. Usually there are two to four PSOs for a program.

All OBE approaches take a criterion-based view of assessment and focus on what students can do with knowledge after a period of learning

LEVELS OF OUTCOMES:

- **Program Educational Objectives:** PEOs are broad statements that describe the career and professional accomplishments in five years after graduation that the program is preparing graduates to achieve.
- **Program Specific Outcomes:** PSOs are statements that describe what the graduates of a specific engineering program should be able to do.
- **Program Outcomes:** POs are statements that describe what the students graduating from engineering programs should be able to do.
- **Course Outcomes:** COs are statements that describe what students should be able to do at the end of a course. The method of assessment of the candidates during the program is left for the institution to decide. The various assessment tools for measuring Course Outcomes include Mid -Semester and End Semester Examinations, Tutorials, Assignments, Project work, Labs, Presentations, Employer/Alumni Feedback etc…

FOUR PRINCIPLES IN OBE:



Dr. William Spady is considered as the father of OBE.

The most widely used one is the four principles suggested by Dr. William Spady in the year 1994.

CLARITY OF FOCUS:

- Clarity of focus, meaning that all activities (teaching, assessment, etc) are geared towards what we want students to demonstrate;

DESIGNING DOWN:

- Design down, meaning designing the curriculum from the point at which you want students to end up.

HIGH EXPECTATIONS:

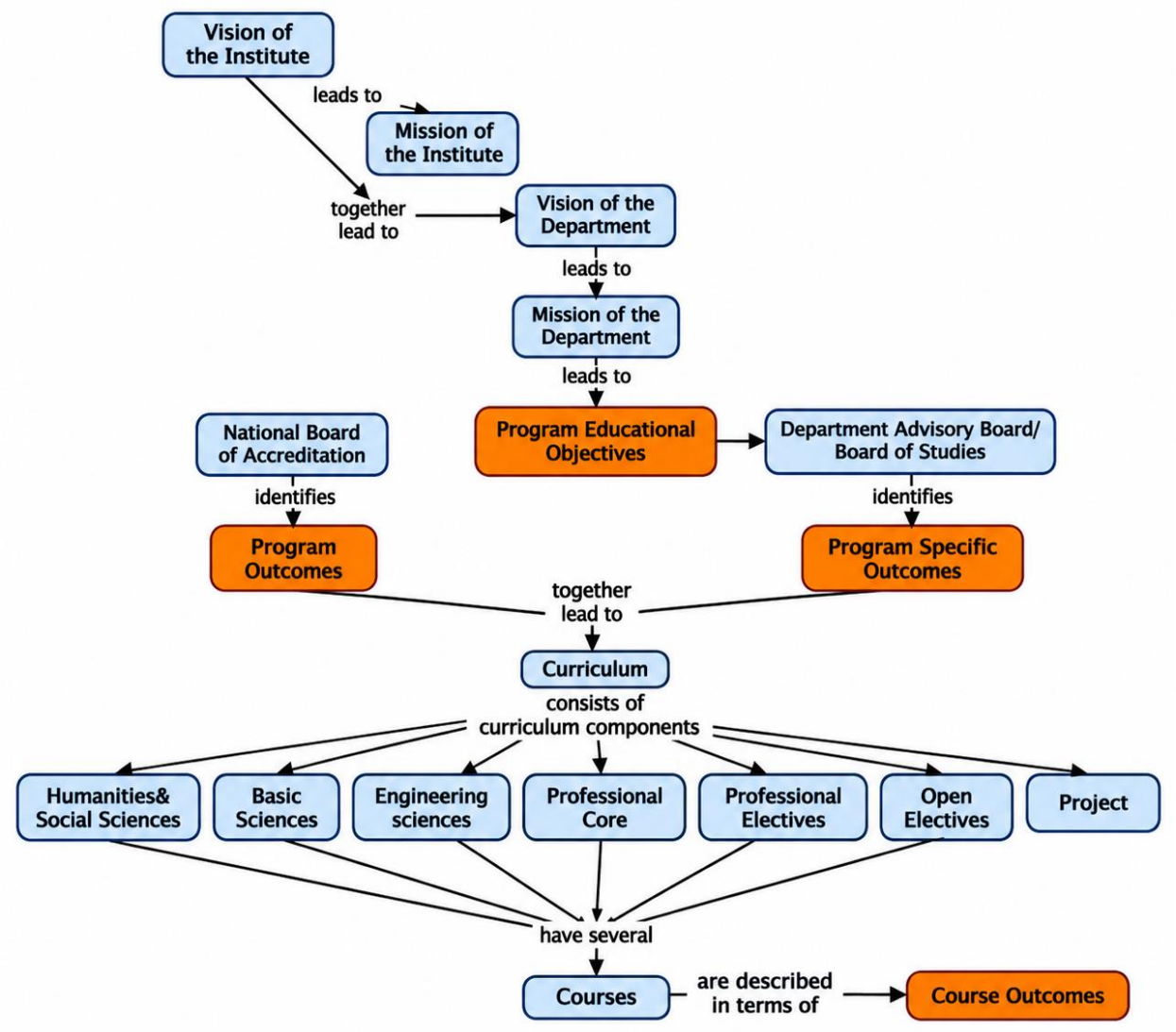
- Establish high, challenging performance standards.
- Engage deeply with issues are learning.

EXPANDED OPPORTUNITES:

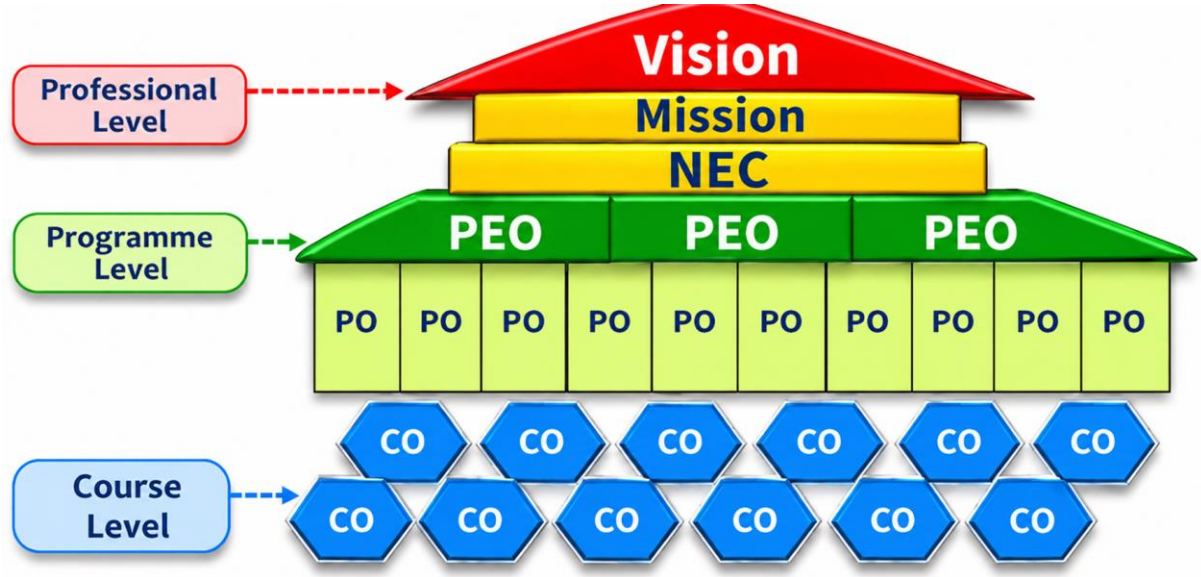
- All students can be successful. It's only that they may require different instructional strategies.
- Additional learning opportunities in order to do so.

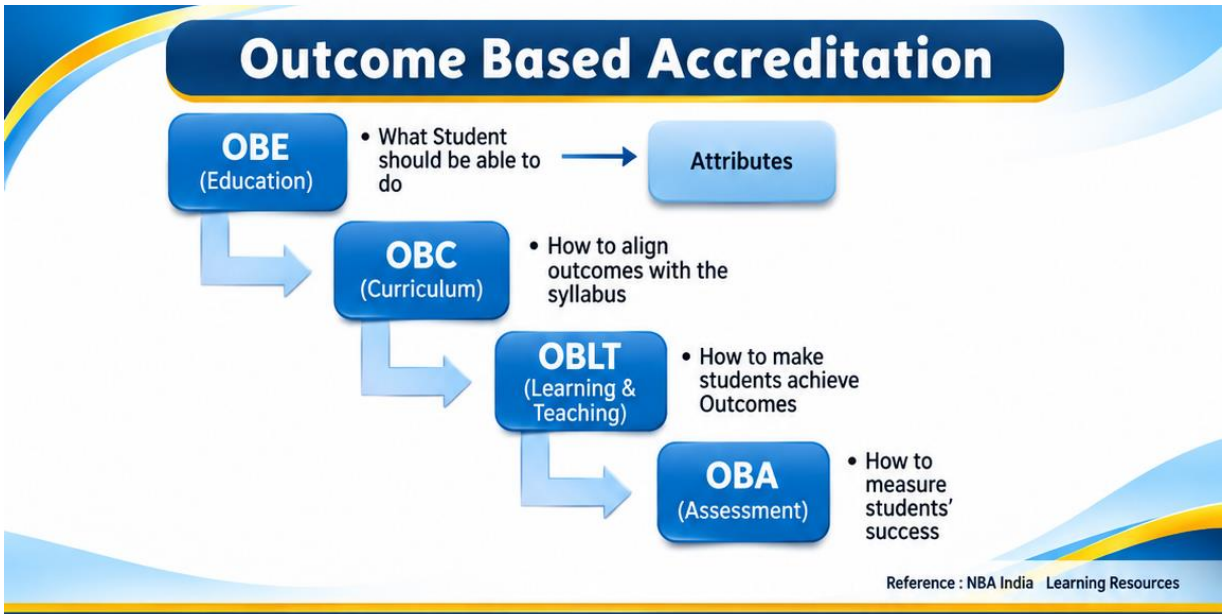
THE ESSENTIALS OF OBE:

