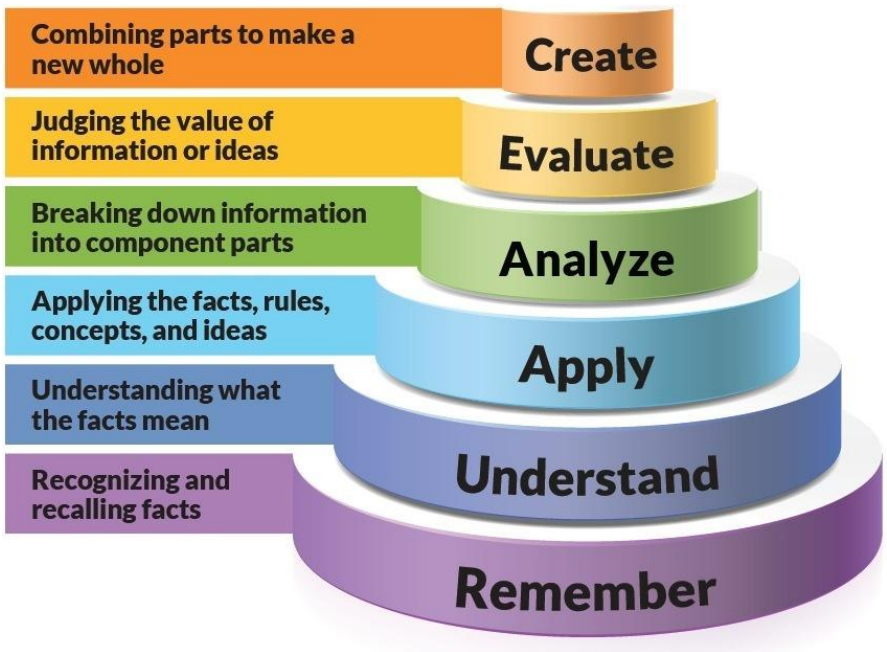
OUTCOME BASED EDUCATION BOOKLET

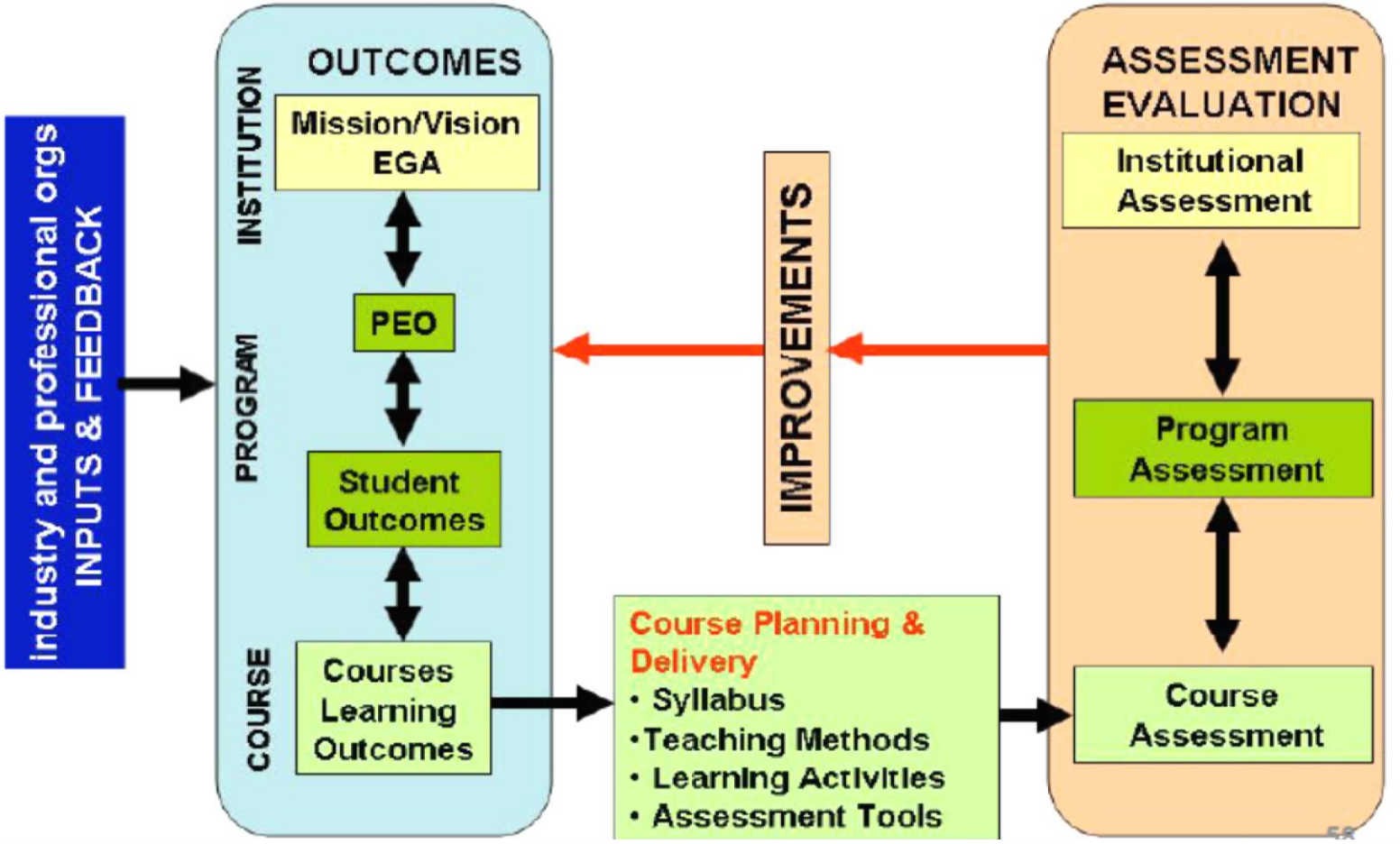
B.Tech
Mechanical Engineering
(Accredited by NBA)

For the batch of students admitted during
Academic Year 2018 – 2019



INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Approved by AICTE; Affiliated to JNTUH and Accredited by NAAC with 'A' Grade
Dundigal, Hyderabad – 500 043

The OBE Framework



Vision

The Department of Mechanical Engineering envisions value based education, research and development in the areas of Manufacturing and Computer Aided Engineering as an advanced center for Mechanical Engineering, producing graduates of world-class competence to face the challenges of global market with confidence, creating effective interface with various organizations.

Mission

The mission of the Mechanical Engineering Department is to prepare effective and responsible engineers for global requirements by providing quality education and to improve pedagogical methods employed in delivering the academic programs to the needs of the industry and changing world by conducting basic and applied research and to generate intellectual property.

Part – I

I. Program Educational Objectives and Assessment Criteria:

Program Educational Objectives, Program Outcomes and Assessment Criteria (Approved by DAC MECH on 30/01/2016):

Mechanical Engineering Department Advisory Council: The Mechanical Engineering Department Advisory Council (MECHDAC) includes a diverse group of experts from academic and industry, as well as alumni representation. The Advisory Board meets annually, or as needed, for a comprehensive review of the Mechanical Engineering Department strategic planning and programs. The Advisory Council meets with administration, faculty and students and prepares a report, which is presented to principal. In each visit, the Department of Mechanical Engineering responds to the report indicating improvements and amendments to the program.

Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.
Outcomes — Program outcomes are narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program.

II. Program Educational Objectives (PEO'S)

A graduate of Institute of Aeronautical Engineering College, Mechanical Engineering should enjoy a successful career in Mechanical Engineering or a related field after graduation. The program aims to:

Program Educational Objective 1

To provide students with a sound foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze engineering problems.

Program Educational Objective 2

To prepare students for successful careers in industry that meet the needs of local, Indian and multinational companies.

