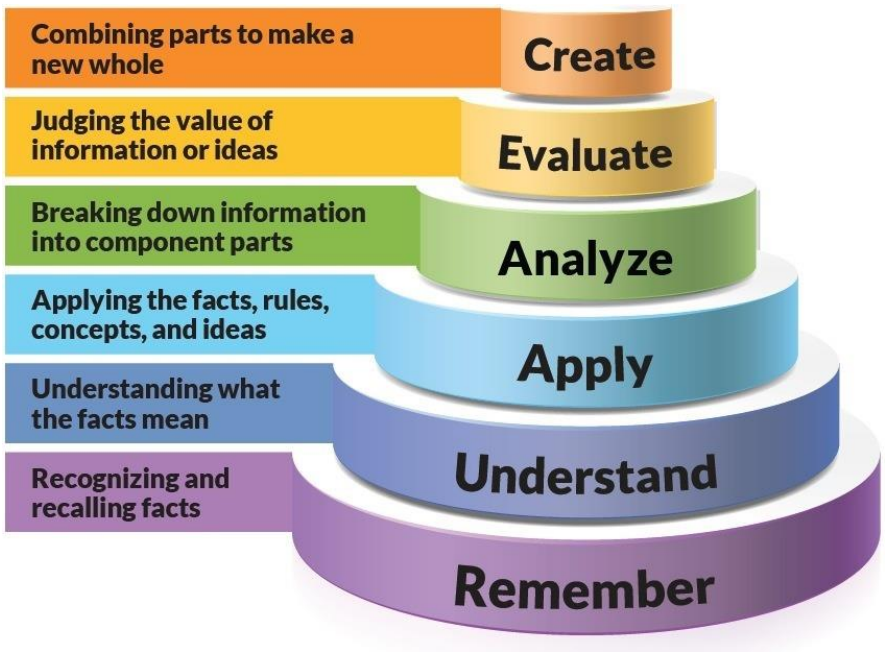
OUTCOME BASED EDUCATION BOOKLET

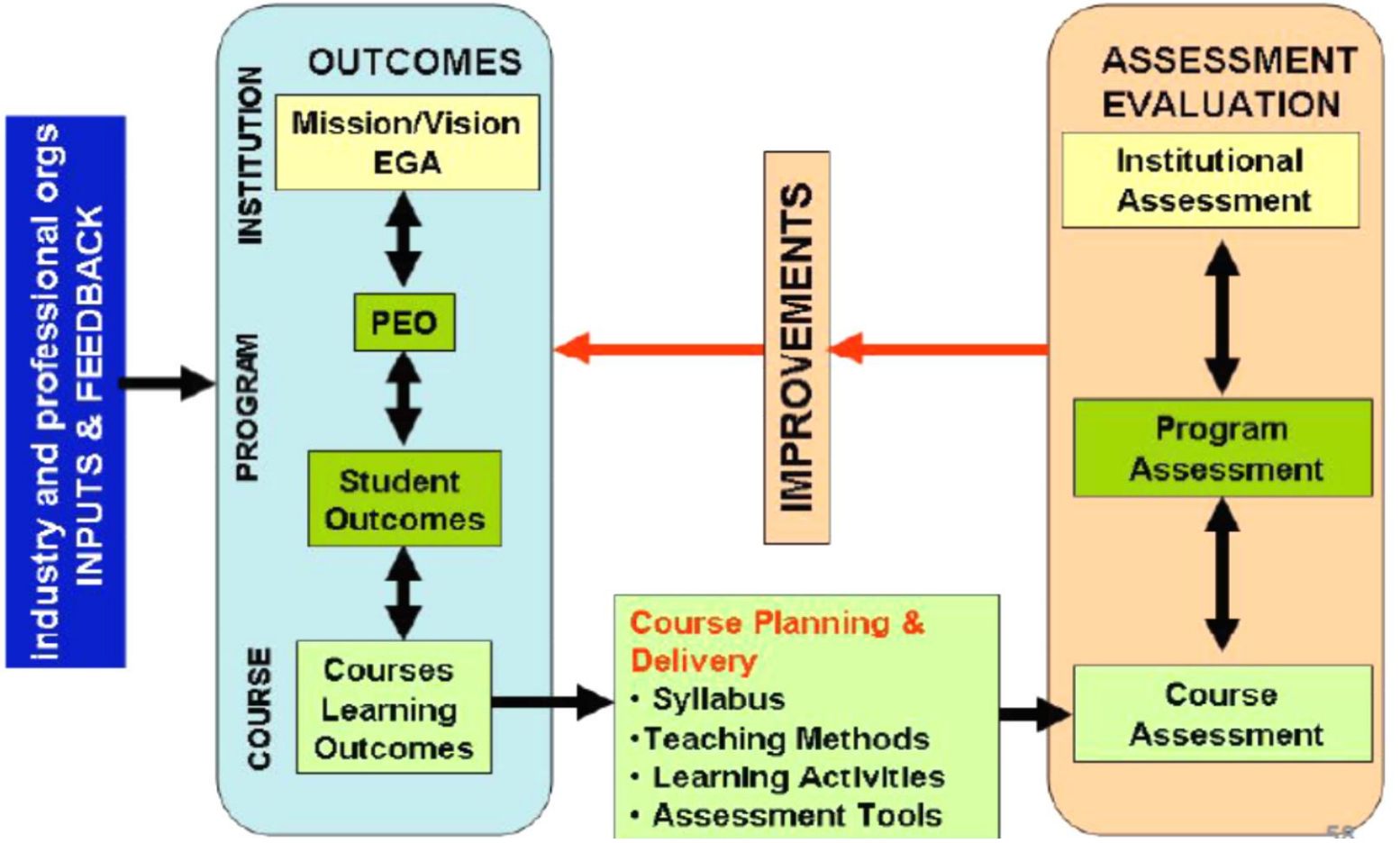
B.Tech
Mechanical Engineering
(Accredited by NBA)

For the batch of students admitted during
2016 – 2017 & 2017-2018 Academic Year



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.