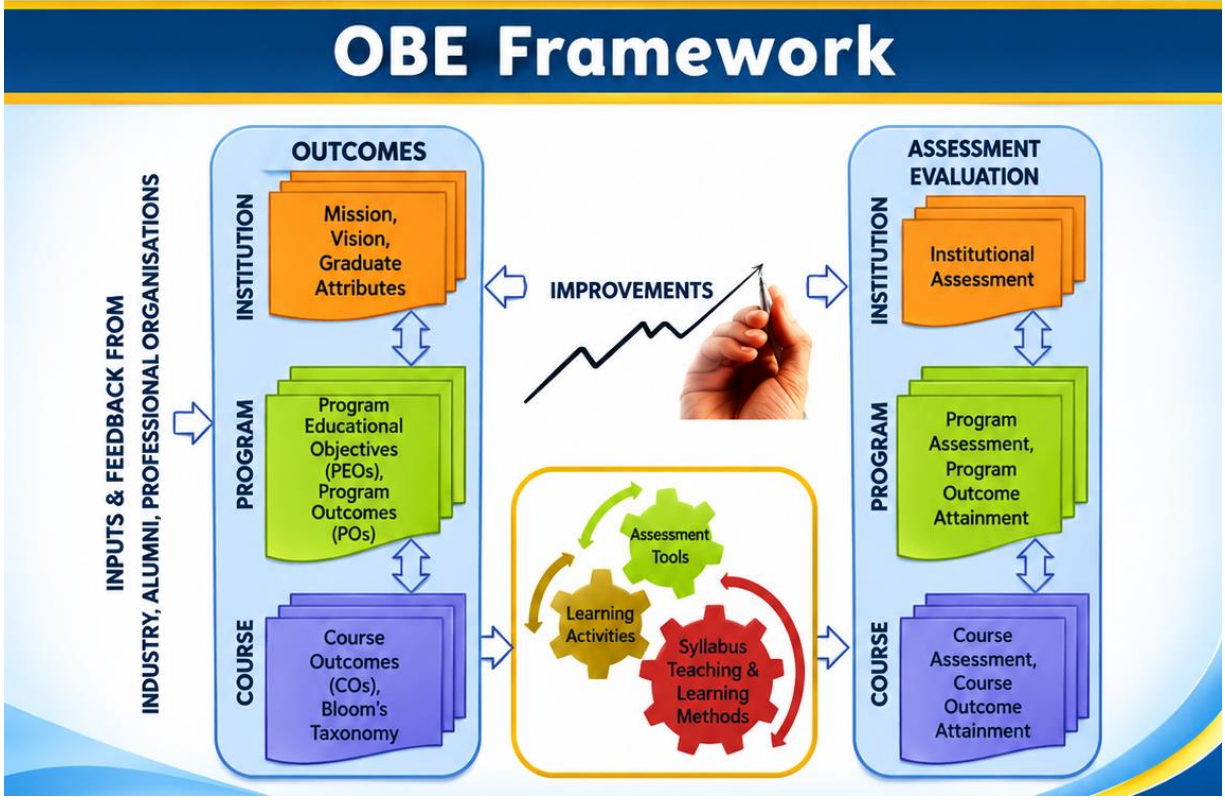
- In OBE, what matters ultimately is not what is taught, but what is learned.
- Teachers must set appropriate course intended learning outcomes, instead of teaching objectives.
- Constructive alignment: What we teach, how we teach and how we assess ought to be aligned with the intended learning outcomes, such that they are fully consistent with each other.
- The quality of teaching is to be judged by the quality of learning that takes place;

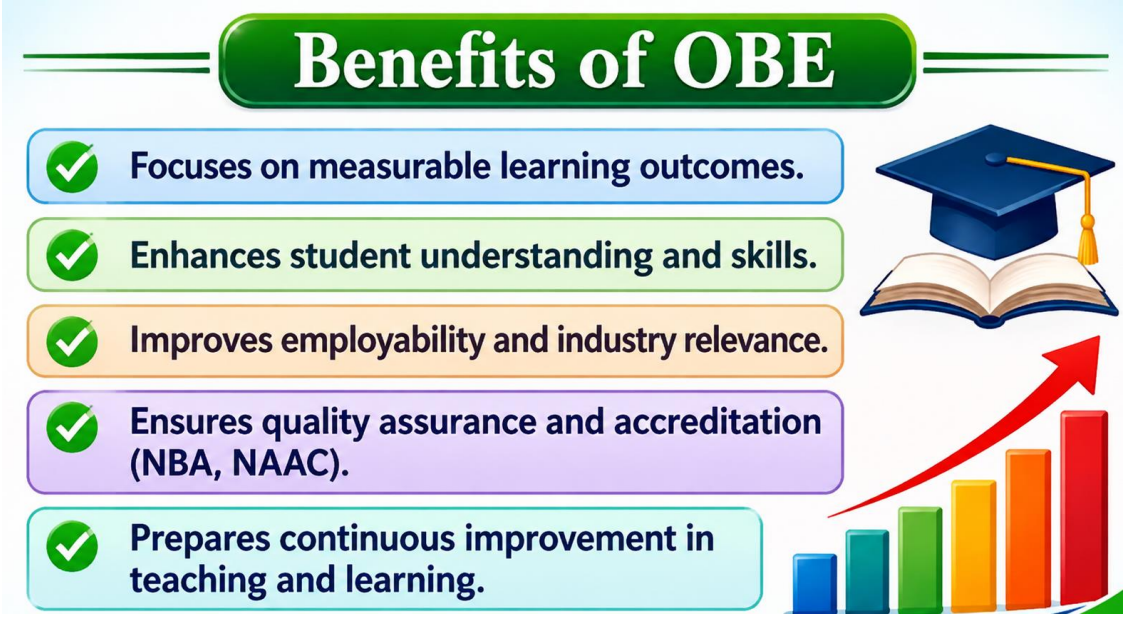


Outcomes and Objectives in NBA framework


Professional Level
Programme Level
Course Level
Vision
Mission
NEC
PEO
PEO
PEO
PO
CO


Outcome Based Accreditation
OBE
(Education)
What Student should be able to do
Attributes
OBC
(Curriculum)
How to align outcomes with the syllabus
OBLT
(Learning & Teaching)
How to make students achieve Outcomes
OBA
(Assessment)
How to measure students' success
Reference : NBA India Learning Resources


OBE Framework
INPUTS & FEEDBACK FROM
INDUSTRY, ALUMNI, PROFESSIONAL ORGANISATIONS
OUTCOMES
INSTITUTION
Mission, Vision, Graduate Attributes
PROGRAM
Program Educational Objectives (PEOs), Program Outcomes (POs)
COURSE
Course Outcomes (COs), Bloom's Taxonomy
IMPROVEMENTS
Assessment Tools
Learning Activities
Syllabus Teaching & Learning Methods
ASSESSMENT EVALUATION
INSTITUTION
Institutional Assessment
PROGRAM
Program Assessment, Program Outcome Attainment
COURSE
Course Assessment, Course Outcome Attainment



TRADITIONAL VS THE OUTCOME-BASED APPROACH:

The traditional way of teaching was where the teacher instructs the students and the students generally take down the notes without even logical thinking. The important thing regarding teaching in the traditional method is that topic is written on the blackboard and students take down notes from the blackboard as a result at the end of the day the students memorize the same and appear for the examination with the at most intention to pass the Examination. With the recent advancement, there is no point in adhering to the Traditional method as the competition towards has increased enormously.

Outcome based education is seen a paradigm shift in the higher education that is student focused and outcome orientated. The table below provides a comparison of the traditional teaching approach and the outcome-based approach.

Outcome-Based Approach	Traditional Teaching Approach
Learner/student-centered	Teacher-centered
Teacher's role as partner/facilitator	Teacher's role as instructor
Focus on learner's output	Focus on teacher's input
Flexible and empowering	Rigid and controlling
Emphasis on progress and overall learning	Emphasis on products
Learning outcomes/Learning programmes are seen as guides that allows teachers to be innovation and creative in achieving learning outcomes	Course objectives/Syllabus is seen rigid & non negotiable
Criterion-reference assessment	Norm-referenced assessment
Ability building and skills development	Content-based and content delivery

Real-World Applications of OBE in Mechanical Engineering

Outcome-Based Education (OBE) ensures that Mechanical Engineering graduates are industry-ready, solve real problems, and contribute effectively to society.



Design & Development

Develop innovative and efficient mechanical products and systems.



Sustainable Solutions

Address energy, environment, and sustainability challenges through engineering.



Advanced Manufacturing

Apply modern manufacturing technologies for quality and productivity.



Simulation & Analysis

Use software tools to analyze and optimize mechanical systems.



Quality & Reliability

Ensure product reliability, safety, and performance standards.



Industry Collaboration

Work with industry to solve real-world problems and drive innovation.

Key Real-World Applications of OBE in Mechanical Engineering

Manufacturing & Industry



OBE prepares engineers to design efficient, safe, and sustainable manufacturing systems.

Real-World Example:
Smart factories with automated robotic assembly lines.

Renewable Energy



OBE builds competencies for designing and optimizing renewable energy systems.

Real-World Example:
Wind turbines and solar power systems.

Aerospace & Defence



OBE develops skills for high-performance, reliable and lightweight design.

Real-World Example:
Aircraft design and spacecraft mechanisms.

Automotive & Mobility



OBE enables engineers to create safer, greener and smarter vehicles.

Real-World Example:
Electric and hybrid vehicles with advanced control systems.

Healthcare & Assistive Devices



OBE prepares engineers to develop precise and reliable medical devices.

Real-World Example:
Robotic surgery systems and prosthetics.

Energy & Environment



OBE promotes solutions for energy efficiency and environmental sustainability.

Real-World Example:
Efficient engines and pollution control technologies.

Key OBE Outcomes (Impact)

- Industry-Ready Graduates
- Innovative Solutions
- Improved Safety & Reliability
- Sustainable Development
- Societal Benefit

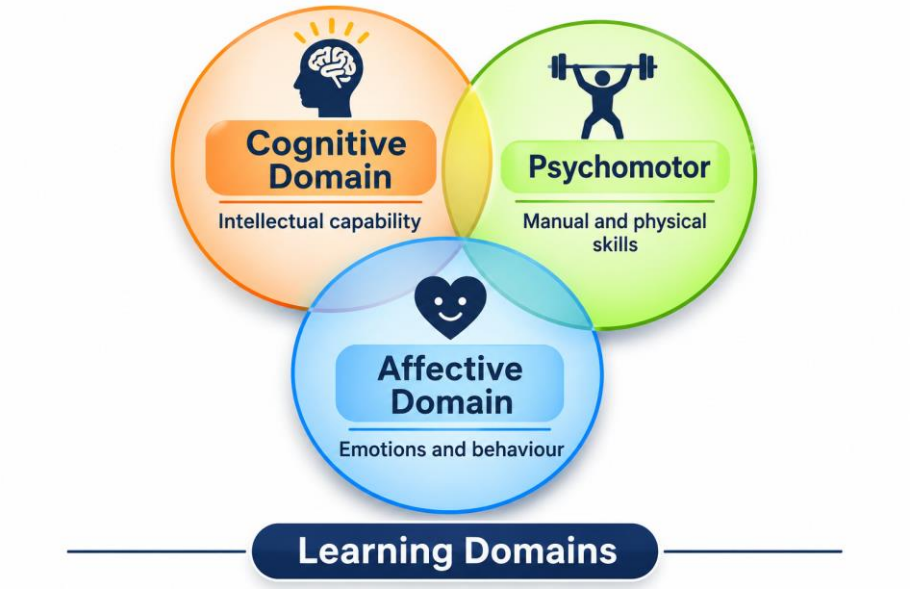
OBE in Mechanical Engineering: Building Skills Today, Creating a Sustainable and Innovative Tomorrow.

ADMINISTRATIVE SYSTEM FOR OBE:



BLOOM'S TAXANOMY:

Bloom's Taxonomy provides an important framework to not only design curriculum and teaching methodologies but also to design appropriate examination questions belonging to various cognitive levels. Bloom's Taxonomy of Educational Objectives developed in 1956 by Benjamin Bloom was widely accepted by educators for curriculum design and assessment. In 2001, Anderson and Krathwohl modified Bloom's Taxonomy to make it relevant to the present-day requirements. It attempts to divide learning into three types of domains (cognitive, affective, and behavioural) and then defines the level of performance for each domain. Conscious efforts to map the curriculum and assessment to these levels can help the programs to aim for higher-level abilities which go beyond remembering or understanding, and require application, analysis, evaluation or creation. Revised Bloom's taxonomy in the cognitive domain includes thinking, knowledge, and application of knowledge. It is a popular framework in engineering education to structure the assessment as it characterizes complexity and higher-order abilities. It identifies six levels of competencies within the cognitive domain as shown below which are appropriate for the purposes of engineering educators.



The blooms taxonomy is shown in figure where the lower levels become foundation for the higher levels. The Bloom's taxonomy process is ordered in such a way that the lowest level is the simplest form of recognition, while the highest level built on lower levels involves more complex form of cognitive skill. By providing a hierarchy of levels, this taxonomy can assist teachers in designing assessment framework to measure the student's learning ability and making teaching method, innovative and adaptive to student's competencies and enhancing the same.