Program Educational Objective 3

To develop the ability among students to synthesize data and technical concepts for application to product design and prepares students to work as part of teams on multidisciplinary projects.

Program Educational Objective 4

To promote student awareness for life-long learning and to introduce them to codes of professional practice, ethics and prepare them for higher studies.

These Program Educational Objectives are broad by intention, permitting the Mechanical Engineering graduates to seek further education or work in diverse areas. To make these objectives meaningful, they may be demonstrated by performance, actions, or achievements.

1. **To provide students with a sound foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze engineering problems.**

- Effectively designing product processing methods.
- Gaining knowledge for appropriate use of several precision tools.
- Analysis of complex design systems related to mechanical Engineering.
- Making use of appropriate laboratory tools and designing innovative methods.
- Effectively utilizing research data published in journals, conference proceedings etc.

2. **To prepare students for successful careers in industry that meet the needs of local, Indian and multinational companies.**

- Effectively understanding the data related to mechanical engineering design systems and to analyze them using mathematical models.
- To motivate students to develop innovative methods of measuring product characteristics.
- To encourage students to develop analytical systems for controlling process parameters.
- To apply various statistical methods to analyze data pertaining to product quality.

3. **To develop the ability among students to synthesize data and technical concepts for application to product design and prepares students to work as part of teams on multidisciplinary projects.**

- To enhance the ability of students to work in teams and to establish the leadership role.
- Improving student's skills to adopt modern methods in mechanical engineering quest for improving technology.
- Provide students with opportunities in multi-disciplinary design teams to improve communication ability.
- To enhance the ability to work as practicing mechanical engineers in manufacturing industry and consulting firms.
- To participate effectively in technical association activities to enhance engineering professionalism with a view to ethics.

4. **To promote student awareness for life-long learning and to introduce them to codes of professional practice, ethics and prepare them for higher studies.**

- To enhance the ability of students to apply mathematics and fundamentals of science for solving engineering problems.
- To enhance the skills of students in applying mathematical methods for optimizing resources.
- To enhance the ability of students to apply scientific methods for protection and preservation of environment.
- To promote awareness necessary to understand the impact of engineering on a global, economic, environmental and societal context.

III. Program Outcomes (PO'S):

1. Capability to apply the knowledge of Mathematics, science and Engineering in the field of Mechanical Engineering.
2. An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering.
3. Competence to design a system, component or process to meet societal needs within realistic constraints.
4. To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.
5. An ability to formulate solve complex engineering problem using modern engineering and Information technology tools.
6. To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.
7. To understand impact of engineering solutions in the societal context and demonstrate the knowledge for sustainable development.
8. An understanding and implementation of professional and Ethical responsibilities.
9. To function as an effective individual and as a member or leader in Multi-disciplinary environment and adopt in diverse teams.
10. An ability to assimilate, comprehends, communicate, give and receive instructions to present effectively with engineering community and society.
11. An ability to provide leadership in managing complex engineering projects at multi-disciplinary environment and to become a professional engineer.
12. Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.

IV. Program Specific Outcomes (PSO's):

1. To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.
2. An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.
3. To build the nation, by imparting technological inputs and managerial skills to become Technocrats.

V. PEO's Vs PO's

S. No	Program Educational Objectives	Program Outcomes
PEO - I	To Provide students with a sound foundation in Mathematical, Scientific and Engineering fundamentals necessary to formulate, solve and analyze engineering problems.	1. Capability to apply the knowledge of Mathematics, science and Engineering in the field of Mechanical Engineering. 3. Competence to design a system, component or process to meet societal needs within realistic constraints. 6. To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues. 7. To understand impact of engineering solutions in the societal context and demonstrate the knowledge for sustainable development.

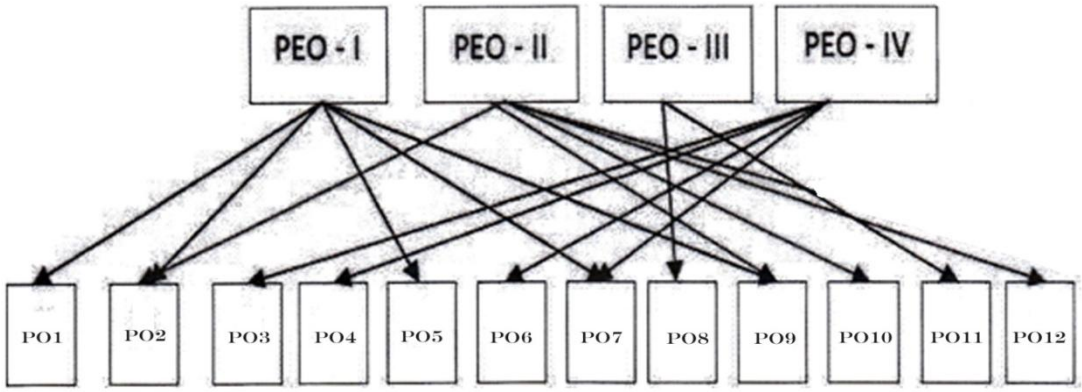
PEO - II	To Prepare students for successful careers in industry that meet the needs of local, Indian and multinational companies.	2. An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering. 3. Competence to design a system, component or process to meet societal needs within realistic constraints. 5. An ability to formulate solve complex engineering problem using modern engineering and Information technology tools.
PEO - III	To develop the ability among students to synthesize data and technical concepts for application to product design and prepares students to work as part of teams on multidisciplinary projects.	8. An understanding and implementation of professional and Ethical responsibilities. 9. To function as an effective individual and as a member or leader in Multi-disciplinary environment and adopt in diverse teams. 10. An ability to assimilate, comprehend, communicate, give and receive instructions to present effectively with engineering community and society. 11. An ability to provide leadership in managing complex engineering projects at multi-disciplinary environment and to become a professional engineer. 12. Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.
PEO - IV	To promote student awareness for life-long learning and to introduce them to codes of professional practice, ethics and prepare them for higher studies.	1. Capability to apply the knowledge of Mathematics, science and Engineering in the field of Mechanical Engineering. 2. An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering. 4. To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies. 5. An ability to formulate solve complex engineering problem using modern engineering and Information technology tools.

VI. PEO's Vs PSO's

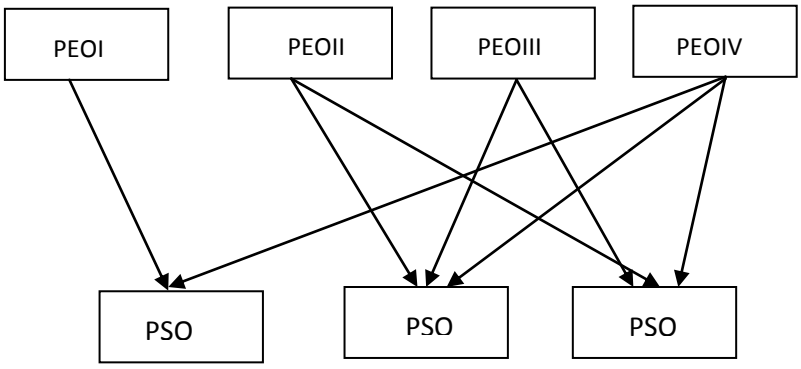
S. No	Program Educational Objectives	Program Specific Outcomes
PEO - I	To Provide students with a sound foundation in Mathematical, Scientific and Engineering fundamentals necessary to formulate, solve and analyze engineering problems.	PSO-1.To produce Engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.
PEO - II	To Prepare students for successful careers in industry that meet the needs of local, Indian and multinational companies.	PSO-2. An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability. PSO-3. To build the nation, by imparting technological inputs and managerial skills to become Technocrats.
PEO - III	To develop the ability among students to synthesize data and technical concepts for application to product design and prepares students to work as part of teams on multidisciplinary projects.	PSO-2.An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability. PSO-3. To build the nation, by imparting technological inputs and managerial skills to

		become Technocrats.
PEO - IV	To promote student awareness for life-long learning and to introduce them to codes of professional practice, ethics and prepare them for higher studies.	PSO-1.To produce Engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams. PSO-2. An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability. PSO-3. To build the nation, by imparting technological inputs and managerial skills to become Technocrats.