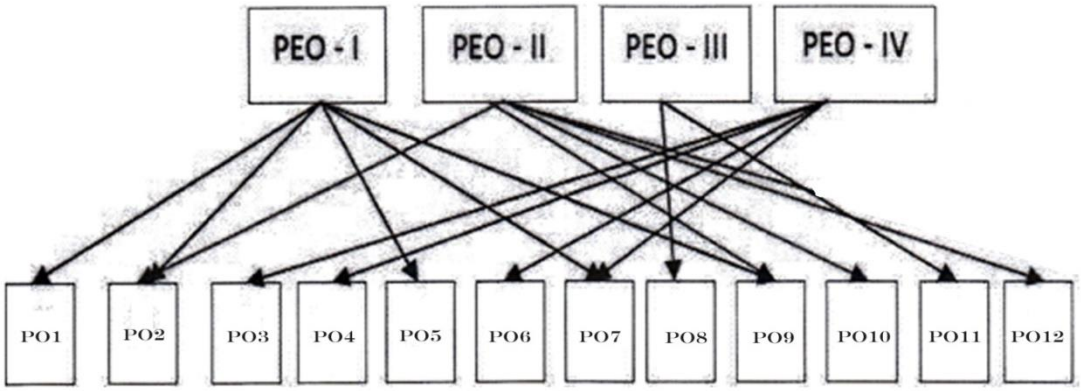
PEO - II	To Prepare students for successful careers in industry that meet the needs of local, Indian and multinational companies.	2. An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering. 3. Competence to design a 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

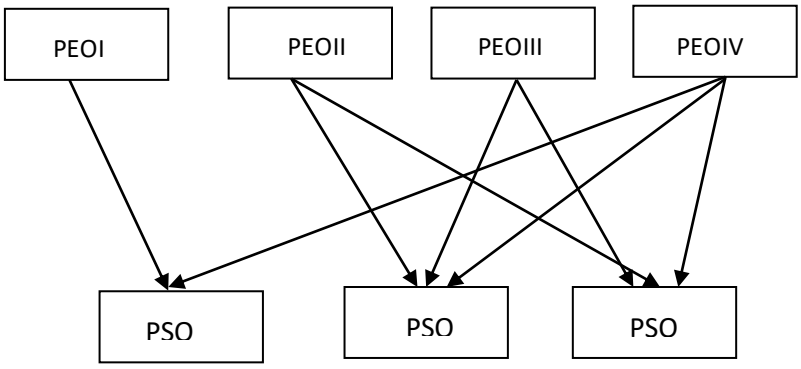
S. No	Program Educational Objectives	Program Specific Outcomes
PEO - I	To Provide students with a sound foundation in Mathematical, Scientific and Engineering fundamentals necessary to formulate, solve and analyze engineering problems.	PSO-1.To produce Engineering professional capable of synthesizing 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 16): FOR THE BATCHES ADMITTED DURING 2016-2017 & 2017- 2018 MAPPING OF COURSES TO PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

B. Tech (R16)

	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**
AHS001	English for Communication									✔	✔	✔				✔
AHS002	Linear Algebra and Ordinary Differential Equations	✔	✔		✔									✔		
AHS005	Engineering Chemistry	✔	✔					✔						✔		
AHS007	Applied Physics	✔	✔		✔									✔		
AME001	Engineering Drawing	✔	✔	✔	✔	✔				✔		✔	✔	✔	✔	
PRACTICAL																
AHS101	Communication Skills Laboratory	✔									✔		✔		✔	✔
AHS103	Engineering Chemistry Lab	✔	✔	✔	✔	✔	✔	✔		✔			✔	✔	✔	
ACS113	IT Workshop	✔	✔			✔	✔		✔	✔			✔	✔	✔	✔
AME101	Basic Workshop					✔	✔			✔		✔	✔	✔	✔	✔

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**
AME002	Engineering Mechanics	✔	✔		✔									✔		
AHS003	Computational Mathematics and Integral Calculus	✔	✔		✔									✔		
AHS008	Modern Physics	✔	✔		✔									✔		
AHS009	Environmental Studies	✔		✔		✔		✔						✔		
ACS001	Computer Programming	✔	✔	✔		✔							✔	✔	✔	✔
PRACTICAL																
AHS102	Computational Mathematics Laboratory	✔	✔	✔	✔	✔									✔	
AHS105	Engineering Physics Lab	✔	✔	✔	✔	✔	✔	✔		✔			✔	✔	✔	
ACS101	Computer Programming Lab	✔	✔			✔	✔		✔	✔			✔	✔	✔	✔
AME102	Computer Aided Engineering Drawing Practice	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔	

II Year I Semester		PO'S												PSO'S		
CODE	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
AHS010	Probability and Statistics	✔	✔		✔									✔		
AME003	Thermodynamics	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
AME004	Mechanics of Solids	✔	✔	✔			✔	✔						✔	✔	✔
AME005	Metallurgy and Materials Science	✔	✔	✔	✔		✔			✔		✔	✔	✔	✔	✔
AEE018	Basic Electrical and Electronics Engineering	✔	✔		✔									✔		
AHS017	Gender Sensitivity						✔		✔							
PRACTICAL																
AME104	Metallurgy & Mechanics of Solids Lab	✔	✔	✔	✔			✔		✔			✔	✔	✔	✔
AME105	Machine Drawing through CAD Lab		✔	✔	✔	✔		✔		✔	✔	✔	✔	✔	✔	✔
AEE103	Basic Electrical and Electronics Engineering Lab	✔	✔	✔	✔	✔	✔	✔		✔			✔	✔	✔	✔