The cognitive processes dimension — categories, cognitive processes (and alternative names)

lower order thinking skills → higher order thinking skills

remember	understand	apply	analyze	evaluate	create
recognizing *(identifying)*	**interpreting** *(clarifying, paraphrasing, translating)*	**executing** *(carrying out)*	**differentiating** *(discriminating, distinguishing, focusing, selecting)*	**checking** *(coordinating, defecting, monitoring, testing)*	**generating** *(hypothesizing)*
recalling *(retrieving)*	**exemplifying** *(illustrating, instantiating)*	**implementing** *(using)*	**organizing** *(finding coherence, integrating, outlining, parsing, structuring)*	**critiquing** *(judging)*	**planning** *(designing)*
	classifying *(categorizing, subsuming)*		**attributing** *(deconstructing)*		**producing** *(construct)*
	summarizing *(abstracting, generalizing)*				
	inferring *(concluding, extrapolating, interpolating, predicting)*				
	comparing *(contrasting, mapping, matching)*				
	explaining *(constructing models)*				



Bloom's Taxonomy Action Verbs

Definitions	I. Remembering	II. Understanding	III. Applying	IV. Analyzing	V. Evaluating	VI. Creating
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 solutions.
Verbs	• Choose • Define • Find • How • Label • List • Match • Name • Omit • Recall • Relate • Select • Show • Spell • Tell • What • When • Where • Which • Who • Why	• Classify • Compare • Contrast • Demonstrate • Explain • Extend • Illustrate • Infer • Interpret • Outline • Relate • Rephrase • Show • Summarize • Translate	• Apply • Build • Choose • Construct • Develop • Experiment with • Identify • Interview • Make use of • Model • Organize • Plan • Select • Solve • Utilize	• Analyze • Assume • Categorize • Classify • Compare • Conclusion • Contrast • Discover • Dissect • Distinguish • Divide • Examine • Function • Inference • Inspect • List • Motive • Relationships • Simplify • Survey • Take part in • Test for • Theme	• Agree • Appraise • Assess • Award • Choose • Compare • Conclude • Criteria • Criticize • Decide • Deduct • Defend • Determine • Disprove • Estimate • Evaluate • Explain • Importance • Influence • Interpret • Judge • Justify • Mark • Measure • Opinion • Perceive • Prioritize • Prove • Rate • Recommend • Rule on • Select • Support • Value	• Adapt • Build • Change • Choose • Combine • Compile • Compose • Construct • Create • Delete • Design • Develop • Discuss • Elaborate • Estimate • Formulate • Happen • Imagine • Improve • Invent • Make up • Maximize • Minimize • Modify • Original • Originate • Plan • Predict • Propose • Solution • Solve • Suppose • Test • Theory

Anderson, L. W., & Krathwohl, D. R. (2001). A taxonomy for learning, teaching, and assessing. Abridged Edition. Boston, MA: Allyn and Bacon.

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DEPARTMENT OF MECHANICAL ENGINEERING

Assessment Process of COs, POs & PSOs

COURSE OUTCOME ASSESSMENT PROCESS:

The Key aspects in Outcome-Based Education (OBE) are the assessment of Course Outcomes. At the initial stage of OBE implementation, the Course Outcomes (COs) for each course are defined based on the Program Outcomes (POs) and other requirements. At the end of each course, the COs need to be assessed and evaluated to check whether they have been attained or not.

The process of attainment of COs, POs and PSOs starts from writing appropriate COs for each course of the program from first year to fourth year in a four-year engineering degree program. The course outcomes are written by the respective faculty member using action verbs of learning levels suggested by Bloom and Anderson. Then, a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high). A mapping matrix is prepared in this regard for every course in the program including the elective subjects. The course outcomes written and their mapping with POs are reviewed frequently by a committee of senior faculty members before they are finalized.

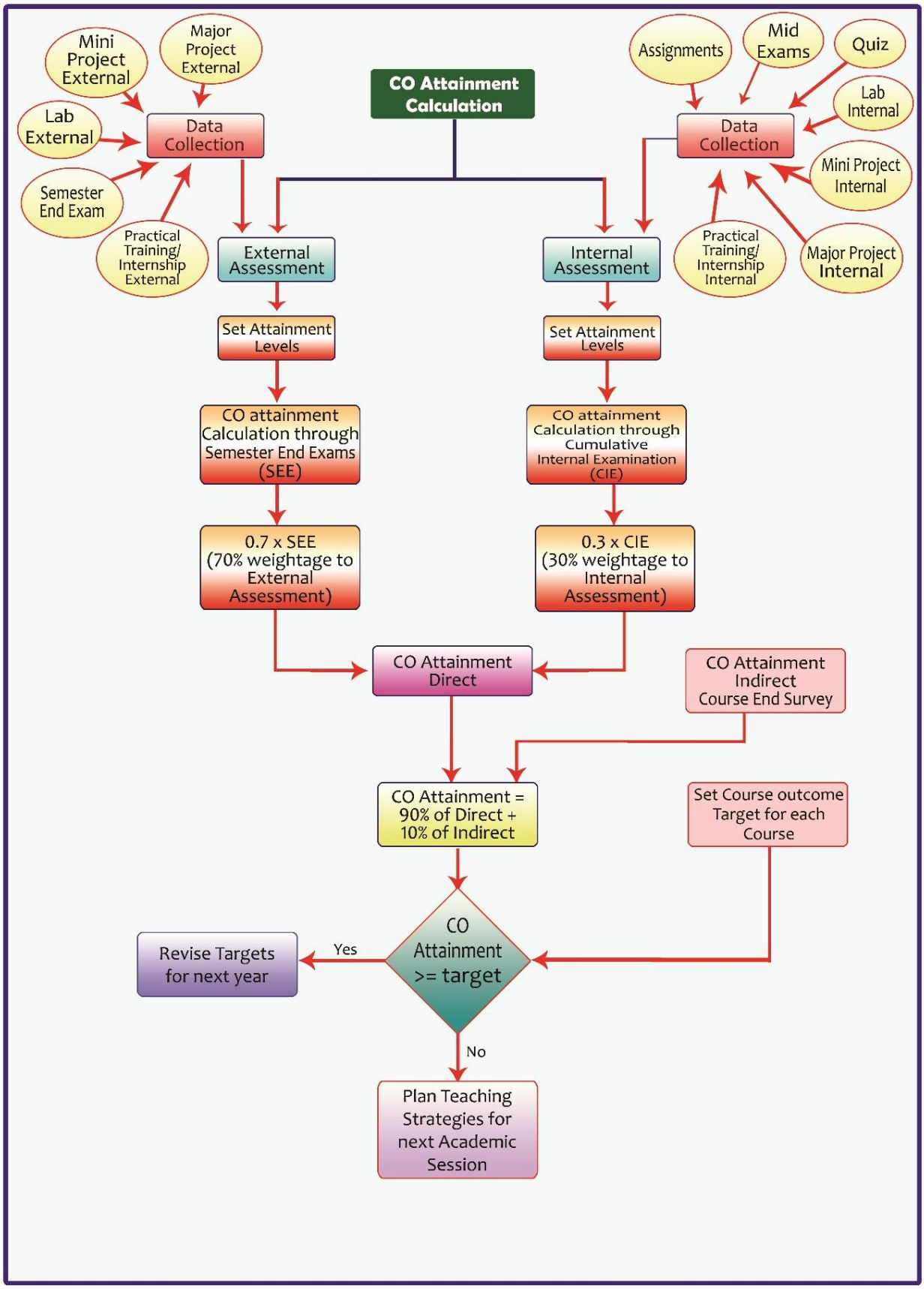
Assessment is one or more processes carried out by the department, which identify, collect and prepare data to evaluate the achievement of POs and Program Specific Outcomes (PSOs). Attainment is the action or fact of achieving a standard result towards accomplishment of desired goals. Primarily attainment is the standard of academic attainment as observed by examination results.

Course Outcomes (COs): Statements indicating what a student can do after the successful completion of a course. Every Course leads to some Course Outcomes. The CO statements are defined by considering the course content covered in each module of a course. For every course there may be 3 or 6 COs. The keywords used to define COs are based on Bloom's Taxonomy.

Attainment of the COs can be measured directly and indirectly. Direct attainment displays the student's knowledge and skills from their performance. It can be determined from the performance of the students in all the relevant assessment instruments like internal assessments, assignments, quiz and final examinations. These methods provide a sampling of what students know and/or can do and provide strong evidence of student learning.

Indirect methods such as Course End Surveys ask the students to reflect on their learning. They access opinions or thoughts about the graduate's knowledge or skills. Indirect measures can provide information about graduate's perception of their learning and how this learning is valued by different stakeholders.

CO ATTAINMENT CALCULATION PROCESS



CO ATTAINMENT CALCULATION PROCESS

CO Attainment using Direct Assessment:

Direct CO Attainment is calculated based on internal and external examinations.

Direct CO Attainment % = 30% of CIE + 70% of SEE.

EXTERNAL EXAMINATION ASSESSMENT PROCESS:

External Examination Assessment Format			
Course Name: XXXXX			
Sub Code: XXXX		Course Code: CXXX	Year/Sem: XX
S.No	**Roll. No**	**External Grades**	**Attainment Level**
1	xxxxxxxxxx	B	3
2	xxxxxxxxxx	C	2
3	xxxxxxxxxx	E	1
4	xxxxxxxxxx	A	3
Average Attainment Level			**2.25**

RUBRICS:

If Grade "A+" (>90), "A"(80 to 89) and "B" (70 to 79) : Attainment Level is 3
If Grade "C"(60 to 69) and "D" (50 to 59) : Attainment Level is 2
If Grade "E"(40 to 49) and "F" (<40) : Attainment Level is 1

INTERNAL EXAMINATION ASSESSMENT:

Internal Examination Assessment																												
Course Code: CXXX								Course Name:XXXXX											Year/Sem: X/X										
S.No	Roll. No	Test	Mid1			A1	Quiz 1	Mid2				A2	Quiz 2	CO I			CO II			CO III			CO IV			CO V		
		Q.No	1	2	3			1	2	3				Max. Mark	% of Marks	A. L.	Max. Marks	% of Marks	A. L.	Max. Marks	% of Marks	A. L.	Max. Marks	% of Marks	A. L.	Max. Mark	% of Marks	A. L.
			1.a	2.a	3.a			1.a	2.a	3.a																		
		COs	I	II	III	I		III	IV	V																		
		Max. Marks	10	10	5	5	10	5	10	10	5	10		19.00	100		14.00	100		16.50	100		16.50	100		14.00	100	
1	xxxxxxxxxx		9	4	2	4	7	5	7	4	4	6		16.13	85	3	6.80	49	1	11.60	70	3	11.40	69	2	6.40	46	1
2	xxxxxxxxxx		4	5	3	5	6	4	7	6	5	7		11.40	60	2	7.40	53	2	12.10	73	3	12.30	75	3	8.80	63	2
3	xxxxxxxxxx		6	9	3	4	9	5	5	7	4	5		13.60	72	3	12.93	92	3	12.80	78	3	9.00	55	2	9.00	64	2
4	xxxxxxxxxx		5	4	1	5	8	4	4	4	3	8		13.20	69	2	7.20	51	2	9.70	59	2	8.70	53	2	7.20	51	2
Attainment Level														CO I		2.50	CO II		2.00	CO III		2.75	CO IV		2.25	CO V		1.75

RUBRICS:

If % of CO Marks ≥ 70% : Attainment Level 3
If % of CO Marks Between 50% to 69%: Attainment Level 2
If % of CO Marks ≤ 49%: Attainment Level 1

CO Attainment using Indirect Assessment:

It is based on course end survey. A google form is created to take the course end survey at the end of each semester for Indirect Assessment.