VII. Mapping of Program Outcomes to Program Educational Objectives



VIII. Mapping of Program Specific Outcomes to Program Educational Objectives



IX. MAPPING OF PO's Vs PEO's

Program Outcomes	PEO-I	PEO-II	PEO-III	PEO-IV
1. Capability to apply the knowledge of Mathematics, science and Engineering in the field of Mechanical Engineering.	✔			✔
2. An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering.		✔		✔
3. Competence to design a system, component or process to meet societal needs within realistic constraints.	✔	✔		
4. To design and conduct research oriented experiments as well as to analyze and implement data using research				✔

	methodologies.				
5.	An ability to formulate solve complex engineering problem using modern engineering and Information technology tools.		✔	✔	
6.	To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.	✔			
7.	To understand impact of engineering solutions in the societal context and demonstrate the knowledge for sustainable development.	✔			
8.	An understanding and implementation of professional and Ethical responsibilities.			✔	
9.	To function as an effective individual and as a member or leader in Multi-disciplinary environment and adopt in diverse teams.			✔	
10.	An ability to assimilate, comprehend, communicate, give and receive instructions to present effectively with engineering community and society.			✔	
11.	An ability to provide leadership in managing complex engineering projects at multi-disciplinary environment and to become a professional engineer.			✔	
12.	Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.			✔	

Note:

- The assessment process can be direct or indirect.
- The direct assessment will be through interim assessment by the faculty or by industry / technology experts.
- The indirect assessment on the other hand could be by students through course outcomes, lab evaluation, department associations, exit interviews, engineering services, GATE examination etc.
- Frequency of assessment can be once in a semester and justified by the programme coordinator.

X. Table-1 Relation between the Program Educational Objectives and Program Outcomes:

A broad relation between the program objective and the outcomes is given in the following table:

	(PEO-I) To Prepare students with a sound foundation in Basic Sciences and Engineering Fundamentals	**(PEO-II) To Prepare students for successful career in industry throughout world**	**(PEO-III) To Prepare students to synthesis data and technical concepts for application of product design**	**(PEO-IV) To Prepare students with awareness for life-long learning**
1. Engineering Knowledge	3	2	3	3
2. Problem Analysis	3	3	3	3
3. Design/Development of Solutions	3	3	3	3
4. Conduct Investigations of Complex problems	3	2	3	2

5. Modern Tools usage	2	3	3	3
6. The Engineer and Society	2	2	3	2
7. Environment and Sustainability	2	2	3	2
8. Ethics	2	2	2	3
9. Individual and Teamwork	2	3	3	3
10. Communication	3	2	3	3
11. Project Management and Finance	2	3	3	2
12. Life-long Learning	3	3	3	3

Table 1- Relationships between program objectives and program outcomes
Key: 3 = Strong relationship; 2 = Moderate relationship

Note:

- The assessment process can be direct or indirect.
- The direct assessment will be through interim assessment by the faculty or by industry / technology experts.
- The indirect assessment on the other hand could be by students through course outcomes, lab evaluation, department associations, exit interviews, engineering services, GATE examination etc.
- Frequency of assessment can be once in a semester and justified by the programme coordinator.

Program Specific Outcomes (PSO's)

1. To Produce Engineering Professionals capable of analyzing and synthesizing Mechanical systems including allied Engineering streams.

- Applying basic mathematics to engineering problems and to analyze in a scientific way.
- Enhancing the ability to apply contemporary knowledge for engineering projects.
- Ability to integrate various sciences to solve mechanical engineering problems.
- Ability to apply simple formulas of science to the experiments of mechanical engineering.
- Improving various analytical skills for solving engineering problems.

2. An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.

- Ability to conduct experiments connected with mechanical engineering.
- Applying various analytical skills to develop innovative methods in experimentation.
- Ability to synthesize data and interpret them in a scientific way.
- Enhancing the knowledge of integrating analysis and results.
- Ability to utilize results of various experiments and come up with new concepts and theories.

3. To build the nation, imparting technological inputs and managerial skills to become technocrats.

- Ability to analyze existing system.
- Ability designing to a new innovative thermal (or) mechanical system.
- Visualize the requirements of mechanical system.
- Ability to utilize various utilities to design a system.

- Understand the specifications of various utilities, and appreciate their use under various conditions.
- Ability to explain and demonstrate the various mechanical systems.

Faculty Objectives: Each faculty member should:

F1: Be able to teach various Mechanical Engineering undergraduate courses.
F2: Be able to continuously update the knowledge of Mechanical Engineering trends.
F3: Strive to improve the quality of their teaching.
F4: Be able to conduct the various experiments in the laboratories and could innovate newer methods of calibration, testing etc.
F5: Be able to carry out the research activities and make students to involve in the technical projects
F6: Be able to participate in formulation, maintaining of institutional governing methods.
F7: Be able to encourage the students to participate various co-curricular and extracurricular activities

XI. A LIST OF COURSES OFFERED IN MECHANICAL ENGINEERING CURRICULUM (IARE-R 18): FOR THE BATCHES ADMITTED DURING 2018- 2019
MAPPING OF COURSES TO PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

B. Tech (R18)

	I Year I Semester	**PO'S**												**PSO'S**		
CODE	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
AHSB02	Linear Algebra and Calculus	✔	✔											✔		
AHSB04	Waves and Optics	✔	✔		✔										✔	
ACSB01	Programming for Problem Solving	✔	✔	✔		✔							✔	✔	✔	✔
PRACTICAL																
AHSB10	Engineering Physics Lab	✔	✔		✔					✔		✔	✔			✔
ACSB02	Programming for Problem Solving Lab	✔	✔	✔		✔							✔	✔	✔	✔
AMEB01	Workshop Manufacturing Practice Lab					✔	✔			✔			✔	✔	✔	✔

I Year II Semester		PO'S												PSO's		
CODE	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
AHSB01	English									✔	✔	✔				✔
AHSB11	Mathematical Transform Techniques	✔	✔		✔									✔		
AHSB03	Engineering Chemistry	✔	✔		✔			✔						✔		
AEEB04	Basic Electrical and Electronics Engineering	✔	✔		✔									✔		
PRACTICAL																
AHSB08	English Language and Communications Skills Lab	✔									✔		✔		✔	✔
AHSB09	Engineering Chemistry Lab	✔	✔	✔	✔	✔	✔	✔		✔			✔	✔	✔	
AMEB02	Engineering Graphics and Design Lab	✔	✔	✔	✔	✔				✔		✔	✔	✔	✔	
AEEB08	Basic Electrical and Electronics Engineering Lab	✔	✔	✔	✔	✔	✔	✔		✔			✔	✔	✔	✔

XII. Outcome Delivery and Assessment (R18)
(For batches admitted during 2018)

The categorization of outcomes of the above Mechanical Engineering courses is grouped as follows:

Program Outcome (1): Capability to apply the knowledge of Mathematics, science and Engineering in the field of Mechanical Engineering.			
AHSB02	Linear Algebra and Calculus	AHSB04	Waves and Optics
ACSB01	Programming for Problem Solving	AHSB10	Engineering Physics Lab
ACSB02	Programming for Problem Solving Lab	AEEB08	Basic Electrical and Electronics Engineering Lab
AHSB03	Engineering Chemistry	AHSB11	Mathematical Transform Techniques
AHSB08	English Language and Communication Skills Lab	AEEB04	Basic Electrical and Electronics Engineering
AMEB02	Engineering Graphics and Design Lab	AHSB09	Engineering Chemistry Lab
Program Outcome (2): An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering.			
AHSB02	Linear Algebra and Calculus	AHSB04	Waves and Optics
ACSB01	Programming for Problem Solving	AHSB10	Engineering Physics Lab
ACSB02	Programming for Problem Solving Lab	AHSB11	Mathematical Transform Techniques
AHSB03	Engineering Chemistry	AEEB04	Basic Electrical and Electronics Engineering
AMEB02	Engineering Graphics and Design Lab	AHSB09	Engineering Chemistry Lab
AEEB08	Basic Electrical and Electronics Engineering Lab		
Program Outcome (3): Competence to design a system, component or process to meet societal needs within realistic constraints.			
ACSB01	Programming for Problem Solving	AHSB09	Engineering Chemistry Lab
ACSB02	Programming for Problem Solving Lab	AEEB08	Basic Electrical and Electronics Engineering Lab
AMEB02	Engineering Graphics and Design Lab		
Program Outcome (4): To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.			
AHSB03	Engineering Chemistry	AHSB04	Waves and Optics
AMEB02	Engineering Graphics and Design Lab	AHSB10	Engineering Physics Lab
AHSB11	Mathematical Transform Techniques	AHSB09	Engineering Chemistry Lab
AEEB04	Basic Electrical and Electronics Engineering	AEEB08	Basic Electrical and Electronics Engineering Lab
Program Outcome (5): An ability to formulate solve complex engineering problem using modern engineering and Information technology tools.			
ACSB01	Programming for Problem Solving	AHSB09	Engineering Chemistry Lab
ACSB02	Programming for Problem Solving Lab	AEEB08	Basic Electrical and Electronics Engineering Lab
AMEB02	Engineering Graphics and Design Lab		
Program Outcome (6): To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.			
AHSB09	Engineering Chemistry Lab	AEEB08	Basic Electrical and Electronics Engineering Lab
Program Outcome (7): To understand impact of engineering solutions in the societal context and demonstrate the knowledge for sustainable development.			
AHSB03	Engineering Chemistry	AHSB09	Engineering Chemistry Lab

AEEB08	Basic Electrical and Electronics Engineering Lab		

Program Outcome (8): An understanding and implementation of professional and Ethical responsibilities.			
Program Outcome (9): To function as an effective individual and as a member or leader in Multi-disciplinary environment and adopt in diverse teams.			
AHSB01	English	AHSB10	Engineering Physics Lab
AMEB02	Engineering Graphics and Design Lab	AMEB01	Workshop Manufacturing Practice Lab
AHSB09	Engineering Chemistry Lab	AEEB08	Basic Electrical and Electronics Engineering Lab
Program Outcome (10): An ability to assimilate, comprehend, communicate, give and receive instructions to present effectively with engineering community and society.			
AHSB01	English	AHSB08	English Language and Communication Skills Lab
Program Outcome (11): An ability to provide leadership in managing complex engineering projects at multi-disciplinary environment and to become a professional engineer.			
AHSB01	English	AHSB10	Engineering Physics Lab
AMEB02	Engineering Graphics and Design Lab		
Program Outcome (12): Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.			
ACSB01	Programming for Problem Solving	AHSB10	Engineering Physics Lab
ACSB02	Programming for Problem Solving Lab	AMEB01	Workshop Manufacturing Practice Lab
AHSB08	English Language and Communication Skills Lab	AHSB09	Engineering Chemistry Lab
AMEB02	Engineering Graphics and Design Lab	AEEB08	Basic Electrical and Electronics Engineering Lab

XIII. Methods of Measuring Program Outcomes

Methodologies that are used to measure student learning each have their own limitations and biases, and no method can be counted on to be completely error free. That is why best practice in educational research dictates triangulating the data. If several different sources of data are used, it increases the probability that the findings present an accurate picture. We employ the following formal assessment procedures:

1. End-of-semester course evaluations
2. Departmental mid-semester course evaluations
3. Departmental course objective surveys
4. Course portfolio evaluations
5. Exit Interviews
6. Alumni feedback
7. Employer surveys
8. Department academic council meetings
9. Faculty meetings
10. Project work
11. Job Placements
12. Professional societies

Each is described in more detail below:

1. University end-of-semester course evaluations:

J N T University conducts end-of-semester examination for all courses. Summary results for each course are distributed to the appropriate instructor and the HOD, summarizing the

course-specific results and comparing them to the average across the university. Students are encouraged to write specific comments about the positive and negative aspects of the course. The statistical summary and student comments are presented are also submitted to the principal and department academic council for review.

2. Departmental mid-semester course evaluations:

Mechanical Engineering department conducts mid-semester reviews for all courses. All departmental students are encouraged to fill out a brief survey on the state of the courses they are currently taking, and space is provided for a written comment. Faculty are strongly encouraged to review these evaluations, and draft a brief response on how they will react to correct any deficiencies noted by the students. The results are reviewed by departmental faculty (all faculty have permission to read results for all courses).

3. Departmental course objective surveys:

Mechanical Engineering department conducts end-of-semester course objective surveys for all of our courses. All departmental students are encouraged to fill out a brief survey on the state of the courses they are currently taking, and space is provided for a written comment. Faculty are strongly encouraged to review these evaluations, and draft a brief response on how they will react to correct any deficiencies noted by the students. The results are reviewed by departmental faculty (all faculty have permission to read results for all courses). The results of how courses satisfy their objectives are discussed at a faculty meeting. Based on this feedback for certain courses, alterations or changes to the course objectives can be done.

4. Course portfolio evaluations:

We collect course portfolios from the instructor of each course offered in the given semester. They remain on file for our entire faculty to study. These portfolios help the course coordinator monitor how the course is being taught, and help new faculty understand how more experienced colleagues teach the given course. With respect to assessment, each portfolio contains two surveys to be filled out by the instructor of the course. The beginning-of-semester survey encourages faculty members to think about what they can do to improve the teaching and administration of their course, compared with the last time they taught it. The end-of-semester survey encourages faculty to record what did and did not work well during this course offering and what changes should be made for the future.

5 Exit Interviews:

Inputs from final year students are solicited annually through Computer Science and Engineering Exit Survey. The results are disseminated to the faculty and department advisory council for analysis and discussion. The questioner is designed to survey program outcomes, solicit about program experiences, career choices as well as suggestions and comments. This instrument seeks to assess how students view the department's program in retrospect.

6 Alumni feedback:

The alumni survey is a written questionnaire which alumni are asked to complete. We use this survey seeking input on the Program Objectives and Learning Outcomes based on their experience after graduation and after they have spent time in the working world. Alumni are an excellent resource with perspective on the value and advantages of their education. They are also resource for current students for potential networking and employment. The data will be analyzed and used in continuous improvement.

7 Employer surveys:

The employer survey is a written questionnaire which employers of the program's graduates are asked to complete. We review the effectiveness of our curriculum and how well the student is prepared in the department of Mechanical Engineering, IARE. To do this, we survey Employers and Advisors of alumni who graduated four years ago. We ask about several categories of preparation, and for each category, how well do you think he or she was prepared, and how important you think preparation in that area is to him or her in the current position. This survey will greatly assist us in determining the college overall level of achievement of our Program Educational Objectives.

8 Department academic council meetings:

Mechanical Engineering Department Advisory Council (MEDAC) includes a diverse group of experts from academe and industry, as well as alumni representation. The Advisory Board meets annually, or as needed, for a comprehensive review of the Mechanical Engineering Department strategic planning and programs. The Advisory Council meets with administration, faculty and students and prepares a report, which is presented to principal. In each visit, the Department of Mechanical Engineering responds to the report indicating improvements and amendments to the program.

9 Faculty meetings:

The state of undergraduate program is always on the agenda at the monthly meeting of faculty. The faculty devotes a substantial amount of time to formal and informal discussions assessing the state of program and searching for improvements.