II Year II Semester		PO'S												PSO'S		
CODE	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
AHS011	Mathematical Transforms Techniques	✔	✔		✔									✔		
AME006	Production Technology	✔	✔	✔		✔								✔	✔	
AME007	Applied Thermodynamics	✔	✔	✔										✔		
AME008	Mechanics of Fluids and Hydraulic Machines	✔	✔	✔	✔									✔	✔	
AME009	Kinematics of Machinery	✔	✔	✔	✔									✔	✔	
PRACTICAL																
AME106	Computational Mechanical Engineering Laboratory	✔	✔		✔	✔		✔					✔	✔	✔	
AME107	Production Technology Lab	✔		✔			✔	✔		✔		✔	✔	✔	✔	✔
AME108	Mechanics of Fluids & Hydraulic Machines Lab	✔	✔	✔	✔	✔	✔	✔		✔			✔	✔	✔	✔
III Year I Semester		**PO'S**												**PSO'S**		
CODE	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
AME010	Machine Tools & Metrology	✔	✔	✔	✔									✔	✔	✔

AME011	Dynamics of Machinery	✔	✔		✔		✔						✔		
AME012	Design of Machine Members	✔	✔	✔	✔								✔	✔	✔
AME013	Thermal Engineering	✔	✔		✔								✔		✔
AHS015	Business Economics and Financial Analysis	✔	✔	✔			✔			✔		✔			✔
Professional Elective – I															
AME507	Unconventional Machining Processes	✔	✔		✔		✔						✔	✔	✔
AME508	Computer Numerical Control Technology														
AME509	Tool Design	✔	✔	✔			✔						✔		
PRACTICAL															
AME109	Thermal Engineering Lab	✔	✔	✔	✔	✔	✔	✔		✔			✔	✔	✔	✔
AME110	Machine Tools & Metrology Lab	✔		✔				✔		✔		✔	✔	✔	✔	✔
AHS106	Research and Content Development Lab		✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔

III Year II Semester		PO'S												PSO'S		
CODE	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
AME014	Finite Element Modeling	✔	✔	✔		✔								✔	✔	✔
AME015	Machine Design	✔	✔											✔	✔	✔
AME016	Heat Transfer	✔	✔		✔									✔		
Professional Elective - II																
Open Electives-I																
AAE551	Aerospace Propulsion and Combustion	✔	✔	✔										✔		
Note: * indicates that subject not offered to the students of Mechanical Engineering department.																
PRACTICAL																
AME111	Theory of Machines Laboratory	✔	✔	✔	✔	✔	✔	✔		✔			✔	✔	✔	
AME112	Heat Transfer Lab	✔	✔	✔	✔	✔	✔	✔		✔			✔	✔	✔	✔
AME113	Fluid, Thermal Modeling and Simulation Laboratory	✔									✔		✔			✔
AME201	Ideation and Product Development Lab			✔			✔			✔	✔	✔		✔	✔	✔

IV Year I Semester		PO'S												PSO'S		
CODE	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
AME019	Instrumentation and Control Systems	✔	✔	✔			✔							✔	✔	
Professional Elective - III																
AME525	Solar Energy Systems	✔	✔		✔									✔		
AME526	Non-Destructive Testing	✔		✔	✔	✔								✔	✔	✔
PRACTICAL																
AME114	Computer Aided Design and Production Drawing Practice Laboratory	✔	✔	✔	✔	✔		✔		✔			✔	✔	✔	✔
AME115	Computer Aided Numerical Control Laboratory	✔	✔	✔	✔	✔		✔		✔			✔	✔	✔	✔
AME116	Instrumentation and Control Systems Laboratory	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔
AME301	Project Work (Phase- I)	✔	✔	✔	✔	✔		✔		✔		✔	✔	✔	✔	✔
IV Year II Semester		**PO'S**												**PSO'S**		
CODE	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
AME020	Automobile Engineering	✔	✔	✔	✔	✔	✔	✔		✔			✔	✔	✔	✔
AME021	Operations Research	✔	✔				✔	✔		✔	✔	✔	✔	✔	✔	✔

Professional Elective - IV																
AME531	Mechatronics	✔	✔	✔	✔	✔	✔	✔		✔			✔	✔	✔	✔
AME532	Automation in Manufacturing	✔	✔	✔	✔	✔	✔	✔				✔	✔	✔	✔	✔
AME533	Robotics	✔	✔	✔	✔	✔	✔	✔		✔			✔	✔	✔	✔
AME534	Wind Tunnel Testing Techniques	✔			✔	✔							✔	✔	✔	
AME535	Maintenance and Safety Engineering	✔	✔				✔	✔	✔	✔	✔	✔	✔	✔	✔	
AME536	Flexible Manufacturing System	✔	✔	✔			✔						✔	✔		✔
PRACTICAL																
AME401	Comprehensive Examination					✔					✔	✔			✔	✔
AME302	Project work (Phase-II)	✔	✔	✔	✔	✔		✔		✔		✔	✔	✔	✔	✔
AUDIT COURSES																
AHS601	Intellectual Property Rights	✔	✔				✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
AHS602	Total Quality Management	✔	✔				✔	✔	✔	✔	✔	✔	✔	✔	✔	
AHS603	Professional Ethics and Human Values	✔	✔				✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
AHS604	Legal Sciences			✔		✔			✔	✔	✔					
AHS605	Clinical Psychology							✔	✔		✔					
AHS606	English for Special Purposes								✔		✔				✔	