Indirect Survey						
Course Name: XXXXXX						
Sub Code: XXXX		**Course Code: CXXX**			**Year/Sem: X/X**	
S.No	**Roll. No**	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
1	xxxxxxxxxx	3	3	2	3	1
2	xxxxxxxxxx	3	1	3	3	3
3	xxxxxxxxxx	2	2	2	2	1
4	xxxxxxxxxx	3	3	3	3	3
Average		**2.75**	**2.25**	**2.50**	**2.75**	**2.00**

Total CO Attainment:

CO Attainment % = 90% of Direct CO Attainment + 10% of Indirect CO Attainment.

CO Attainment							
Course Code: CXXX		**Course Name:XXXXX**			**Year/Sem: X/X**		
CO	**CO Attainment Level (Internal)**	**CO Attainment Level (External)**	**Direct CO Attainment Level (Internal * 30%) + (External * 70%)**	**Indirect CO Attainment Level**	**Total CO Attainment Level (Direct CO Attainment * 90% + Indirect CO Attainment * 10%)**	**CO Target Level**	**CO Target Attained or not**
CXXX.1	2.50	2.25	2.33	2.75	2.37	2.10	YES
CXXX.2	2.00	2.25	2.18	2.25	2.18	2.10	YES
CXXX.3	2.75	2.25	2.40	2.50	2.41	2.10	YES
CXXX.4	2.25	2.25	2.25	2.75	2.30	2.10	YES
CXXX.5	1.75	2.25	2.10	2.50	2.14	2.10	YES
CXXX					2.28	2.10	YES

PROCESS INVOLVED IN CO-PO MAPPING

COURSE ALLOTMENT
The department Hod allots courses to the respective faculty members.

▼

CO–PO/PSO MAPPING
The course instructor, course coordinator and module coordinator maps each CO with the relevant Program Outcomes (POs) and Program specific Outcomes (PSOs).

▼

REVIEW AND VERIFICATION
DAC review the relevance of each proposed mapping and verify that the strength of correlation is justified by the knowledge and skills addressed in the CO.

▼

YEAR-WISE CONSOLIDATION AND DOCUMENTATION
The program coordinator consolidates the CO–PO/PSO mapping

▼

SUBMISSION OF CO Attainment, PO Attainment and PSO Attainment
The course instructor submits the consolidated records and supporting documents to the program coordinator.

▼

FINAL OBE DOCUMENTATION AND REVIEW
PO attainment and PSO attainment records are consolidated and reviewed under the guidance of the DAC.

FORMULATION OF COURSE ARTICULATION MATRIX:

Course Articulation Matrix correlates the individual COs of a course with POs and PSOs. The Course Outcomes are mapped with POs and PSOs in the scale of 1 to 3. The strength of correlation is indicated as 3 for **substantial (high)** 2 for correlation, **moderate (medium)** correlation, and 1 for **slight (low)** correlation.

A typical CO-PO mapping and CO-PSO mapping table is shown below.

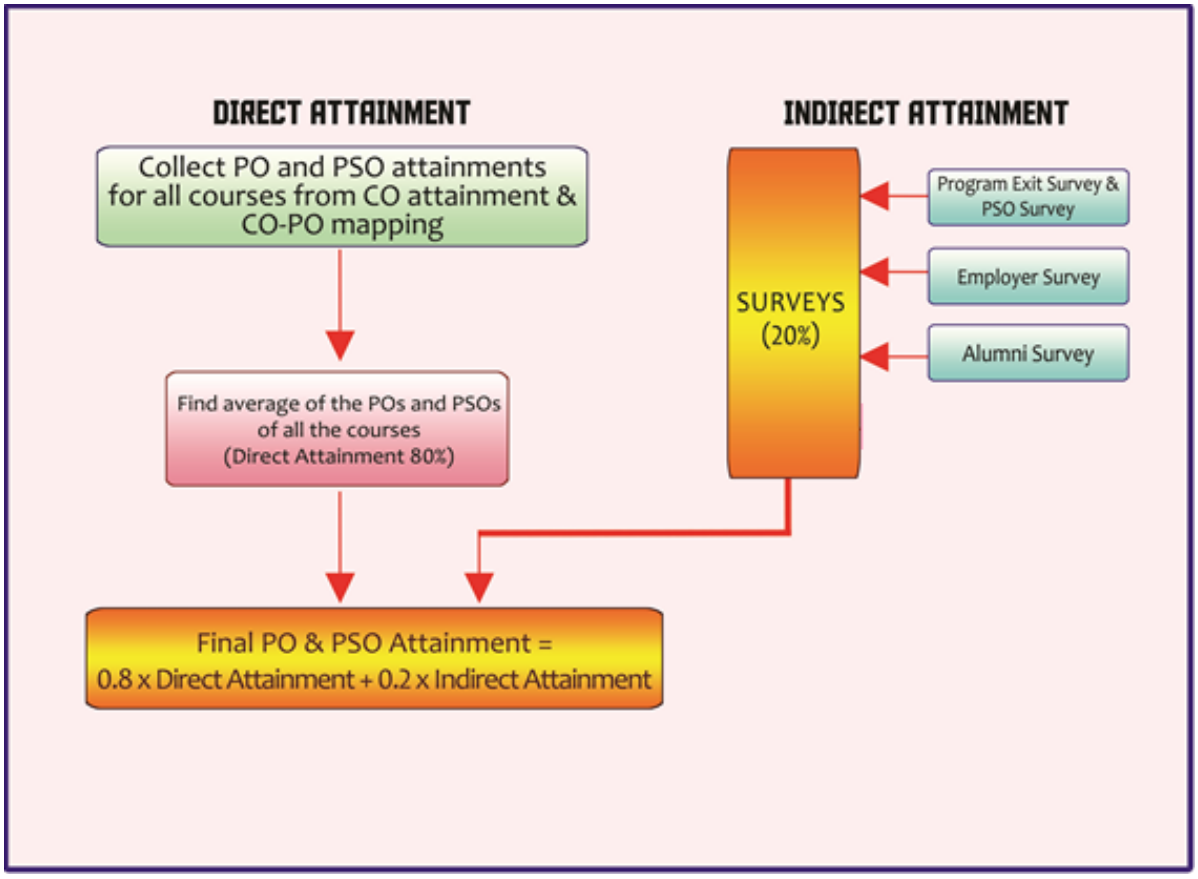
Course Name: FINITE ELEMENT METHODS		Course Code: C416
CO	**After successful completion of this course, the students will be able to:**	
C416.1	**Apply** the knowledge of Differential calculus to solve problems related to structural engineering **by** approximate methods.	
C416.2	**Analyze** finite element method to solve problems in one dimensional bar element problems.	
C416.3	**Evaluate** finite element method for trusses and beams.	
C416.4	**Develop** finite element method for 2-D CST element, numerical integration.	
C416.5	**Evaluate** the rate of heat transfer and temperature distribution in thin plates and fin the longitudinal and transverse vibrations by Eigen values and Eigen vectors.	

Course Code: CXXX		Course Name: XXXXX										Year/Sem: X/X			
CO-PO & CO-PSO Mapping															
COs	Total CO Attainment Level	POs & PSOs													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CXXX.1	2.37	3	2	1	1	2	-	-	-	-	-	-	2	-		3
CXXX.2	2.18	3	3	2	2	3	-	-	-	-	-	-	2	-		3
CXXX.3	2.41	3	3	3	3	3	-	-	-	-	-	-	2	-		3
CXXX.4	2.30	3	3	3	3	3	-	-	-	-	-	-	2	-		3
CXXX.5	2.14	3	3	3	3	3	-	-	-	-	-	-	2	-	3	2

ATTAINMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

ASSESSMENT TOOLS & PROCESSES:

Programme outcome (PO) attainment process and Programme specific outcome (PSO) attainment process is done through direct and indirect assessment tools. 80% of direct attainment and 20% of indirect attainment is considered for calculation of PO attainment and PSO attainment. The PO and PSO Attainment process is diagrammatically shown in the below figure.



PO AND PSO ATTAINMENT PROCESS

Assessment tools and process used for evaluation of Program Outcomes and Program Specific Outcomes are presented below.

Following are the different methods for Assessment, Evaluation and Measurement of POs/PSOs:

- **Direct Assessment methods**
- **Indirect Assessment methods**

DIRECT ASSESSMENT METHODS:

Continuous Assessment: COs are assessed through Sessional & Assignment Examinations and Lab records. The COs are mapped against each question and CO analysis is carried out by faculty for each course and documented. The contribution of COs are assessed in high, moderate and low levels, towards the attainment of POs/PSOs.

Semester-end Theory Examinations: The questions in semester-end examinations are tested pertaining to all COs, in varying Blooms Taxonomy Levels.

Laboratory Records: Both continuous and semester-end examinations are conducted to test the COs attainment.

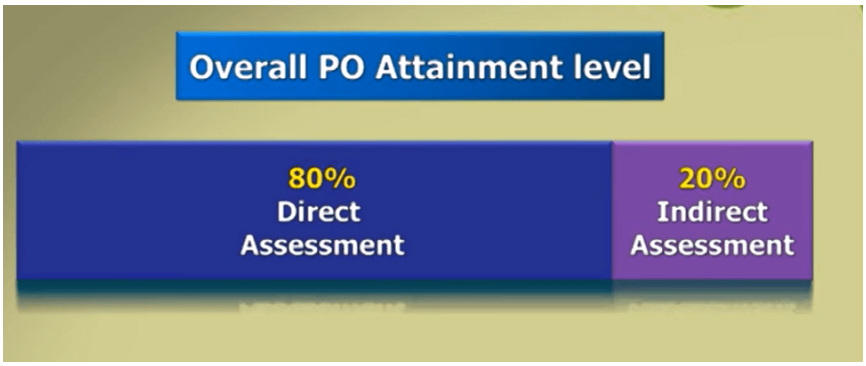
INDIRECT ASSESSMENT METHODS:

Programme – Exit survey: This survey taken from the final year students at the completion of their B.Tech programme, stands as the comprehensive feedback for the PO/PSO assessment

Alumni Survey: This survey is conducted annually through Google link or mail with the Alumni to obtain the inputs and suggestions on PO attainment in the real time societal environment

Employer Survey: This survey is taken from the employer to measure the PO attainments.