10 Project work:

The final project reports, must demonstrate that students produced solutions to research/industry problems involving contemporary issues. There is no scale for this tool as the reports provide qualitative data.

11 Job Placements:

Data from the Placement and Training Centre on graduates' job placement reflects how successful our graduates are in securing a job in a related field.

12 Professional societies:

The role of professional societies in introducing our students to technical, entrepreneurial and Societal aspects of the field and in providing outstanding opportunities for lifelong learning makes them important constituents.

Part – II

METHODOLOGY FOR PREPARATION AND ASSESSMENT OF COURSE LEVEL STUDENT LEARNING OUTCOMES

Although the term "Expected Learning Outcome" may be new, the process of identifying the key concepts or skills that students are expected to learn during specific courses is not. Many people are more familiar with the terms "course objective" or "course competency". Expected learning outcomes are really very similar to both of these concepts, so if you already have course objectives or competencies, you are close to having expected learning outcomes for class.

This will provide information on exactly what expected learning outcomes are and what methods can be used to assess them. This is designed to assist faculty with the process of developing expected learning outcomes and methods for assessing those outcomes in their courses. This provides basic information related to (1) course purpose; (2) expected learning outcomes; (3) methods for assessing expected learning outcomes; (4) criteria for grade determination; and (5) a course outline.

I. **Expected Course Outcomes:**
After reading and completing this, individuals will be able to :

- Prepare a description of the course as well as a written statement regarding the course's purpose;
- Construct/develop expected learning outcomes for the course;
- Create an assessment plan that outlines the specific methods that will be used to assess the expected student learning outcomes for a course;
- Describe how grades will be determined in a process that is separate and distinct from assessing the expected learning outcomes;
- Identify the common components of a course outline
- Revise their course syllabi to incorporate a course purpose, expected learning outcomes, methods to assess those outcomes, the criteria for grade determination, and a course outline.
- This process uses some terminology related to expected learning outcomes and assessment. A brief glossary of terms has been provided below for reference purposes.

Assessment of expected learning outcomes :

The process of investigating (1) what students are learning and (2) how well they are learning it in relation to the stated expected learning outcomes for the course.

Assessment plan: The proposed methods and timeline for assessment-related activities in a given course (e.g., when are you going to check what/how well the students are learning and how are you going to do that?).

Classroom Assessment Technique (CAT): Angelo and Cross (1993) developed a variety of techniques/activities than can be used to assess students' learning. These CATs are often done anonymously and are not graded. These activities check on

the class' learning while students are still engaged in the learning process. An example of a CAT is a non-graded quiz given a few weeks before the first exam.

Course description: A formal description of the material to be covered in the course.

Course purpose: The course purpose describes the intent of the course and how it contributes to the program. The course purpose goes beyond the course description.

Expected teaming outcome: A formal statement of what students are expected to learn in a course (synonyms for "expected learning outcome" include learning outcome, learning outcome statement, and student learning outcome).

Evaluation: Making a judgment about the quality of student's learning/work and assigning marks based on that judgment. Evaluation activities (such as exams, papers, etc.) are often seen as formal ways to assess the expected learning outcomes for a course.

Methods for assessing student learning outcomes: This term refers to any technique or activity that is used to identify what students are learning or how well they are learning. Formal methods for evaluating student learning outcomes include Continuous Assessment Tests, Mid Semester Test, Tutorials, End Semester Examination etc. The assessment methods are used to identify how the well students have acquired the learning outcomes for the course.

II. COURSE PURPOSE

One of the first steps in identifying the expected learning outcomes for a course is identifying the purpose of teaching in the course. By clarifying the purpose of the course, faculty can help discover the main topics or themes related to students' learning. These themes help to outline the expected learning outcomes for the course.

The course purpose involves the following:

1. What role does this course play within the program?
2. How is the course unique or different from other courses?
3. Why should/do students take this course? What essential knowledge or skills should they gain from this experience?
4. What knowledge or skills from this course will students need to have mastered to perform well in future classes or jobs?
5. Why is this course important for students to take?

The "Course Description" provides general information regarding the topics and content addressed in the course, the "Course Purpose" goes beyond that to describe how this course fits in to the students' educational experience in the program.

III EXPECTED LEARNING OUTCOMES

Expected Learning Outcome (definition)

An expected learning outcome is a formal statement of what students are expected to learn in a course. Expected 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 (Suskie, 2004). Expected learning outcomes are also often referred to as "learning outcomes", "student learning outcomes", or "learning outcome statements".

Simply stated, expected learning outcome statements describe:

1. What faculty members want students to *know* at the end of the course and
2. What faculty members want students *to be able to do* at the end of the course?

Learning outcomes have three major characteristics

1) They specify an action by the students/learners that is *observable*
2) They specify an action by the students/learners that is *measurable*
3) 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 (Suskie, 2004).

IV. WRITING EFFECTIVE LEARNING OUTCOMES STATEMENTS

When stating expected learning outcomes, it is important to use verbs that describe exactly what the learner(s) will be able to *do* upon completion of the course.

Examples of good action words to include in expected learning outcome

Statements : Compile, identify, create, plan, revise, analyze, design, select, utilize, apply, demonstrate, prepare, use, compute, discuss, explain, predict, assess, compare, rate, critique, outline, or evaluate

There are some verbs that are unclear in the context of an expected learning outcome statement (e.g., know, be aware of, appreciate, learn, understand, comprehend, become familiar with). These words are often vague, have multiple interpretations, or are simply difficult to observe or measure (American Association of Law Libraries, 2005). As such, it is best to avoid using these terms when creating expected learning outcome statements.

For example, please look at the following learning outcomes statements:

- The students will understand basic Thermal system.
- The students will appreciate knowledge discovery from Design of Machine members.

  Both of these learning outcomes are stated in a manner that will make them difficult to assess. Consider the following:
- How do you observe someone "understanding" a theory or "appreciating" Design of Machine members and Thermal systems?
- How easy will it be to measure "understanding" or "appreciation"?

These expected learning outcomes are more effectively stated the following way:

- The students will be able to identify and describe what techniques are used to extract knowledge from Thermal systems.
- The students will be able to identify the characteristics of Classification techniques from other Design of machine members.

Incorporating Critical Thinking Skills into Expected Learning Outcomes 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 below.

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 condusions 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.

V. Table of Blooms Taxonomy
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

REMEMBER	UNDERSTAND	APPLY	ANALYZE	EVALUATE	CREATE
Count	Associate	Add	Analyze	Appraise	Categorize
Define	Compute	Apply	Arrange	Assess	Combine
Describe	Convert	Calculate	Breakdown	Compare	Compile
Draw	Defend	Change	Combine	Conclude	Compose
Identify	Discuss	Classify	Design Detect	Contrast	Create
Label	Distinguish	Complete	Develop	Criticize	Drive
List	Estimate	Compute	Diagram	Critique	Design
Match	Explain	Demonstrate	Differentiate	Determine	Devise
Na me	Extend	Discover	Discriminate	Grade	Explain
Outline	Extrapolate	Divide	Illustrate Infer	Interpret	Generate
Point	Generalize	Examine	Outline Point	Judge	Group
Quote	Give examples	Graph	out Relate	Justify	Integrate
Read	Infer	Interpolate	Select	Measure	Modify

Recall	Paraphrase	Manipulate	Separate	Rank	Order
Recite	Predict	Modify	Subdivide	Rate	Organize
Recognize	Rewrite	Operate	Utilize	Support	Plan
Record	Summarize	Prepare		Test	Prescribe
Repeat		Produce			Propose
Reproduce		Show			Rearrange
Select		Solve			Reconstruct
State Write		Subtract			Related
		Translate			Reorganize
		Use			Revise
					Rewrite
					Summarize
					Transform
					Specify

VI. TIPS FOR DEVELOPING COURSE LEVEL EXPECTED LEARNING OUTCOMES STATEMENTS

- Limit the course-level expected learning outcomes to 5 - 10 statements for the entire course (more detailed outcomes can be developed for individual units, assignments, chapters, etc.)
- Focus on overarching or general 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.
- Focus on the learning that results from the course rather than describing activities or lessons in the course.
- Incorporate or reflect the institutional and departmental missions.
- Incorporate various ways for students to show success (outlining, describing, modeling, depicting, etc.) rather than using a single statement such as "at the end of the course, students will know " as the stem for each expected outcome statement.