AHS607	Entrepreneurship				✔	✔	✔		✔							✔
AHS608	Any Foreign Language						✔	✔	✔	✔	✔	✔				
AHS609	Design History			✔	✔	✔		✔				✔		✔	✔	
AHS017	Gender Sensitivity								✔	✔	✔	✔				

XII. Outcome Delivery and Assessment (R16)
(For batches admitted during 2016)

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.			
		AHS015	Business Economics and Financial Analysis
AHS002	Linear Algebra and Ordinary Differential Equations	AME504	Renewable Energy Sources
AHS005	Engineering Chemistry	AHS101	Communication Skills Laboratory
AHS007	Applied Physics	AHS103	Engineering Chemistry Laboratory
ACS113	IT Workshop	AME507	Unconventional Machining Processes
AME002	Engineering Mechanics	AME509	Tool Design
AHS003	Computational Mathematics and Integral Calculus	AME510	Additive Manufacturing Techniques
AHS008	Modern Physics	AME511	Design Fabrication of Composites
AHS009	Environmental Studies	AME512	Precision Engineering
ACS001	Computer Programming	AME109	Thermal Engineering Laboratory
AHS102	Computational Mathematics Laboratory	AME110	Machine Tools and Metrology laboratory
AHS105	Engineering Physics Laboratory	AME014	Finite Element Modeling
ACS101	Computer Programming Laboratory	AME015	Machine Design
AME102	Computer Aided Engineering Drawing Practice	AME016	Heat Transfer
AHS010	Probability and Statistics	AME513	Plant Layout and Material Handling
AME003	Thermodynamics	AME514	Management Information Systems
AME004	Mechanics of Solids	AME515	Nanomaterials
AME005	Metallurgy and Material Science	AME516	Engineering Optimization
AEE018	Basic Electrical and Electronics Engineering	AME517	Engineering Materials
AME104	Metallurgy and Mechanics of Solids Laboratory	AME518	Production Planning and Control
AEE103	Basic Electrical and Electronics Engineering Laboratory	AME519	Design of Hydraulic and Pneumatic Systems
AHS011	Mathematical Transforms Techniques	AME520	Design for Manufacturing and Assembly
AME006	Production Technology	AME521	Design and Analysis of Composite Structures
AME007	Applied Thermodynamics	AME522	Advanced Strength of Materials
AME008	Mechanics of Fluids and Hydraulic Machines	AME523	Machine Dynamics
AME009	Kinematics of Machinery	AME524	Mechanical Vibrations
AME106	Computational Mechanical Engineering Laboratory	AME551	Elements of Mechanical Engineering*
AME107	Production Technology Laboratory	ACE551	Disaster Management
AME108	Mechanics of Fluids and Hydraulic Machines Laboratory	ACE552	Geospatial Techniques
AME010	Machine Tools and Metrology	ACS003	Object Oriented Programming through JAVA
AME011	Dynamics of Machinery	AME019	Instrumentation and Control Systems
AME012	Design of Machine Members	AME525	Solar Energy Systems
AME013	Thermal Engineering	AME526	Non-Destructive Testing
AAE551	Aerospace Propulsion and Combustion	AME201	Ideation and Product Development Lab
AME111	Theory of Machines Laboratory	AME114	Computer Aided Design and Production Drawing Practice

			Laboratory
AME112	Heat Transfer Laboratory	AME115	Computer Aided Numerical Control Laboratory
AME113	Fluid, Thermal Modeling and Simulation Laboratory	AME116	Instrumentation and Control Systems Laboratory
AME301	Project Work (Phase- I)	AME534	Wind Tunnel Testing Techniques
AME020	Automobile Engineering	AME535	Maintenance and Safety Engineering
AME021	Operations Research	AME536	Flexible Manufacturing System
AME531	Mechatronics	AME302	Project Work (Phase- II)
AME532	Automation in Manufacturing	AHS601	Intellectual Property Rights
AME533	Robotics	AHS602	Total Quality Management
AHS603	Professional Ethics and Human Values		
Program Outcome (2): An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering.			
AHS002	Linear Algebra and Ordinary Differential Equations		
AHS007	Applied Physics	AME001	Engineering Drawing
AHS005	Engineering Chemistry	AHS103	Engineering Chemistry Laboratory
ACS113	IT Workshop	AME002	Engineering Mechanics
AME005	Metallurgy and Material Science	AHS008	Modern Physics
AME006	Production Technology	AHS010	Probability and Statistics
AME010	Machine Tools and Metrology	AME004	Mechanics of Solids
AME019	Instrumentations and Control Systms	AME104	Metallurgy and Mechanics of Solids Laboratory
AME003	Thermodynamics	AEE103	Basic Electrical and Electronics Engineering Laboratory
AEE018	Basic Electrical and Electronics Engineering	AME007	Applied Thermodynamics
AME105	Machine Drawing through CAD Laboratory	AME009	Kinematics of Machinery
AHS011	Mathematical Transforms Techniques	AME108	Mechanics of Fluids and Hydraulic Machines Laboratory
AME008	Mechanics of Fluids and Hydraulic Machines	AME012	Design of Machine Members
AME106	Computational Mechanical Engineering Laboratory	AHS015	Business Economics and Financial Analysis
AME011	Dynamics of Machinery	ACS001	Computer Programming
AME013	Thermal Engineering	AME526	Non Destructive Testing
AHS009	Environmental Studies	AME509	Tool Design
AHS015	Business Economics and Financial Analysis	AHS106	Research and Content Development Laboratory
AME507	Unconventional Machining Processes	AME015	Machine Design
AME109	Thermal Engineering Laboratory	AAE551	Aerospace Propulsion and Combustion
AME014	Finite Element Modeling	AME112	Heat Transfer Laboratory
AME016	Heat Transfer	AME114	Computer Aided Design and Production Drawing Practice Laboratory
AME111	Theory of Machines Laboratory	AME116	Instrumentation and Control Systems Laboratory
AME115	Computer Aided Numerical Control Laboratory	AME020	Automobile Engineering
AME301	Project Work (Phase- I)	AME531	Mechatronics
AME021	Operations Research	AME533	Robotics
AME532	Automation in Manufacturing	AME536	Flexible Manufacturing System
AME535	Maintenance and Safety Engineering	AHS601	Intellectual Property Rights