OVERALL LEVELS OF ATTAINMENT:



PO attainment is calculated with the following formula:

1. Copy CO - PO matrix and CO attainment matrix from previous pages and find PO attainment.
2. PO attainment is calculated as per the following formula:

$$PO\ Direct\ Assessment\ = \frac{\sum(level\ of\ mapping\ of\ PO\ with\ CO\ \times\ CO\ attainment)}{\sum(level\ of\ Mapping\ of\ PO\ with\ CO)}$$

PO Attainment = SUM (POi * COi) / (SUM (POi)) where 'i' ranges from 1 to 5

PSO attainment is calculated with the following formula:

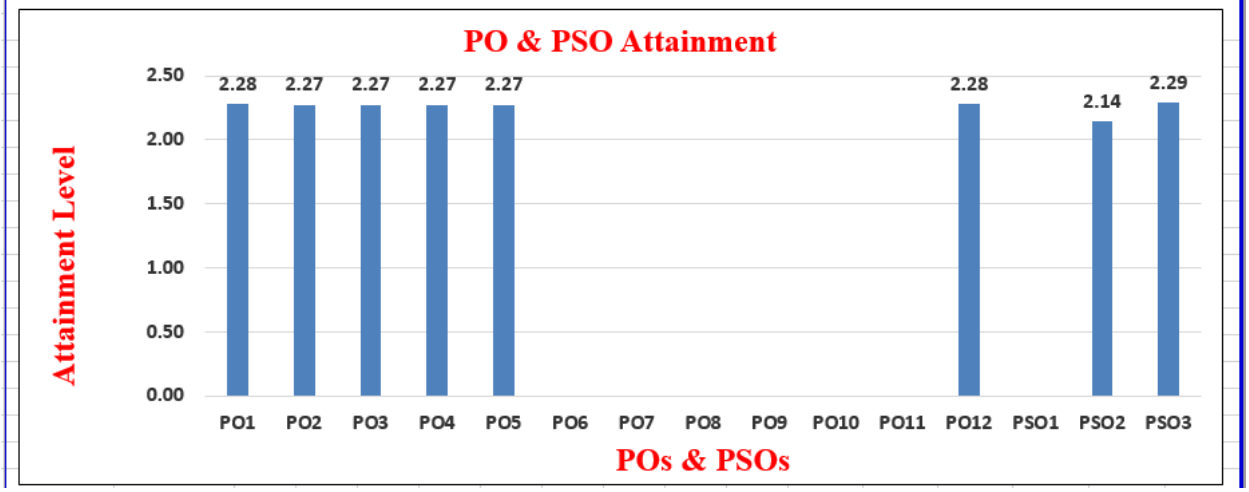
1. Copy CO - PSO matrix and CO attainment matrix from previous pages and find PSO attainment.
2. PSO attainment is calculated as per the following formula:

$$PSO\ Direct\ Assessment\ = \frac{\sum(level\ of\ mapping\ of\ PSO\ with\ CO\ \times\ CO\ attainment)}{\sum(level\ of\ Mapping\ of\ PSO\ with\ CO)}$$

PSO Attainment = SUM (PSOi * COi) / (SUM (PSOi)) where 'i' ranges from 1 to 5

PO & PSO Attainment

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PO Attainment	2.28	2.27	2.27	2.27	2.27	-	-	-	-	-	-	2.28		2.14	2.29



NARASARAOPETA ENGINEERING COLLEGE
(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

B.TECH

R20 REGULATION

COURSE OUTCOMES

NARASARAOPETA ENGINEERING COLLEGE
(AUTONOMOUS)

DEPARTMENT OF MECHANICAL ENGINEERING

B.TECH – R20 REGULATION - COURSE OUTCOMES

I B. TECH I SEMESTER

Course Name: ENGINEERING CHEMISTRY	Course Code: C111
CO	**After successful completion of this course, the students will be able to:**
C111.1	**Analyze** the suitable method of water treatment depending on the quality treatment.
C111.2	**Compare** different types of polymers, fuels and their importance.
C111.3	**Utilize** the advanced materials as engineering materials and apply them in domestic and industrial life.
C111.4	**Distinguish** electrical energy sources and importance of corrosion science.
C111.5	**Identify** different types of engineering materials and applications in engineering.

Course Name: LINEAR ALGEBRA AND CALCULUS	Course Code: C112
CO	**After successful completion of this course, the students will be able to:**
C112.1	**Solve** the system of linear equations.
C112.2	**Analyze** the applications of matrices in various fields and obtain Eigen values and Eigenvectors.
C112.3	**Relate** the results of mean value theorems in calculus to Engineering problems.
C112.4	**Apply** the functions of several variables to evaluate the rates of change with respect to time and space variables in engineering.
C112.5	**Identify** the area and volume by interlinking them to appropriate double and triple integrals.

Course Name: TECHNICAL AND COMMUNICATIVE ENGLISH-I	Course Code: C113
CO	**After successful completion of this course, the students will be able to:**
C113.1	**Infer** explicit and implicit meaning of a text, recognize key passages; raise questions and summarize it.
C113.2	**Compose** paragraphs, essays, emails, letters, reports, resume and transfer information into tables, Pie and bar diagrams.
C113.3	**Build** grammatically correct sentences using a variety of sentence structures.
C113.4	**Enhance** word power and usage of lexicons.

Course Name: ENGINEERING MECHANICS	Course Code: C114
CO	**After successful completion of this course, the students will be able to:**
C114.1	**Apply** the principles of mechanics to determine the resultant of several concurrent forces acting on a particle.

C114.2	**Analyze** the trusses using method of joints and method of sections; apply the basic concepts of dry friction and wedges.
C114.3	**Illustrate** the centroid and center of gravity bodies and composite sections.
C114.4	**Determine** the Area Moment of Inertia and Mass Moment of Inertia of areas bodies and Composite sections
C114.5	**Apply** the work-energy principle to particles and connected systems for engineering applications.

Course Name: PROBLEM SOLVING USING PYTHON	**Course Code: C115**
CO	**After successful completion of this course, the students will be able to:**
C115.1	**Outline** the computer system concepts and the flowcharts using raptor to solve the given problems.
C115.2	**Summarize** the fundamental concepts of python programming.
C115.3	**Interpret** object oriented and event driven programming in python.
C115.4	**Apply** the suitable data structures to solve the real time situational problems.

Course Name: SOFT SKILLS AND COMMUNICATION SKILLS LAB -I	**Course Code: C116**
CO	**After successful completion of this course, the students will be able to:**
C116.1	**Communicate** effectively with good pronunciation, overcoming mother tongue influence in academic and professional environment.
C116.2	**Listen** and comprehend several accents of English Language.
C116.3	**Take** part in various conversations/discourses using formal and informal expressions.
C116.4	**Adapt** soft skills successfully in personal and professional life.

Course Name: ENGINEERING CHEMISTRY LAB	**Course Code: C117**
CO	**After successful completion of this course, the students will be able to:**
C117.1	**Develop** and perform analytical chemistry techniques to address the water related problems (hardness, alkalinity, Chlorine, DO).
C117.2	**Explain** the functioning of different analytical instruments.
C117.3	**Compare** viscosity and surface tension of different oils.
C117.4	**Measure** molecular/system properties such as strength of solutions, conductance of solutions and acid number of lubricating oils, etc.

Course Name: PROBLEM SOLVING USING PYTHON PROGRAMMING LAB	**Course Code: C118**
CO	**After successful completion of this course, the students will be able to:**
C118.1	**Create** interactive visual programs using Scratch.
C118.2	**Develop** flowcharts using raptor to solve the given problems.
C118.3	**Develop** Python programs for numerical and text based problems.
C118.4	**Develop** graphics and event based programming using Python.

I B. TECH II SEMESTER

Course Name: DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS	Course Code: C121
CO	**After successful completion of this course, the students will be able to:**
C121.1	**Apply** first order ordinary differential equations to real life situations.
C121.2	**Identify** and apply suitable methods in solving the higher order differential equations.
C121.3	**Solve** the partial differentiation equations.
C121.4	**Interpret** the physical meaning of different operators as gradient, curl and divergence.
C121.5	**Estimate** the work done against a field, circulation and flux using vector calculus.

Course Name: ENGINEERING PHYSICS	Course Code: C122
CO	**After successful completion of this course, the students will be able to:**
C122.1	**Recognize** the experimental evidence of wave nature of light and interference in thin films, Diffraction grating and Polarisation in various fields.
C122.2	**Analyze** and understand various types of lasers & optical fibers.
C122.3	**Identifies** the crystal structures and XRD techniques.
C122.4	**Knowing** the applications of magnetic and superconducting materials in engineering field.
C122.5	**Identifies** the use of Acoustics and Ultrasonics in engineering field.

Course Name: ENGINEERING DRAWING	Course Code: C123
CO	**After successful completion of this course, the students will be able to:**
C123.1	**Construc**t the geometrical shapes of regular polygons, Engineering Curves, and scales.
C123.2	**Illustrate** the orthographic projections, projections of points, and lines inclined to both the planes.
C123.3	**Construct** the projection of planes inclined to both the planes.
C123.4	**Analyze** the projection of solids and the development of surfaces for regular solids.
C123.5	**Analyze** the conversion of isometric views to orthographic views vice versa.

Course Name: ELEMENTS OF ELECTRICAL AND ELECTRONICS ENGINEERING	Course Code: C124
CO	**After successful completion of this course, the students will be able to:**
C124.1	**Analyze** the behaviour of an electrical circuit.
C124.2	**Measure** the performance quantities such as losses, efficiency of DC machines.
C124.3	**Create** the construct of transformer and Induction motor.
C124.4	**Classify** the importance and applications of p-n junction diode.
C124.5	**Evaluate** the configurations and applications of Transistor.

Course Name: MATERIAL SCIENCE AND METALLURGY	Course Code: C125
CO	**After successful completion of this course, the students will be able to:**
C125.1	**Illustrate** the knowledge related to the structure and properties of materials, crystal Systems and phase diagrams of alloys.
C125.2	**Examine** properties of ferrous materials and their engineering applications.
C125.3	**Explain** the basic concepts of Heat treatment processes and their applications.
C125.4	**Examine** nonferrous materials properties and their engineering applications.
C125.5	**Choose** the various types of ceramics, composite materials and basic steps involved in the Powder Metallurgy process.

Course Name: ELEMENTS OF ELECTRICAL AND ELECTRONICS ENGINEERING LAB	Course Code: C126
CO	**After successful completion of this course, the students will be able to:**
C126.1	**Determine** the efficiency and regulation of 1-phase transformer.
C126.2	**Compute** the performance characteristics of transformers and DC machines through suitable tests.
C126.3	**Calculate** the ripple factor of half-wave & full-wave rectifiers.
C126.4	**Gain** practical experience related to electronics circuits; stimulate more interest and Motivation for further studies of electrical circuits.

Course Name: ENGINEERING PHYSICS LAB	Course Code: C127
CO	**After successful completion of this course, the students will be able to:**
C127.1	**Understand** the principle of physics and interpret them in engineering field and compares the results with theoretical calculations.
C127.2	**Use** modern engineering physics techniques and tools in real time applications in engineering studies.
C127.3	K**now** about the characteristics and the behaviour of materials in a practical manner and gain knowledge and its usage.

Course Name: ENGINEERING WORKSHOP	Course Code: C128
CO	**After successful completion of this course, the students will be able to:**
C128.1	**Make Use** of the various carpentry tools, machines, devices used in engineering practice for preparing different carpentry joints.
C128.2	**Make Use** of the various fitting tools, machines, devices used in engineering practice for preparing different Fits.
C128.3	**Develop** different components using Tin Smithy and black smithy tools
C128.4	**Demonstrate** the various house wiring connections for different house wiring connections.
C128.5	**Demonstrate** the need of PC hardware components, applications and software.

Course Name: CONSTITUTION OF INDIA	Course Code: C129
CO	**After successful completion of this course, the students will be able to:**
C129.1	**Examine** salient features of Indian Constitution and live accordingly in society & interpret the meaning of Fundamental Rights of State Policy.
C129.2	**Discover** various aspects of Union Government legislation and live up to the expectations of the rules.
C129.3	**Examine** State Government legislation and improve your living standards by following the rules strictly.
C129.4	**Examine** powers and functions of local bodies such as Municipalities and Panchayats and, take advantage of available resources for better living.
C129.5	**Analyze** the powers and functions of Election Commission and The Union Public Service Commission and decide upon it for safe and secured life.

II B. TECH I SEMESTER

Course Name: NUMERICAL METHODS AND TRANSFORMATIONS	Course Code: C211
CO	**After successful completion of this course, the students will be able to:**
C211.1	**Evaluate** approximating roots of polynomials and transcendental equations by different algorithms.
C211.2	**Apply** Newton's forward backward and Lagrange's interpolation for equal and unequal intervals.
C211.3	**Apply** different algorithms for approximating solutions of ordinary differential equation to its analytical computations.
C211.4	**Select** appropriate technique of Laplace transforms in solving differential equations.
C211.5	**Relate** Fourier series, integral, transforms techniques in their core.