VII. EXPECTED LEARNING OUTCOMES STATEMENTS (R18)

The following depict some sample expected learning outcome statements from selected courses.

<table>
<tr><td colspan="2">THERMAL ENGINEERING</td></tr>
<tr><td>Course Objectives</td><td>Course Learning Outcomes</td></tr>
<tr><td>1. Enrich the knowledge of solving Algebraic and Transcendental equations and Differential equation by numerical methods.
2. Determine the Fourier transforms for various functions in a given period.
3. Determine the Laplace and Inverse Laplace transforms for various functions using</td><td><table><tr><td>S. No.</td><td>Description</td></tr><tr><td>AHSB11.01</td><td>Evaluate the real roots of algebraic and transcendental equations by Bisection method, False position and Newton - Raphson method.</td></tr></table></td></tr>
</table>

standard types. 4. Formulate to solve Partial differential equation.	AHSB11.02	Apply the symbolic relationship between the operators using finite differences.
	AHSB11.03	Apply the Newtons forward and Backward Interpolation method to determine the desired values of the given data at equal intervals.
	AHSB11.04	Apply the Gauss forward and Backward Interpolation method to determine the desired values of the given data at equal intervals.
	AHSB11.05	Apply the Interpolation method to determine the desired values of the given data at unequal intervals.
	AHSB11.06	Ability to curve fit data using several linear and non linear curves by method of least squares.
	AHSB11.07	Apply numerical methods to obtain approximate solutions to Taylors, Eulers, Modified Eulers and Runge-Kutta methods of ordinary differential equations.
	AHSB11.08	Understand the concept of numerical solutions of ordinary differential equations to the real-world problems of physics, biology and electrical circuits.
	AHSB11.09	Apply the nature of properties to Laplace transform and inverse Laplace transform of the given function.
	AHSB11.10	Solving Laplace transforms and inverse Laplace transform of a given function using shifting theorems.
	AHSB11.11	Evaluate Laplace transforms and inverse Laplace transform using derivatives of a given function.
	AHSB11.12	Evaluate Laplace transforms and inverse Laplace transform using multiplication of a variable to a given function.
	AHSB11.13	Apply Laplace transforms to periodic functions.
	AHSB11.14	Solving Laplace transforms and inverse Laplace transform using derivatives and integrals.
	AHSB11.15	Evaluate inverse of Laplace transforms and inverse Laplace transform by the method of convolution.
	AHSB11.16	Solving the linear differential equations using Laplace transform.

AHSB11.17	Understand the concept of Laplace transforms to the real-world problems of electrical circuits, harmonic oscillators, optical devices, and mechanical systems
AHSB11.18	Understand the nature of the Fourier integral.
AHSB11.19	Ability to compute the Fourier transforms of the given function.
AHSB11.20	Ability to compute the Fourier sine and cosine transforms of the function.
AHSB11.21	Evaluate the inverse Fourier transform, Fourier sine and cosine transform of the given function.
AHSB11.22	Evaluate finite and infinite Fourier transforms.
AHSB11.23	Understand the concept of Fourier transforms to the real-world problems of circuit analysis, control system design
AHSB11.24	Understand the concept of order and degree with reference to partial differential equation
AHSB11.25	Formulate and solve partial differential equations by elimination of arbitrary constants and functions
AHSB11.26	Understand partial differential equation for solving linear equations by Lagrange method.
AHSB11.27	Apply the partial differential equation for solving non-linear equations by Charpit's method.
AHSB11.28	Solving the heat equation and wave equation in subject to boundary conditions.
AHSB11.29	Understand the concept of partial differential equations to the real-world problems of electromagnetic and fluid dynamics

VIII. AN OVERVIEW OF ASSESSMENT

What is assessment?

According to Palomba and Banta (1999) assessment involves the systematic collection, review, and use of evidence or information related to student learning. Assessment helps faculty understand how well their students understand course topics/lessons. Assessment exercises are often anonymous. This anonymity allows students to respond freely, rather than trying to get the "right" answer or look good. Assessment exercise attempt to gauge students' understanding in order to see what areas need to be re-addressed in order to increase the students' learning.

In other words, assessment is the process of investigating (1) what students are learning and (2) how well they are learning it in relation to the stated expected learning outcomes for the course. This process also involves providing feedback to the students about their learning and providing new learning opportunities/strategies to increase student learning.

For example, Dr. KGK Murti initiates a class discussion on material from Chapter One and determines that most students are confused about Topic X. This class discussion served as a method for assessing student learning and helped determine the fact that student learning related to Topic X is somewhat lacking. Dr. KGK Murti now has the opportunity to (1) inform the students that there is some confusion and (2) make clarification to address this confusion (e.g., ask student to re-read Chapter One, re-lecture over Topic X, etc.). This assessment process helps increase students' learning.

What is the difference between "evaluation" and "assessment"?

Evaluation focuses on making a judgment about student work to be used in assigning marks that express the level of student performance. Evaluation is usually used in the process of determining marks. Evaluation typically occurs after student learning is assumed to have taken place (e.g., a final exam). Evaluation is part of the assessment process. Course assignments that are evaluated/graded (e.g., exams, papers, tutorials, etc.) are often seen as formal assessment techniques.

While evaluation is an important component of most classrooms, it does have some limitations. For example, if the class average on an exam is a 45%, it seems pretty clear that something went wrong along the way. When one has only evaluated the final learning product, it can be challenging to go back and discover what happened. It can also be difficult to address the situation or provide opportunities for students to learn from their mistakes. Yes, a curve on an exam can help address a low dass average, but does it help the students learn? Engaging in informal assessment activities throughout the course can help avoid this situation.

What is involved in the assessment process?

1. Establishing expected learning outcomes for the course;
2. Systematically gathering, analyzing, and interpreting evidence (through formal assessment activities such as exams or papers and informal assessment activities such as in-class discussions exercises) to determine how well the students' learning matches:
    - faculty expectations for what students will learn and
    - the stated expected learning outcomes for the course
3. Faculty members should use this evidence/assessment of student learning to:
    - provide questionary to students about their learning (or lack thereof) and
    - adjust their teaching methods and/or students' learning behaviors to ensure greater student learning (Maki, 2006).

The Best Practice in a Classroom Assessment and is an example of a method that can be used to assess learning outcomes. At the end of a class period or major topic, faculty ask students to anonymously write down what point(s) were the most unclear to them. After class, faculty members review these responses and then re-teach or re-address any confusing topics, thus increasing student learning (Angelo & Cross, 1993).

IX. WRITING A COURSE PURPOSE

Determining the PURPOSE of teaching the course

When planning a course and determining the Learning Outcomes for that course, it is important to examine the course's purpose within the context of the college, and/or the department/program. This process will assist faculty in determining the intent of the course as well as how the course fits into the curriculum. This will help identify the essential knowledge, skills, etc. that should be incorporated into the course and the stated expected learning outcomes for the course. The course purpose section should clarify the course's standing within the programme (e.g., is the course required or an elective?, does this class have a pre-requisite?, etc.). It should also describe the course's role in the departmental/programmatic curriculum by addressing the intent (importance, main contribution, intrinsic value, etc.) of the class.