AME302	Project Work (Phase- II)	AHS603	Professional Ethics and Human Values
AHS602	Total Quality Management		
Program Outcome (3): Competence to design a system, component or process to meet societal needs within realistic constraints.			
AHS005	Engineering Chemistry	AHS007	Applied Physics
AME001	Engineering Drawing	AHS103	Engineering Chemistry Laboratory
AME002	Engineering Mechanics	AHS008	Modern Physics
AHS102	Computational Mathematics Laboratory	AHS105	Engineering Physics Laboratory
AME102	Computer Aided Engineering Drawing Practice	AME003	Thermodynamics
AME004	Mechanics of Solids	AME005	Metallurgy and Material Science
AME104	Metallurgy and Mechanics of Solids Laboratory	AME105	Machine Drawing through CAD Laboratory
AEE103	Basic Electrical and Electronics Engineering Laboratory	AME006	Production Technology
AME007	Applied Thermodynamics	AME008	Mechanics of Fluids and Hydraulic Machines
AME009	Kinematics of Machinery	AME107	Production Technology Laboratory
AME108	Mechanics of Fluids and Hydraulic Machines Laboratory	AME010	Machine Tools and Metrology
AME013	Thermal Engineering	AME012	Design of Machine Members
AME109	Thermal Engineering Laboratory	AME501	Heating Ventilation and Air-Conditioning System
AHS106	Research and Content Development Laboratory	AME110	Machine Tools and Metrology laboratory
AAE551	Aerospace Propulsion and Combustion	AME014	Finite Element Modeling
AME112	Heat Transfer Laboratory	AME111	Theory of Machines Laboratory
AME019	Instrumentation and Control Systems	AME201	Mini Project
AME114	Computer Aided Design and Production Drawing Practice Laboratory	AME509	Tool Design
AME116	Instrumentation and Control Systems Laboratory	AME115	Computer Aided Numerical Control Laboratory
AME020	Automobile Engineering	AME301	Project Work (Phase- I)
AME532	Automation in Manufacturing	AME531	Mechatronics
AME536	Flexible Manufacturing System	AME533	Robotics
AHS604	Legal Sciences	AME302	Project Work (Phase- II)
AME524	Mechanical Vibrations	AHS609	Design History
Program Outcome (4): To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.			
AHS002	Linear Algebra and Ordinary Differential Equations	AHS102	Computational Mathematics Laboratory
AHS007	Applied Physics	AME001	Engineering Drawing
AHS103	Engineering Chemistry Laboratory	AME002	Engineering Mechanics
AHS003	Computational Mathematics and Integral Calculus	AHS008	Modern Physics
AHS105	Engineering Physics Laboratory	AME102	Computer Aided Engineering Drawing Practice
AHS010	Probability and Statistics	AME003	Thermodynamics
AME004	Mechanics of Solids	AME104	Metallurgy and Mechanics of Solids Laboratory
AEE018	Basic Electrical and Electronics Engineering	AME105	Machine Drawing through CAD Laboratory
AEE103	Basic Electrical and Electronics	AME109	Thermal Engineering Laboratory

	Engineering Laboratory		
AHS011	Mathematical Transforms Techniques	AME008	Mechanics of Fluids and Hydraulic Machines
AME009	Kinematics of Machinery	AME106	Computational Mechanical Engineering Laboratory
AME108	Mechanics of Fluids and Hydraulic Machines Laboratory	AME011	Dynamics of Machinery
AME012	Design of Machine Members	AME013	Thermal Engineering
AHS609	Design History	AME005	Metallurgy and Material Science
AME010	Machine Tools and Metrology	AME507	Unconventional Machining Process
AHS106	Research and Content Development Laboratory	AME016	Heat Transfer
AME111	Theory of Machines Laboratory	AME112	Heat Transfer Laboratory
AME526	Non-Destructive Testing	AME525	Solar Energy Systems
AME114	Computer Aided Design and Production Drawing Practice Laboratory	AME115	Computer Aided Numerical Control Laboratory
AME116	Instrumentation and Control Systems Laboratory	AME301	Project Work (Phase- I)
AME020	Automobile Engineering	AME531	Mechatronics
AME532	Automation in Manufacturing	AME533	Robotics
AME534	Wind Tunnel Testing Techniques	AME302	Project Work (Phase- II)
AHS607	Entrepreneurship		
Program Outcome (5): An ability to formulate solve complex engineering problem using modern engineering and Information technology tools.			
AHS103	Engineering Chemistry Laboratory	AHS007	Applied Physics
AME101	Basic Workshop	AME001	Engineering Drawing
AME014	Finite Element Modeling	ACS113	IT Workshop
AHS009	Environmental Studies	ACS001	Computer Programming
AHS102	Computational Mathematics Laboratory	AHS105	Engineering Physics Laboratory
ACS101	Computer Programming Laboratory	AME102	Computer Aided Engineering Drawing Practice
AME401	Comprehensive Examination	AME003	Thermodynamics
AME526	Non-Destructive Testing	AEE018	Basic Electrical and Electronics Engineering
AME105	Machine Drawing through CAD Laboratory	AEE103	Basic Electrical and Electronics Engineering Laboratory
		AME006	Production Technology
AME106	Computational Mechanical Engineering Laboratory	AME108	Mechanics of Fluids and Hydraulic Machines Laboratory
AME109	Thermal Engineering Laboratory	AHS106	Research and Content Development Laboratory
AME111	Theory of Machines Laboratory	AME112	Heat Transfer Laboratory
AME114	Computer Aided Design and Production Drawing Practice Laboratory	AME115	Computer Aided Numerical Control Laboratory
AME116	Instrumentation and Control Systems Laboratory	AME301	Project Work (Phase- I)
AME020	Automobile Engineering	AME531	Mechatronics
AME532	Automation in Manufacturing	AME533	Robotics
AME534	Wind Tunnel Testing Techniques	AME302	Project Work (Phase- II)
AHS604	Legal Sciences	AHS607	Entrepreneurship
AHS609	Design History		
Program Outcome (6): To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.			