Course Name: FLUID MECHANICS AND HYDRAULIC MACHINERY	Course Code: C212
CO	**After successful completion of this course, the students will be able to:**
C212.1	**Explain** about Fluid Properties and hydrostatic forces acting on different surfaces.
C212.2	**Apply** conversation laws to fluid flow problems in engineering applications.
C212.3	**Compute** theory of Boundary layer flows, Identifies dimensionless parameters.
C212.4	**Illustrate** the force required to move the vane using by Jet.
C212.5	**Demonstrate** the turbines and its functions & Operating conditions of Centrifugal and Reciprocating pumps.

Course Name: METROLOGY AND INSTRUMENTATION	Course Code: C213
CO	**After successful completion of this course, the students will be able to:**
C213.1	**Explain** the design tolerances and fits for selected product quality.
C213.2	**Illustrate** the standards of length, angle measurement.
C213.3	**Demonstrate** the concepts of limit gauges and optical measurements.
C213.4	**Explain** of various transducers to measure displacement.
C213.5	**Analyze** various temperature and pressure transducers for engineering applications.

Course Name: THERMODYNAMICS	Course Code: C214
CO	**After successful completion of this course, the students will be able to:**
C214.1	**Illustrate** the concepts of heat, work, and forms of energy.
C214.2	**Classify** various thermal systems using thermodynamic laws and principles.
C214.3	**Apply** the laws of thermodynamics for various thermodynamic systems.
C214.4	**Evaluate** the performance parameters of pure substances and gas mixtures.
C214.5	**Analyze** different thermodynamic cycles and estimate work done and performance.

Course Name: MECHANICS OF SOLIDS	Course Code: C215
CO	**After successful completion of this course, the students will be able to:**
C215.1	**Illustrate** the concepts of stress and strain and thermal stress in members, strain energy due gradually, suddenly applied loads.
C215.2	**Analyze** shear force diagrams and bending moment diagrams to the different loads for the different support arrangements.
C215.3	**Determine** shear stresses induced in the beams which are made with different cross sections like rectangular, circular, I, T sections.
C215.4	**Solve** the equations of slope and deflection for different support arrangements by double integration method, Macaulay's method.
C215.5	**Determine** stresses induced in cylinders subjected to internal, external pressures.

Course Name: FLUID MECHANICS AND HYDRAULIC MACHINERY LAB	Course Code:C216
CO	**After successful completion of this course, the students will be able to:**
C112.1	**Experiment** with the flow discharge measuring devices used in pipes, channels and tanks.
C112.2	**Solve** the flow equations to estimate performance of the pump.
C113.3	**Evaluate** the friction factor of a pipe flow.
C114.4	**Apply** conservation principles to hydraulic machines.

Course Name: MECHANICS OF SOLIDS AND METALLURGY LAB	Course Code: C217
CO	**After successful completion of this course, the students will be able to:**
C217.1	**Experiment** with different materials for the evaluation of material properties through various destructive testing procedures.
C217.2	**Examine** the microstructures of different materials and also identify the hardness values.

Course Name: METROLOGY AND INSTRUMENTATION LAB	Course Code: C218
CO	**After successful completion of this course, the students will be able to:**
C218.1	**Examine** different instruments that are available for linear, angular and roughness measurements and select and use the appropriate measuring instrument according to a specific requirement.
C218.2	**Analyze** proper measuring instrument and know the requirement of calibration, errors in measurement

Course Name: SOLID MODELLING	Course Code: C219
CO	**After successful completion of this course, the students will be able to:**
C219.1	**Create** a model machine parts by using software packages.
C219.2	**Create** Simple Extruded Solid Models, understand the Basic Parametric modelling and Create and Edit Parametric Dimensions.

Course Name: ENVIRONMENTAL STUDIES	Course Code: C2110
CO	**After successful completion of this course, the students will be able to:**
C2110.1	**Explain** the concepts of the ecosystem and its function in the environment. The need for protecting the producers and consumers in various ecosystems and their role in the food web.
C2110.2	**Analyze** the natural resources and their importance for the sustenance of the life and recognize the need to conserve the natural resources.
C2110.3	**Explain** the biodiversity of India and the threats to biodiversity, and conservation practices to protect the biodiversity
C2110.4	**Distinguish** various attributes of the pollution, their impacts and measures to reduce or control the pollution along with waste management practices.
C2110.5	**Define** Environmental policy, legislation, environmental assessment and the stages involved in EIA Environmental audit.

II B. TECH II SEMESTER

Course Name: APPLIED THERMODYNAMICS	Course Code: C221
CO	**After successful completion of this course, the students will be able to:**
C221.1	**Illustrate** the reasons and effects of various losses that occur in the actual engine operation.
C221.2	**Analyze** the combustion phenomenon and knocking in SI and CI engines.
C221.3	**Explain** the performance and emission parameters of SI and CI engines.
C221.4	**Evaluate** the parameters of performance and measurement of IC engines.
C221.5	**Examine** the working of different types of compressors.

Course Name: COMPLEX VARIABLES, PROBABILITY AND STATISTICS	Course Code: C222
CO	**After successful completion of this course, the students will be able to:**
C222.1	**Apply** the probability concepts in their respective engineering data.
C222.2	**Apply** discrete and continuous probability distributions to solve various engineering problems.
C222.3	**Analyze** the multivariate problems in engineering.
C222.4	**Apply** the method of least squares to estimate the parameters of a regression model.
C222.5	**Determine** the confidence interval for a population parameter for single sample and two sample cases.

Course Name: KINEMATICS OF MACHINERY	Course Code: C223
CO	**After successful completion of this course, the students will be able to:**
C223.1	**Illustrate** the various types of kinematic links, kinematic joints & mechanisms.

C223.2	**Interpret** the various types of lower pair mechanisms for engineering applications.
C223.3	**Construct** the velocity and acceleration diagram of different mechanisms.
C223.4	**Construct** the different CAM profiles under motion.
C223.5	**Demonstrate** the Gears and Gear Trains.

Course Name: MANUFACTURING TECHNOLOGY	**Course Code: C224**
CO	**After successful completion of this course, the students will be able to:**
C224.1	**Explain** various manufacturing processes and fundamentals of casting process.
C224.2	**Outline** different types of welding process for fabrication of metals.
C224.3	**Demonstrate** advanced welding processes by make use of sketches.
C224.4	**Compare** the characteristics of cold and hot working processes of Forming, Forging and Rolling.
C224.5	**Explain** principles of Extrusion and Drawing processes by make use of sketches

Course Name: TECHNICAL AND COMMUNICATIVE ENGLISH-II	**Course Code: C225**
CO	**After successful completion of this course, the students will be able to:**
C225.1	**Infer** explicit and implicit meaning of a text, recognize key passages; raise questions and summarize it**.**
C225.2	**Compose** paragraphs, essays, emails, letters, reports, resume and transfer information into tables, Pie and bar diagrams.
C225.3	**Build** grammatically correct sentences using a variety of sentence structures.
C225.4	**Enhance** word power and usage of lexicons.

Course Name: MACHINE DRAWING LAB	**Course Code: C226**
CO	**After successful completion of this course, the students will be able to:**
C226.1	**Explain** about sectional views, limits, fits and tolerances, screw fasteners, keys, cotter Joints, bearings.
C226.2	**Construct** assembly drawings of engine parts, machine pars, and valves

Course Name: APPLIED THERMODYNAMICS LAB	**Course Code: C227**
CO	**After successful completion of this course, the students will be able to:**
C227.1	**Examine** the performance and emission parameters of SI and CI engines.
C227.2	**Evaluation** of engine friction by conducting Morse test on 4-stroke multi cylinder petrol engine.
C227.3	**Analyze** Performance test on reciprocating air compressor unit.

Course Name: MANUFACTURING TECHNOLOGY LAB	**Course Code: C228**
CO	**After successful completion of this course, the students will be able to:**
C228.1	**Prepare** and **Test** different green sand mold and welding joints.
C228.2	**Experiment** on injection molding machines and different mechanical presses.

Course Name: COMPUTER AIDED ENGINEERING LAB	Course Code: C229
CO	**After successful completion of this course, the students will be able to:**
C229.1	**Solve** simple structural, heat and fluid flow problems using standard FEA software.
C229.2	**Analysing** of various components using analytical tools like ANSYS, Fusion 360 for engineering simulation.

III B. TECH I SEMESTER

Course Name: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	Course Code:C311
CO	**After successful completion of this course, the students will be able to:**
C311.1	**Summarize** the characteristics of AI that make it useful to real-world problems.
C311.2	**Analyze** different search techniques and predicate logic in artificial Intelligence.
C311.3	**Interpret** knowledge representation and symbolic reasoning using different rules.
C311.4	**Apply** the basic knowledge on learning and reinforcement learning.
C311.5	**Explore** different machine learning algorithms.

Course Name: HEAT POWER ENGINEERING	Course Code: C312
CO	**After successful completion of this course, the students will be able to:**
C312.1	**Illustrate** the various types of efficiency improvements of Rankine cycle
C312.2	**Describe** the various boilers, mountings and accessories.
C312.3	**Identify** different types of nozzles used in steam turbines.
C312.4	**Classify** different turbines based on utility and applications.
C312.5	**Discuss** gas turbines, jet propulsion and rocket propulsion.

Course Name: DESIGN OF MACHINE ELEMENTS-1	Course Code: C313
CO	**After successful completion of this course, the students will be able to:**
C313.1	**Analyze** the design considerations and stresses in machine members.
C313.2	**Solve** the problems related to strength of machine elements.
C313.3	**Apply** the engineering principles for the design of simple engineering machine members such as riveted joints, welded joints.
C313.4	**Apply** the engineering principles for the design of keys, cotters, knuckle joints and power transmission of joints.
C313.5	**Solve** the problems related to shaft coupling.

Course Name: RAPID PROTOTYPING AND 3D PRINTING (Open Elective –I)	Course Code: C314
CO	**After successful completion of this course, the students will be able to:**
C314.1	**Identify** the use of Rapid Prototyping Techniques in the manufacturing of complex Components.
C314.2	**Classify** the Stereo lithography Apparatus and its process.

C314.3	**Illustrate** the process of laminated object manufacturing and fused Deposition Modelling.
C314.4	**Explain** the Selective laser sintering process.
C314.5	**Compare** different method and discuss the effects of the Additive Manufacturing Technologies.

Course Name: OPERATIONS RESEARCH (Open Elective –I)	**Course Code: C315**
CO	**After successful completion of this course, the students will be able to:**
C315.1	**Illustrate** and **solve** linear programming problems.
C315.2	**Solve** transportation and assignment problems.
C315.3	**Select** a suitable sequencing and Solve waiting line theory problems.
C315.4	**Solve** networking models and replacement problems.
C315.5	**Analyze** game theory & Dynamic Programming.

Course Name: AUTOMOBILE ENGINEERING (Professional Elective-I)	**Course Code: C316**
CO	**After successful completion of this course, the students will be able to:**
C316.1	**Identify** chassis models for different automobile applications.
C316.2	**Understand** the concept of Ignition and Fuel supply.
C316.3	**Estimate** suitable conventional and automatic transmission system, contrast steering, braking and suspension systems.
C316.4	**Identify** the usage of Electrical vehicles / Hybrid vehicles and power plants.
C316.5	**Predict** the formation of pollution and its control methods.

Course Name: REFRIGERATION AND AIR CONDITIONING (Professional Elective-I)	**Course Code: C317**
CO	**After successful completion of this course, the students will be able to:**
C317.1	**Illustrate** of concepts of refrigeration and their applications.
C317.2	**Evaluate** the performance parameters of different types of refrigeration systems.
C317.3	**Identify** the desirable properties of refrigerant and its use in various refrigeration systems.
C317.4	**Examine** the special types of refrigeration systems.
C317.5	**Design** of Air Conditioning systems for human comfort conditions.