STEP ONE: Determine if the course is part of the ASME / I Mech E / AICTE Model Curriculum

The earliest curriculum was published in 1970 for CAD-CAM in American Universities like MIT, Leigh University and it was introduced in the late 1990s in Indian Universities. MHRD, Govt. of India has funded towards the establishment of National Institutes (CITD) and Indo German Collaboration and this helped promoting of CAD-CAM in India. The core curriculum covers basics of CAD-CAM and followed by AICTE model curriculum. This course was introduced at under graduate level and also Laboratory exercises were framed with the advent of introduction of CAD-CAM software in India.

STEP TWO: Determine how the course fits into the departmental curriculum

Here are some questions to ask to help determine how a course fits in the departmental curriculum:

What role does the course play in the departmental/programmatic curriculum?

- Is this course required?
- Is this course an elective?
- Is this course required for some students and an elective for others?
- Does this class have a pre-requisite?
- Is this class a pre-requisite for another class in the department?
- Is this course part of ASME / IMechE / AICTE Model Curriculum?
  How advanced is this course?
- Is this course an undergraduate or graduate course?
- Where does this course fall in students' degree plan - as an introductory course or an advanced course?
- Can I expect the students taking this course to know anything about the course topic?
- Are other faculty members counting on students who have taken this course to have mastered certain knowledge or skills?
  When students leave this course, what do they need to know or be able to do?
- Is there specific knowledge that the students will need to know in the future?
- Are there certain practical or professional skills that students will need to apply in the future?
- Five years from now, what do you hope students will remember from this course?
  What is it about this course that makes it unique or special?
- Why does the program or department offer this course?
- Why can't this course be "covered" as a sub-section of another course?

- What unique contributions to students' learning experience does this course make?
- What is the value of taking this course? How exactly does it enrich the program or department?

X. WRITING EXPECTED LEARNING OUTCOMES FOR A COURSE

The following pages should be of assistance in developing several broad, effectively stated expected learning outcomes for a course. When beginning to construct expected learning outcome statements, it is always good to think about the learners.
Please take a moment to think about the student learners in the course. Please consider the following questions:

- What are the most essential things the students need to know or be able to do at the end of this course?
- What knowledge and skills will they bring with them?
- What knowledge and skills should they learn from the course?
  When you begin thinking about the expected learning outcomes for a course, it is a good idea to think broadly. Course-level expected learning outcomes do not need to focus on small details; rather, they address entire classes of theories, skill sets, topics, etc.

The "Course Description" contains the following contents: **(Annexure - A)**

- Course Overview
- Prerequisite(s)
- Marks Distribution
- Evaluation Scheme
- Course Objectives
- Course Outcomes
- How Course Outcomes are assessed
- Syllabus
- List of Text Books / References / Websites /Journals / Others
- Course Plan
- Mapping course objectives leading to the achievement of the programme outcomes
- Mapping course outcomes leading to the achievement of the programme outcomes

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XII. MODEL COURSE DESCRIPTION FORM

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MATHEMATICAL TRANSFORM TECHNIQUES**				
Course Code	AHSB11				
Programme	B.Tech				
Semester	II	AE | ECE | EEE | ME | CE			
Course Type	Foundation				
Regulation	**IARE - R18**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. Ch Soma Shekar, Assistant Professor				
Course Faculty	Dr. M Anita, Professor Dr. S Jagadha, Professor Mr. V SubbaLakshmi, Assistant Professor Ms. C Rachana, Assistant Professor Ms. L Indira, Assistant Professor Ms. P Rajani, Assistant Professor				

I. COURSE OVERVIEW:

The course focuses on more advanced Engineering Mathematics topics which provide with the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes root finding techniques, Interpolation and its applications, Curve fitting of linear and non linear curves, Laplace transforms, Fourier transforms and Partial differential equations with applications. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic principles of calculus

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Mathematical Transform Techniques	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	

CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. 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 section XI.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Seminar
PO 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.	1	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Software Engineering Practices:** An ability to adopt and integrate current technologies in the design and manufacturing	-	-

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
	domain to enhance the employability.		
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats..	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Enrich the knowledge of solving Algebraic and Transcendental equations and Differential equation by numerical methods.
II	Determine the Fourier transforms for various functions in a given period.
III	Determine the Laplace and Inverse Laplace transforms for various functions using standard types.
IV	Formulate to solve Partial differential equation.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHSB11.01	CLO 1	Evaluate the real roots of algebraic and transcendental equations by Bisection method, False position and Newton -Raphson method.	PO1	3
AHSB11.02	CLO 2	Apply the symbolic relationship between the operators using finite differences.	PO1	3
AHSB11.03	CLO 3	Apply the Newtons forward and Backward Interpolation method to determine the desired values of the given data at equal intervals.	PO2	2
AHSB11.04	CLO 4	Apply the Gauss forward and Backward Interpolation method to determine the desired values of the given data at equal intervals.	PO2	2
AHSB11.05	CLO 5	Apply the Interpolation method to determine the desired values of the given data at unequal intervals.	PO4	1
AHSB11.06	CLO 6	Ability to curve fit data using several linear and non linear curves by method of least squares.	PO2	2
AHSB11.07	CLO 7	Apply numerical methods to obtain approximate solutions to Taylors, Eulers, Modified Eulers and Runge-Kutta methods of ordinary differential equations.	PO1, PO2	3
AHSB11.08	CLO 8	Understand the concept of numerical solutions of ordinary differential equations to the real-world problems of physics, biology and electrical circuits.	PO4	1
AHSB11.09	CLO 9	Apply the nature of properties to Laplace transform and inverse Laplace transform of the given function.	PO2, PO4	2
AHSB11.10	CLO 10	Solving Laplace transforms and inverse Laplace transform of a given function using shifting theorems.	PO1, PO2	3
AHSB11.11	CLO 11	Evaluate Laplace transforms and inverse Laplace transform using derivatives of a given function.	PO1, PO2	3

AHSB11.12	CLO 12	Evaluate Laplace transforms and inverse Laplace transform using multiplication of a variable to a given function.	PO1	3
AHSB11.13	CLO 13	Apply Laplace transforms to periodic functions.	PO2	2
AHSB11.14	CLO 14	Solving Laplace transforms and inverse Laplace transform using derivatives and integrals.	PO1, PO2	3
AHSB11.15	CLO 15	Evaluate inverse of Laplace transforms and inverse Laplace transform by the method of convolution.	PO2, PO4	2
AHSB11.16	CLO 16	Solving the linear differential equations using Laplace transform.	PO4	1
AHSB11.17	CLO 17	Understand the concept of Laplace transforms to the real-world problems of electrical circuits, harmonic oscillators, optical devices, and mechanical systems	PO4	1
AHSB11.18	CLO 18	Understand the nature of the Fourier integral.	PO2	2
AHSB11.19	CLO 19	Ability to compute the Fourier transforms of the given function.	PO1, PO2	3
AHSB11.20	CLO 20	Ability to compute the Fourier sine and cosine transforms of the function.	PO1	3
AHSB11.21	CLO 21	Evaluate the inverse Fourier transform, Fourier sine and cosine transform of the given function.	PO1	3
AHSB11.22	CLO 22	Evaluate finite and infinite Fourier transforms.	PO1	3
AHSB11.23	CLO 23	Understand the concept of Fourier transforms to the real-world problems of circuit analysis, control system design	PO4	1
AHSB11.24	CLO 24	Understand the concept of order and degree with reference to partial differential equation	PO1	3
AHSB11.25	CLO 25	Formulate and solve partial differential equations by elimination of arbitrary constants and functions	PO1, PO2	3
AHSB11.26	CLO 26	Understand partial differential equation for solving linear equations by Lagrange method.	PO2, PO4	2
AHSB11.27	CLO 27	Apply the partial differential equation for solving non-linear equations by Charpit's method.	PO2, PO4	2
AHSB11.28	CLO 28	Solving the heat equation and wave equation in subject to boundary conditions.	PO2, PO4	2
AHSB11.29	CLO 29	Understand the concept of partial differential equations to the real-world problems of electromagnetic and fluid dynamics	PO4	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												gram Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	02	03
CLO 1	3														