AME003	Thermodynamics	AME004	Mechanics of Solids
AME005	Metallurgy and Material Science	AHS103	Engineering Chemistry Laboratory
ACS113	IT Workshop	AME101	Basic Workshop
AME002	Engineering Mechanics	AME011	Dynamics of Machinery
AME507	Unconventional Machining Process	AME201	Ideation and Product Development Lab
AHS105	Engineering Physics Laboratory	AME102	Computer Aided Engineering Drawing Practice
ACS101	Computer Programming Laboratory	AME509	Tool Design
AHS017	Gender Sensitivity	AEE103	Basic Electrical and Electronics Engineering Laboratory
AME107	Production Technology Laboratory	AME108	Mechanics of Fluids and Hydraulic Machines Laboratory
AHS015	Business Economics and Financial Analysis	AME109	Thermal Engineering Laboratory
AHS106	Research and Content Development Laboratory	AME112	Heat Transfer Laboratory
AME116	Instrumentation and Control Systems Laboratory	AME111	Theory of Machines Laboratory
AHS607	Entrepreneurship	AME017	Refrigeration and Air Conditioning
AHS608	Any Foreign Language	AME019	Instrumentation and Control Systems
AME020	Automobile Engineering	AME021	Operations Research
AME531	Mechatronics	AME532	Automation in Manufacturing
AME533	Robotics	AME536	Flexible Manufacturing System
AME535	Maintenance and Safety Engineering	AHS601	Intellectual Property Rights
AHS602	Total Quality Management	AHS603	Professional Ethics and Human Values
Program Outcome (7): To understand impact of engineering solutions in the societal context and demonstrate the knowledge for sustainable development.			
AHS103	Engineering Chemistry Laboratory	AHS005	Engineering Chemistry
AHS009	Environmental Studies	AME105	Machine Drawing through CAD Laboratory
AHS105	Engineering Physics Laboratory	AME003	Thermodynamics
AME004	Mechanics of Solids	AME104	Metallurgy and Mechanics of Solids Laboratory
AEE103	Basic Electrical and Electronics Engineering Laboratory	AME108	Mechanics of Fluids and Hydraulic Machines Laboratory
AME106	Computational Mechanical Engineering Laboratory	AME107	Production Technology Laboratory
AME109	Thermal Engineering Laboratory	AME110	Machine Tools and Metrology laboratory
AHS106	Research and Content Development Laboratory	AME201	Ideation and Product Development Lab
AME111	Theory of Machines Laboratory	AME112	Heat Transfer Laboratory
AME114	Computer Aided Design and Production Drawing Practice Laboratory	AME115	Computer Aided Numerical Control Laboratory
AME116	Instrumentation and Control Systems Laboratory	AME301	Project Work (Phase- I)
AME020	Automobile Engineering	AME021	Operations Research
AME531	Mechatronics	AME532	Automation in Manufacturing
AME533	Robotics	AME535	Maintenance and Safety Engineering
AME302	Project Work (Phase- II)	AHS601	Intellectual Property Rights
AHS602	Total Quality Management	AHS603	Professional Ethics and Human Values
AHS605	Clinical Psychology	AHS608	Any Foreign Language
AHS609	Design History		