Course Name: METAL CUTTING AND MACHINE TOOLS (Professional Elective-I)	**Course Code: C318**
CO	**After successful completion of this course, the students will be able to:**
C318.1	**Identify** different cutting tool materials, and tool nomenclature and calculate cutting parameters to enhance tool life.
C318.2	**Explain** the construction and specification of various machine tools and apply machining economics.
C318.3	**Explain** the working of Shaping, slotting, planning, drilling, and boring machines and apply machining economics.

C318.4	**Illustrate** the working of milling machines and apply machining economics.
C318.5	**Distinguish** the working of grinding, lapping, honing, and broaching processes.

Course Name: WORK STUDY (Professional Elective-I)	**Course Code: C319**
CO	**After successful completion of this course, the students will be able to:**
C319.1	**Demonstrate** the fundamental concepts of work systems and work study**.**
C319.2	**Demonstrate** the fundamental concepts of method study.
C319.3	**Analyze** the movements at workplace.
C319.4	**Explain** work measurement and time study.
C319.5	**Explain** work sampling and predetermined time standards. Predetermined motion time measurement (MTM).

Course Name: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LAB	**Course Code: C3110**
CO	**After successful completion of this course, the students will be able to:**
C3110.1	**Apply** various pre-processing Techniques on the given data.
C3110.2	**Construct** regression models for a given data.
C3110.3	**Build** classification models for a given data.

Course Name: HEAT POWER ENGINEERING LAB	**Course Code: C3111**
CO	**After successful completion of this course, the students will be able to:**
C3111.1	**Demonstrate** the various horse powers, Calorific values, emissions of IC engines.
C3111.2	D**etermine** the various efficiencies and energy balance for several types of Internal Combustions Engines and compressors.

Course Name: ROBOTICS & 3D PRINTING LAB	**Course Code: C3112**
CO	**After successful completion of this course, the students will be able to:**
C3112.1	**Model** and manufacture mechanical components using 3D printer.
C3112.2	**Operate** a robot efficiently.

Course Name: PROFESSIONAL ETHICS AND HUMAN VALUES	**Course Code: C3113**
CO	**After successful completion of this course, the students will be able to:**
C3113.1	**Interpret** the fundamentals of Human values.
C3113.2	**Analyse** the ethical issues and role of engineers in industry.
C3113.3	**Develop** the principles of harmony in value education.
C3113.4	**List** out the duties and rights of engineers.
C3113.5	**Summarise** the engineer's responsibilities towards safety and risk.

Course Name: INTERNSHIP/ COMMUNITY SERVICE PROJECT	**Course Code: C3114**
CO	**After successful completion of this course, the students will be able to:**
C3114.1	**Apply** engineering concepts acquired in the classroom to actual industrial conditions.

C3114.2	**Develop** an increased sense of social responsibility.
C3114.3	**Apply** academic learning to real-life events.
C3114.4	**Improve** lifelong communication, interpersonal, and critical thinking skills.

III B. TECH II SEMESTER

Course Name: DESIGN OF MACHINE ELEMENTS -II	**Course Code: C321**
CO	**After successful completion of this course, the students will be able to:**
C321.1	**Apply** the design procedure to engineering problems, including the consideration of technical and manufacturing constrains of bearings.
C321.2	**Identify** the loads and stresses while designing the connecting rod and crank shaft.
C321.3	**Analyze** stresses on the piston and cylinder depending upon Design and proportions.
C321.4	**Identify** the loads and machine members subjected and calculate static and dynamic stresses to ensure safe design.
C321.5	**Compare** capacities of power transmission of Belt, Rope and Chain Drives.

Course Name: HEAT TRANSFER	**Course Code: C322**
CO	**After successful completion of this course, the students will be able to:**
C322.1	**Illustrate** various modes of heat transfer.
C322.2	**Analyze** various methods of heat transfer using extended surfaces and fins.
C322.3	**Estimate** heat loss from the system to the surroundings using convection.
C322.4	**Determine** various methods of design of heat exchangers.
C322.5	**Estimation** of radiation heat transfer between bodies.

Course Name: DYNAMICS OF MACHINERY	**Course Code: C323**
CO	**After successful completion of this course, the students will be able to:**
C323.1	**Analyse** the effect of precession motion on the stability of motor cycles, aero planes and ships, under gyroscope
C323.2	**Compute** the frictional losses and transmission in clutches and Brakes.
C323.3	**Analyze** the stability of different types of governors under dynamic analysis and study
C323.4	**Analyze** balancing of rotating and reciprocating masses for primary and secondary forces by analytical and graphical methods
C323.5	**Analyse** balancing of reciprocating masses for primary and secondary forces by analytical and graphical methods

Course Name: ADVANCED MECHANICS OF SOLIDS (Professional Elective-II)	**Course Code: C324**
CO	**After successful completion of this course, the students will be able to:**
C324.1	**Illustrate** the theories of stress strain relations for engineering applications
C324.2	**Analyze** bending stresses in beams subjected to unsymmetrical bending.
C324.3	**Analyze** the radial stress in curved beams subjected to concentrated and uniform loads.

C324.4	**Analyze** stresses induced cylindrical bending of thin rectangular plates by classical methods.
C324.5	**Illustrate** the torsion of thin wall torsion members subjected to multiple connected cross sections.

Course Name: NON- CONVENTIONAL SOURCES OF ENERGY (Professional Elective-II)	**Course Code: C325**
CO	**After successful completion of this course, the students will be able to:**
C325.1	**Describe** the environmental aspects of non-conventional energy resources.
C325.2	**Describe** the use of solar energy and the various components used in the energy production with respect to applications.
C325.3	**Appreciate** the need of Wind Energy, OTEC and the various components used in energy generation and know the classifications.
C325.4	**Illustrate** the concept of geothermal energy resources.
C325.5	**Acquire** the knowledge of fuel cells and its applications.

Course Name: QUALITY CONCEPTS IN DESIGN (Professional Elective-II)	**Course Code: C326**
CO	**After successful completion of this course, the students will be able to:**
C326.1	**Apply** the knowledge of Differential calculus to solve problems related to the field of structural and thermal engineering by approximate and numerical methods
C326.2	**Design** a new component or improve the existing components using FEA
C326.3	**Solve** the problems in solid mechanics and heat transfer using FEM
C326.4	**Identify, formulate**, and solve engineering problems
C326.5	**Use** the techniques, skills, and modern engineering tools necessary for engineering practice.

Course Name: ROBOTICS AND APPLICATIONS (Professional Elective-II)	**Course Code: C327**
CO	**After successful completion of this course, the students will be able to:**
C327.1	**Distinguish** between automation and robotics and identify various components of robot.
C327.2	**Select** appropriate type of actuators and sensors for different applications.
C327.3	**Analyze** kinematics of a robot
C327.4	**Analyze** Dynamics of a robot
C327.5	**Illustrate** present and future applications of robots.

Course Name: INDUSTRIAL ENGINEERING & MANAGEMENT (Open Elective –II)	**Course Code: C328**
CO	**After successful completion of this course, the students will be able to:**
C328.1	**Differentiate** industrial engineering and industrial engineer, Taylor's and Fayol's principles**.**
C328.2	**Design** a system of organizational structures to achieve desired needs.
C328.3	Understand the techniques, skills on how to provide wages and incentives for the labourers.
C328.4	**Evaluate** the concept of resource management and job evaluation techniques and benefits.
C328.5	**Apply** concepts of operations management for design of industry layout.

Course Name: INDUSTRIAL ROBOTICS (Open Elective –II)	Course Code: C329
CO	**After successful completion of this course, the students will be able to:**
C329.1	**Identify** Robot terminology and importance.
C329.2	**Select** appropriate type of actuators for different applications.
C329.3	**Choose** appropriate sensors for different applications.
C329.4	**Analyse** the kinematics of robot related to transformations.
C329.5	**Illustrate** present and future applications for robots

Course Name: HEAT TRANSFER LAB	Course Code: C3210
CO	**After successful completion of this course, the students will be able to:**
C3210.1	**Evaluate** the amount of heat exchange for plane, cylindrical & spherical geometries.
C3210.2	**Compare** the performance of extended surfaces and heat exchangers.

Course Name: MACHINE TOOLS AND MACHINE DYNAMICS LAB	Course Code: C3211
CO	**After successful completion of this course, the students will be able to:**
C3211.1	**Illustrate** the working of lathe, shaper, and planner, drilling, milling and grinding machines.
C3211.2	**Analyze** the forces acting on cutting tools for different machines.
C3211.3	**Analyze** the static and dynamic analysis by balancing.
C3211.4	**Determine** the natural frequency of vibration of the vibrating system.

Course Name: PNEUMATICS AND HVAC LAB	Course Code: C3212
CO	**After successful completion of this course, the students will be able to:**
C3212.1	**Identify** various components of pneumatic systems.
C3212.2	**Select** pump and actuators for fluid operated systems.
C3212.3	**Develop** different pneumatic circuits for simple applications
C3212.4	**Design** the cooling load requirements of a given Area/Building

Course Name: ENGLISH FOR EMPLOYABILITY SKILLS	Course Code: C3213
CO	**After successful completion of this course, the students will be able to:**
C3213.1	**Write** effective Resume for employment.
C3213.2	**Make** formal presentations using relevant technical style of communication and appropriate strategies for both academic and professional purpose.
C3213.3	**Participate** in Group Discussions using analytical and problem solving skills.
C3213.4	**Face** job interviews confidently and **enhance** employability.

Course Name: ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	Course Code: C3214
CO	**After successful completion of this course, the students will be able to:**
C3214.1	**Interpret** the philosophy of Indian Culture.

C3214.2	**Interpret** the Indian languages, Epics Ramayana and Mahabharata.
C3214.3	**Analyze** the information about Indian arts and architecture.
C3214.4	**Analyze** the spread of cultural exchange in abroad.
C3214.5	**Analyze** the contributions of scientists in different eras.

IV B. TECH I SEMESTER

Course Name: DIGITAL MANUFACTURING (Professional Elective-III)	**Course Code: C411**
CO	**After successful completion of this course, the students will be able to:**
C411.1	**Illustrate** the concepts and learn the tenets of smart manufacturing.
C411.2	**Interpret** agile manufacturing systems and smart manufacturing standards.
C411.3	**Analyze** implemented automated manufacturing systems.
C411.4	**Compare** different concepts for multi-machine systems.
C411.5	**Choose** the opportunities, challenges brought about by Industry 4.0

Course Name: DESIGN FOR MANUFACTURING (Professional Elective-III)	**Course Code: C412**
CO	**After successful completion of this course, the students will be able to:**
C412.1	**Design** components for machining.
C412.2	**Simulate** the casting design and choose the best casting process for a specific product.
C412.3	**Evaluate** the effect of thermal stresses in weld joints.
C412.4	**Design** components for sheet metal work by understanding in depth the sheet metal processes and their formation mechanisms.
C412.5	**Design** plastic components for machining and joining and selecting a proper processes for different joining cases.

Course Name: POWER PLANT ENGINEERING (Professional Elective-III)	**Course Code: C413**
CO	**After successful completion of this course, the students will be able to:**
C413.1	**Explain** the layout, construction and working of the components inside a thermal power plant.
C413.2	**Illustrate** the components inside a Diesel, Gas and Combined cycle power plants.
C413.3	**Analyze** the concepts and flows and processes of different power plants.
C413.4	**Enumerate** the types of power production from renewable energy
C413.5	**Examine** the economics of power plants.

Course Name: OPTIMIZATION TECHNIQUES (Professional Elective-III)	**Course Code: C414**
CO	**After successful completion of this course, the students will be able to:**
C414.1	**Use** the various techniques of optimization and provide an optimum solution to the problems involving the design of machine elements.
C414.2	**Discrete** the type of problems and optimize as per the requirements.