CLO 2	3														
CLO 3		2													
CLO 4		2													
CLO 5				1											
CLO 6		2													
CLO 7	3	2													
CLO 8				1											
CLO 9		2		1											
CLO 10	3	2											1		
CLO 11	3	2											1		
CLO 12	3														
CLO 13		2													
CLO 14	3	2											1		
CLO 15		2		1									1		
CLO 16				1											
CLO 17				1									1		
CLO 18		2													
CLO 19	3	2											1		
CLO 20	3														
CLO 21	3												1		
CLO 22	3														
CLO 23				1									1		
CLO 24	3														
CLO 25	3	2													
CLO 26		2		1											
CLO 27		2		1											
CLO 28		2		1									1		
CLO 29				1									1		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1	SEE Exams	PO 1	Assignments	-	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

Module-I	**ROOT FINDING TECHNIQUES AND INTERPOLATION**
Root finding techniques: Solving algebraic and transcendental equations by bisection method, method of false position, Newton-Raphson method; Interpolation: Finite differences, forward differences, backward differences and central differences; Symbolic relations; Newton's forward interpolation, Newton's backward interpolation; Gauss forward central difference formula, Gauss backward central difference formula; Interpolation of unequal intervals: Lagrange's interpolation.	
Module-II	**CURVE FITTING AND NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**
Fitting a straight line; Second degree curves; Exponential curve, power curve by method of least squares; Taylor's series method; Step by step methods: Euler's method, modified Euler's method and Runge-Kutta method for first order differential equations.	
Module-III	**LAPLACE TRANSFORMS**
Definition of Laplace transform, linearity property, piecewise continuous function, existence of Laplace transform, function of exponential order, first and second shifting theorems, change of scale property, Laplace transforms of derivatives and integrals, multiplied by t, divided by t, Laplace transform of periodic functions. Inverse Laplace transform: Definition of Inverse Laplace transform, linearity property, first and second shifting theorems, change of scale property, multiplied by s, divided by s; Convolution theorem and applications.	
Module-IV	**FOURIER TRANSFORMS**
Fourier integral theorem, Fourier sine and cosine integrals; Fourier transforms; Fourier sine and cosine transform, properties, inverse transforms, finite Fourier transforms.	
Module-V	**PARTIAL DIFFERENTIAL EQUATIONS AND APPLICATIONS**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equation by Lagrange method; Charpit's method; method of separation of variables; One dimensional heat and wave equations under initial and boundary conditions.	
Text Books:	
1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010. 2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008. 3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.	
Reference Books:	
1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 9th Edition, , 2006. 2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008. 3. D. Poole, Linear Algebra: A Modern Introduction, Brooks/Cole, 2nd Edition, , 2005. 4. Dr. M Anita, Engineering Mathematics-I, Everest Publishing House, Pune, 1stEdition, 2016.	

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Defining the terms of Algebraic and Transcendental equations	CLO 1	T1:28.1 R1:17.1
2	Apply Bisection method to determine the root of Algebraic and Transcendental equations	CLO 1	T1:28.2 R1:17.2
3	Apply False Position method to determine the root of Algebraic and Transcendental equations	CLO 1	T1:28.2 R1:17.2
4	Apply Newton-Raphson method to determine the root of Algebraic and Transcendental equations	CLO 1	T1:28.2 R1:17.2
5	Define the term interpolation of the given data	CLO 2	T1:29.1-29.3 R1:17.3
6	Explain symbolic relations the between the operators	CLO 2	T1:29.4-29.5 R1:17.3
7	Apply Newton"s forward interpolation formulae for evenly spaced intervals	CLO 3	T1:29.6 R1:17.3
8	Apply Newton"s backward interpolation formulae for evenly spaced intervals	CLO 3	T1:29.6 R1:17.3
9	Apply Gauss forward interpolation formulae for unevenly spaced intervals	CLO 4	T1:29.7-29.8 R1:17.3
10	Apply Gauss backward interpolation formulae for unevenly spaced intervals	CLO 4	T1:29.7-29.8 R1:17.3
11	Apply Lagrange"s interpolation formulae for unevenly spaced intervals	CLO 5	T1:29.9-29.10 R1:17.3
12	Describe the best fit of a straight line by method of least squares	CLO 6	T1:24.4-24.5 R1:18.5
13	Describe the best fit of a second degree parabola by method of least squares	CLO 6	T1:24.4-24.5 R1:18.5
14	Describe the best fit of an exponential curve by method of least squares	CLO 6	T1:24.6 R1:18.5
15	Describe the best fit of a power curve by method of least squares	CLO 6	T1:24.6 R1:18.5
16	Solve the ordinary differential equation by Taylor"s series method	CLO 7	T1:32.3 R1:19.1
17	Solve the ordinary differential equation by Euler"s Method- Euler"s modified method	CLO 7	T1:32.4-32.5 R1:19.1
18	Solve the ordinary differential equation by Runge-Kutta Method	CLO 7	T1:32.7 R1:19.1
19-20	Define Laplace transform and its properties	CLO 9	T1:21.1,21.4 R1:5.1
21	ne Piecewise continuous function, Existence of Laplace transform, Function of exponential order	CLO 9	T1:21.2 R1:5.1
22	Apply Shifting theorems, Change of scale property to evaluate Laplace Transform of a given function	CLO 10	T1:21.4 R1:5.1
23	ly Laplace transforms of derivatives and integrals, multiplied by t, divided by t to a given function	CLO 11, CLO 12	T1:21.7-21.10 R1:5.2-5.4
24	Define periodic functions	CLO 13	T1:21.5 R1:5.2
25	Solve Inverse Laplace transform	CLO 10	T1:21.12 R1:5.1,5.6

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
26	Define and apply shifting theorem, change of scale property	CLO 10	T1:21.13 R1:5.1,5.3
27	Solve multiplied by s, divided by s	CLO 14	T1:21.13 R1:5.4
28	Define and apply Convolution theorem	CLO 15, CLO 16	T1:21.14 R1:5.5
29	Apply Fourier integral theorem to find integrals	CLO 18	T1:22.1-22.2 R1:10.8
30	Apply Fourier sine and cosine integrals to find integrals	CLO 18	T1:22.3 R1:10.8
31-33	Define and apply Fourier transforms	CLO 19	T1:22.4 R1:10.9
34-35	Use properties to solve the given functions	CLO 20	T1:22.5 R1:10.9
36	Define and apply Inverse transforms	CLO 21	T1:22.4 R1:10.9
37	Define and apply Finite Fourier transforms	CLO 22	T1:22.4 R1:10.9
38	Formulate partial differential equations by elimination of arbitrary constants and arbitrary functions	CLO 24, CLO 25	T1:17.1-17.2 R1:16.1-16.2
39-40	Determine Solutions of first order linear equation by Lagrange method	CLO 26	T1:17.5-17.6 R1:16.3.1
41	Solve by Charpit's method	CLO 27	T1:17.7 R1:16.3.2-16.3.3
42	Apply method of separation of variables	CLO 28	T1:18.1-18.2 R1:16.4
43-45	Solving One dimensional heat and wave equations under initial and boundary conditions.	CLO 28	T1:18.4-18.5 R1:16.4

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH POs	RELEVANCE WITH PSOs
1	Newton Raphson method, Lagranges interpolation, method of least square and Runge-kutta method	Seminars	PO 1	PSO 1
2	Fourier Integral Transforms, Convolution theorem in Fourier Transforms	Seminars / NPTEL	PO 2	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations	NPTEL	PO 4	PSO 1

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