Program Outcome (8): An understanding and implementation of professional and Ethical responsibilities.			
ACS113	IT Workshop	AME003	Thermodynamics
ACS101	Computer Programming Laboratory	AME102	Computer Aided Engineering Drawing Practice
AHS017	Gender Sensitivity	AME535	Maintenance and Safety Engineering
AHS601	Intellectual Property Rights	AHS602	Total Quality Management
AHS603	Professional Ethics and Human Values	AHS604	Legal Sciences
AHS606	English for Special Purposes	AHS607	Entrepreneurship
AHS608	Any Foreign Language	AHS605	Clinical Psychology
Program Outcome (9): To function as an effective individual and as a member or leader in Multi-disciplinary environment and adopt in diverse teams.			
AME001	Engineering Drawing	AHS103	Engineering Chemistry Laboratory
ACS113	IT Workshop	AME101	Basic Workshop
AHS001	English for Communication	AHS105	Engineering Physics Laboratory
ACS101	Computer Programming Laboratory	AME102	Computer Aided Engineering Drawing Practice
AME003	Thermodynamics	AME104	Metallurgy and Mechanics of Solids Laboratory
AME005	Metallurgy and Material Science	AEE103	Basic Electrical and Electronics Engineering Laboratory
AME105	Machine Drawing through CAD Laboratory	AHS015	Business Economics and Financial Analysis
AME107	Production Technology Laboratory	AME108	Mechanics of Fluids and Hydraulic Machines Laboratory
AME111	Theory of Machines Laboratory	AME109	Thermal Engineering Laboratory
AME110	Machine Tools and Metrology laboratory	AHS106	Research and Content Development Laboratory
AME112	Heat Transfer Laboratory	AME201	Ideation and Product Development Lab
AME114	Computer Aided Design and Production Drawing Practice Laboratory	AME115	Computer Aided Numerical Control Laboratory
AME116	Instrumentation and Control Systems Laboratory	AME301	Project Work (Phase- I)
AME020	Automobile Engineering	AME531	Mechatronics
AME021	Operations Research	AME533	Robotics
AME535	Maintenance and Safety Engineering	AME302	Project Work (Phase- II)
AHS601	Intellectual Property Rights	AHS602	Total Quality Management
AHS604	Legal Sciences	AHS608	Any Foreign Language
AHS603	Professional Ethics and Human Values	AHS017	Gender Sensitivity
Program Outcome (10): An ability to assimilate, comprehend, communicate, give and receive instructions to present effectively with engineering community and society.			
AHS001	English for Communication	AME003	Thermodynamics
AHS101	Communication Skills Laboratory		
AME102	Computer Aided Engineering Drawing Practice	AME105	Machine Drawing through CAD Laboratory
AME201	Ideation and Product Development Lab	AHS106	Research and Content Development Laboratory
AME113	Fluid, Thermal Modeling and Simulation Laboratory	AME021	Operations Research
AME116	Instrumentation and Control Systems Laboratory	AHS017	Gender Sensitivity
AME535	Maintenance and Safety	AME401	Comprehensive Examination

	Engineering		
AHS601	Intellectual Property Rights	AHS602	Total Quality Management
AHS603	Professional Ethics and Human Values	AHS604	Legal Sciences
AHS605	Clinical Psychology	AHS606	English for Special Purposes
AHS608	Any Foreign Language		
Program Outcome (11): An ability to provide leadership in managing complex engineering projects at multi-disciplinary environment and to become a professional engineer.			
AME001	Engineering Drawing	AME101	Basic Workshop
AME102	Computer Aided Engineering Drawing Practice	AME005	Metallurgy and Material Science
AME105	Machine Drawing through CAD Laboratory	AME006	Production Technology
AME107	Production Technology Laboratory	AME010	Machine Tools and Metrology
AHS015	Business Economics and Financial Analysis	AME507	Unconventional Machining Processes
AME509	Tool Design	AME512	Precision Engineering
AME110	Machine Tools and Metrology laboratory	AHS106	Research and Content Development Laboratory
AHS001	English for Communication	AME514	Management Information Systems
AME003	Thermodynamics	AME518	Production Planning and Control
		AME520	Design for Manufacturing and Assembly
AME021	Operations Research	AEC016	Embedded Systems
AME301	Project Work (Phase- I)	AME201	Ideation and Product Development Lab
AME535	Maintenance and Safety Engineering	AEC508	Digital Image Processing
AME302	Project Work (Phase- II)	AME116	Instrumentation and Control Systems Laboratory
AHS602	Total Quality Management	AME532	Automation in Manufacturing
AHS608	Any Foreign Language	AME401	Comprehensive Examination
AHS017	Gender Sensitivity	AHS601	Intellectual Property Rights
AHS609	Design History	AHS603	Professional Ethics and Human Values
Program Outcome (12): Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.			
AHS101	Communication Skills Laboratory	AME001	Engineering Drawing
AHS103	Engineering Chemistry Laboratory	AME101	Basic Workshop
ACS113	IT Workshop	AME507	Unconventional Machining Processes
ACS001	Computer Programming	AME109	Thermal Engineering Laboratory
AHS105	Engineering Physics Laboratory	AME110	Machine Tools and Metrology laboratory
ACS101	Computer Programming Laboratory	AHS106	Research and Content Development Lab
AME102	Computer Aided Engineering Drawing Practice	AME015	Machine Design
		AME016	Heat Transfer
AME003	Thermodynamics	AME513	Plant Layout and Material Handling
		AME514	Management Information Systems
AME005	Metallurgy and Material Science	AME515	Nanomaterials
		AME516	Engineering Optimization
AME104	Metallurgy and Mechanics of Solids Laboratory	AME517	Engineering Materials
AME106	Computational Mechanical Engineering Laboratory	AME518	Production Planning and Control
AME107	Production Technology Laboratory	AME519	Design of Hydraulic and Pneumatic Systems

AME108	Mechanics of Fluids and Hydraulic Machines Laboratory	AME520	Design for Manufacturing and Assembly
AME010	Machine Tools and Metrology	AME521	Design and Analysis of Composite Structures
AME111	Theory of Machines Laboratory	AME522	Advanced Strength of Materials
AME112	Heat Transfer Laboratory	AME523	Machine Dynamics
AME113	Fluid, Thermal Modeling and Simulation Laboratory	AME524	Mechanical Vibrations
AME201	Mini Project	AME001	Engineering Drawing
AME114	Computer Aided Design and Production Drawing Practice Laboratory	AME115	Computer Aided Numerical Control Laboratory
AME105	Machine drawing through CAD Lab	AME116	Instrumentation and Control Systems Laboratory
AME301	Project Work (Phase- I)	AME534	Wind Tunnel Testing Techniques
AME020	Automobile Engineering	AME535	Maintenance and Safety Engineering
AME021	Operations Research	AME536	Flexible Manufacturing System
AME531	Mechatronics	AME302	Project Work (Phase- II)
AME532	Automation in Manufacturing	AHS601	Intellectual Property Rights
AME533	Robotics	AHS602	Total Quality Management
AHS603	Professional Ethics and Human Values	AME101	Basic Workshop