C414.3	Assess the search methods and **provide** local and/or global maxima or minima.
C414.4	**Analyze** stresses and the deflection of curved flexural members like chain links and crane hooks.
C414.5	**Apply** the knowledge of optimization in designing of various machine elements and systems.

Course Name: TOTAL QUALITY MANAGEMENT (Professional Elective-III)	**Course Code: C415**
CO	**After successful completion of this course, the students will be able to:**
C415.1	**Interpret** Quality Management principles and process.
C415.2	**Distinguish** different TQM principles of Leadership, Motivation, Team work and supplier relationship.
C415.3	**Identify** and Recommend appropriate type of TQM tools for various industries.
C415.4	**Choose** various Quality charts, Quality functions and TPM concepts.
C415.5	**Select** various quality management systems.

Course Name: FINITE ELEMENT METHODS (Professional Elective-IV)	**Course Code: C416**
CO	**After successful completion of this course, the students will be able to:**
C416.1	**Apply** the knowledge of Differential calculus to solve problems related to structural engineering by approximate methods.
C416.2	**Analyze** finite element method to solve problems in one dimensional bar element problems.
C416.3	**Evaluate** finite element method for trusses and beams.
C416.4	**Develop** finite element method for 2-D CST element, numerical integration.
C416.5	**Evaluate** the rate of heat transfer and temperature distribution in thin plates and fin the longitudinal and transverse vibrations by Eigen values and Eigen vectors.

Course Name: EXPERIMENTAL STRESS ANALYSIS (Professional Elective-IV)	**Course Code: C417**
CO	**After successful completion of this course, the students will be able to:**
C417.1	**Illustrate** the three-dimensional stress strain relations for engineering applications.
C417.2	**Experiment with** recording instruments at different levels of frequencies for static and dynamic recording and birefringent coatings.
C417.3	**Examine** the brittle coating stresses by brittle coating analysis and moiré-fringe analysis.
C417.4	**Illustrate** the Photo elasticity materials and isochromatic fringes for engineering applications.
C417.5	**Analyze the** three dimensional Photo elasticity models by Frozen-stress method, the scattered-light method.

Course Name: SOLAR ENERGY SYSTEMS (Professional Elective-IV)	**Course Code: C418**
CO	**After successful completion of this course, the students will be able to:**
C418.1	**Understand** the potential and importance of non-conventional energy sources, concept of solar radiation and Energy conversion.
C418.2	**Understand** the concept of solar radiation and Flat plate collectors.

C418.3	**Understand** the concept of solar radiation and concentric tube collectors.
C418.4	**Understand** PV technology principles and techniques of various solar cells / materials for energy conversion
C418.5	**Understand** the concepts of solar energy storage and Industrial applications.

Course Name: BIG DATA ANALYTICS (Professional Elective-IV)	**Course Code: C419**
CO	**After successful completion of this course, the students will be able to:**
C419.1	**Interpret** the architectural elements of big data and Hadoop framework.
C419.2	**Analyse** various big data applications using map reduce programming module.
C419.3	**Analyse** Spark capabilities such as distributed datasets, in-memory caching, and the interactive shell.
C419.4	**Summarize** Spark's powerful built-in libraries, including Spark SQL, Spark Streaming.
C419.5	**Analyze** Hadoop data with PIG and Hive. **Interpret** the applications and architecture of Mobile Computing and multiplexing techniques.

Course Name: AUTOMATION IN MANUFACTURING (Professional Elective-IV)	**Course Code: C4110**
CO	**After successful completion of this course, the students will be able to:**
C4110.1	**Illustrate** the basic concepts of automation in machine tools.
C4110.2	**Analyze** various automated flow lines, Explain assembly systems and line balancing methods.
C4110.3	**Describe** the importance of automated material handling and storage systems.
C4110.4	**Interpret** the importance of adaptive control systems and varies parameters.
C4110.5	**Describe** the importance of automated inspection systems. And machine vision.

Course Name: INDUSTRIAL ENGINEERING & MANAGEMENT (Professional Elective-V)	**Course Code: C4111**
CO	**After successful completion of this course, the students will be able to:**
C4111.1	**Differentiate** industrial engineering and industrial engineer, Taylor's and Fayol's principles.
C4111.2	**Design** a system of organizational structures to achieve desired needs.
C4111.3	**Understand** the techniques, skills on how to provide wages and incentives for the labourers.
C4111.4	**Evaluate** the concept of resource management and job evaluation techniques and benefits.
C4111.5	**Apply** concepts of operations management for design of industry layout.

Course Name: MECHANICAL VIBRATIONS (Professional Elective-V)	**Course Code: C4112**
CO	**After successful completion of this course, the students will be able to:**
C4112.1	**Illustrate** the natural frequency of free longitudinal vibrations of systems by using energy principles.
C4112.2	**Determine** Natural frequency of free transverse vibrations over a shaft under Point loads, uniform distributed load and several loads.
C4112.3	**Analyze** the damped vibrations and forced vibrations to the modelled mechanical vibration

	problems.
C4112.4	**Analyze** free and forced vibration analysis of a two degree of freedom system under the formulation of equations of motion.
C4112.5	**Determine** natural frequency of free torsional vibrations of one, two and three rotor systems by using energy principles.

Course Name: WASTE HEAT RECOVERY SYSTEMS (Professional Elective-V)	**Course Code: C4113**
CO	**After successful completion of this course, the students will be able to:**
C4113.1	**Analyze** the waste heat recovery technologies developed for various thermal systems.
C4113.2	**Acquire** knowledge on waste heat recovery in heat pump, thermoelectric and HVAC systems.
C4113.3	**Apply** the economic analysis concepts for the effective implementation of waste heat recovery.
C4113.4	**Examine** the concepts of low grade heat utilization.
C4113.5	**Identify** the need for various energy storage systems in waste heat recovery applications.

Course Name: PRODUCTION PLANNING AND CONTROL (Professional Elective-V)	**Course Code: C4114**
CO	**After successful completion of this course, the students will be able to:**
C4114.1	**Apply** the systems concept for the design of production and service systems.
C4114.2	**Make use** of forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques.
C4114.3	**Understand** the principles and techniques of inventory management
C4114.4	**Choose** routing procedure and able to prepare bill of material.
C4114.5	**Understand** the importance and function of scheduling &Identify dispatching procedure and make use of computer in production planning and control.

Course Name: ELECTRIC AND HYBRID VEHICLES (Professional Elective-V)	**Course Code: C4115**
CO	**After successful completion of this course, the students will be able to:**
C4115.1	**Tabulate** different kinds HEVs.
C4115.2	**Summarize** the working of different components of HEV.
C4115.3	**Demonstrate** the components of Electric Drive Train.
C4115.4	**Identify** the functions and requirements of storage systems.
C4115.5	**Illustrate** the modelling aspects of HEVs.

Course Name: AUTOMOTIVE VEHICLES (Open Elective-III)	**Course Code: C4116**
CO	**After successful completion of this course, the students will be able to:**
C4116.1	**Illustrate** different types of chassis and body parts.
C4116.2	**Examine** the transmission systems and accessories used in automobiles.
C4116.3	**Elaborate** steering mechanisms.

C4116.4	**Analyze** different braking and suspension mechanisms.
C4116.5	**Apply** the knowledge of electrical systems in the automotive vehicles.

Course Name: NANO TECHNOLOGY (Open Elective-III)	**Course Code: C4117**
CO	**After successful completion of this course, the students will be able to:**
C4117.1	**Enumerate** basics of nano materials and technology.
C4117.2	**Illustrate** the synthesis of nano materials.
C4117.3	**Develop** an idea for preparation of nano size materials.
C4117.4	**Summarize** the knowledge on tools used in nano technology.
C4117.5	**Compare** different nano fabrication methods.

Course Name: PNEUMATICS & HYDRAULIC AUTOMATION (Open Elective-IV)	**Course Code: C4118**
CO	**After successful completion of this course, the students will be able to:**
C4118.1	**Compare** the Pneumatic and Hydraulic systems working principles and components.
C4118.2	**Explain** the performance of hydraulic actuators using cylinders.
C4118.3	**Explain** the fluid control valves working and construction.
C4118.4	**Analyze** the performance of hydraulic circuits using various hydraulic elements.
C4118.5	**Analyze** the performance of Pneumatic circuits using various Pneumatic elements

Course Name: MECHATRONICS (Open Elective-IV)	**Course Code: C4119**
CO	**After successful completion of this course, the students will be able to:**
C4119.1	**Discuss** the elements of a microcontroller as well as the operating principles of motors, sensors, and circuits commonly used in mechatronic devices
C4119.2	**Describe** the basics of Semiconductors used in mechatronics.
C4119.3	**Analyze** the Sensors and Transducers for different applications.
C4119.4	**Analyze** different logics ad logical controls.
C4119.5	**Apply** the concepts of mechatronics for various applications**.**

Course Name: BUSINESS MANAGEMENT CONCEPTS FOR ENGINEERS (Humanity & Social Science Elective)	**Course Code: C4120**
CO	**After successful completion of this course, the students will be able to:**
C4120.1	**Summarize** fundamentals of Managerial economics for decision making.
C4120.2	**Apply** concepts of Financial Accounting and BEP for business decisions.
C4120.3	**Evaluate** fundamental concepts and principles of management.
C4120.4	**Discuss** functional areas of management like HR, marketing and finance.
C4120.5	**Apply** project management techniques for project planning and evaluation.

Course Name: ENTREPRENEURSHIP & INNOVATION (Humanity & Social Science Elective)	**Course Code: C4121**

CO	After successful completion of this course, the students will be able to:
C4121.1	**Outline** the concepts of Entrepreneurship.
C4121.2	**Create** the awareness on creativity and innovation.
C4121.3	**Adopt** the Entrepreneurship Development programs.
C4121.4	**Evaluate** the project planning and feasibility studies.
C4121.5	**Analyze** the concept of small and micro enterprises.

Course Name: MECHATRONICS & SIMULATION LAB	Course Code: C4122
CO	**After successful completion of this course, the students will be able to:**
C4122.1	**Interpret** and operate on PLC and mechatronic systems
C4122.2	**Use** of various analytical tools like ANSYS, Fusion 360 etc., for engineering simulation.

Course Name: INTERNSHIP/ COMMUNITY SERVICE PROJECT	Course Code: C4123
CO	**After successful completion of this course, the students will be able to:**
C4123.1	**Understand** the organizational structure, workplace environment, safety practices, and engineering ethics followed in the industry.
C4123.2	**Apply** the theoretical knowledge of mechanical engineering to analyze industrial processes, manufacturing operations, maintenance practices, and quality control activities.
C4123.3	**Identify** engineering problems encountered during the internship and propose appropriate technical solutions using modern engineering tools and techniques.
C4123.4	**Demonstrate** effective communication, teamwork, leadership, professional ethics, and project management skills while working in multidisciplinary industrial environments.
C4123.5	**Prepare** a comprehensive internship report and deliver technical presentations that effectively communicate industrial learning, project outcomes, and professional experiences.

IV B. TECH II SEMESTER

Course Name: MAJOR PROJECT & INTERNSHIP	Course Code: C421
CO	**After successful completion of this course, the students will be able to:**
C421.1	**Identify** and formulate a real-world mechanical engineering problem through literature survey, industrial needs assessment, and engineering analysis.
C421.2	**Develop** a mechanical engineering system, component, or process by applying engineering principles, design methodologies, standards, and modern engineering tools.
C421.3	**Conduct** experiments, simulations, or prototype testing; analyze and interpret results to validate the proposed design and recommend improvements.
C421.4	**Demonstrate** effective teamwork, project planning, communication, leadership, professional ethics, sustainability considerations, and project management throughout the project lifecycle.
C421.5	**Prepare** a comprehensive technical project report and present the project outcomes effectively through seminars, demonstrations, and viva-voce with appropriate documentation.