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 (R16)

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. Visualize the concepts of measurement and dynamic performance characteristics of measuring instruments
2. Understand the measurement of typical physical quantities like displacement, temperature, pressure, discharge, and speed.
3. Comprehend for machine condition</td><td><table><tr><td>S. No.</td><td>Description</td></tr><tr><td>AME019.01</td><td>Understand the basic principles and performance characteristics of measurement</td></tr><tr><td>AME019.02</td><td>Apply the working principles</td></tr></table></td></tr>
</table>

monitoring systems by using seismic instruments.

4. Develop electronic servo and interfacing systems for analogue to digital measurement.

	and identify the measurands for displacement
AME019.03	Understand the temperature and importance of maintaining in various applications
AME019.04	Evaluate the temperature measuring methods in various equipment for knowing the ranges
AME019.05	Visualize the areas affected with pressure in equipment and calibrate the pressure measuring devices
AME019.06	Understand the fluid pressure and the importance of pressure measurement
AME019.07	Comprehend the level of liquid in any container and the measuring devices available for liquid level
AME019.08	Visualize the importance of flow measurement and know various flow measuring devices along with obstruction devices
AME019.09	Evaluate the measurement of speed in engineering applications and importance of speed measurement in instrumentation
AME019.10	Comprehend the importance of acceleration and vibration measurements in various equipment and understand the instruments used for measurement of vibration
AME019.11	Visualize the stress & strain experienced by various elements and to understand the importance of strain measurement with various techniques
AME019.12	Understand the concept of humidity in atmosphere as well as the storage applications and maintenance of humidity by measurement
AME019.13	Apply the basic principles and characteristics for force in engineering applications
AME019.14	Understand the instrumentation for force measurement in various fields of engineering

AME019.15	Visualize the concept of torque and power in various equipment in engineering applications
AME019.16	Apply the principles to gather the data regarding measurement of torque and power
AME019.17	Comprehend the instrumentation techniques in solving the engineering measuring applications for torque
AME019.18	Apply the techniques used for measurement of power and evaluate the power for general requirements of engineering
AME019.19	Understand the control systems for instrumentation in various practical applications
AME019.20	Classify the control systems with their advantages and limitations

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	**INSTRUMENTATION AND CONTROL SYSTEMS**				
Course Code	AME019				
Programme	B.Tech				
Semester	VII	ME			
Course Type	Core				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	2	1
Chief Coordinator	Dr. Paidi Raghavulu, Professor, ME				
Course Faculty	Mr. B D Y Sunil, Associate Professor, ME				

I. COURSE OVERVIEW:

The Present course concentrates on developing basic understanding about various instruments that are involved in measuring. This course enables the student to understand the working of various measuring instruments. The course focuses on all principles, working, advantages, disadvantages and applications of various measuring instruments. In this course; students also will gain a broad understanding of the control systems. Student can learn in detail about how to measure displacement, temperature, pressure, level, flow, acceleration, vibration, strain, humidity, force, torque and power and their appropriate application.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME010	V	Machine Tools and Metrology	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Instrumentation And Control Systems	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 units and each unit 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 unit. 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 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	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 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five 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 / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may

include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**3**	Assignments
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**2**	Seminars
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	**2**	Assignments
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assesssocietal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	**2**	Seminars

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.	**2**	Assignments
PSO 2	**Problem Solving Skills:**An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	**2**	Seminars
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	Visualize the concepts of measurement and dynamic performance characteristics of measuring instruments.
II	Understand the measurement of typical physical quantities like displacement, temperature, pressure, discharge, and speed.
III	Comprehend for machine condition monitoring systems by using seismic instruments.
IV	Develop electronic servo and interfacing systems for analogue to digital measurement.

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
AME019.01	CLO 1	Understand the basic principles and performance characteristics of measurement	PO1,PO2	3
AME019.02	CLO 2	Apply the working principles and identify the measurands for displacement	PO1,PO2	2
AME019.03	CLO 3	Understand the temperature and importance of maintaining in various applications	PO2, PSO3	3
AME019.04	CLO 4	Evaluate the temperature measuring methods in various equipment for knowing the ranges	PO3	3
AME019.05	CLO 5	Visualize the areas affected with pressure in equipment and calibrate the pressure measuring devices	PO2,PO3	2
AME019.06	CLO 6	Understand the fluid pressure and the importance of pressure measurement	PO2	2
AME019.07	CLO 7	Comprehend the level of liquid in any container and the measuring devices available for liquid level	PO3	3
AME019.08	CLO 8	Visualize the importance of flow measurement and know various flow measuring devices along with obstruction devices	PO1,PO3	2
AME019.09	CLO 9	Evaluate the measurement of speed in engineering applications and importance of speed measurement in instrumentation	PO2	3
AME019.10	CLO 10	Comprehend the importance of acceleration and vibration measurements in various equipment and understand the instruments used for measurement of vibration	PO1,PO6	3
AME019.11	CLO 11	Visualize the stress & strain experienced by various elements and to understand the importance of strain measurement with various techniques	PO1, PO2	2
AME019.12	CLO 12	Understand the concept of humidity in atmosphere as well as the storage applications and maintenance of humidity by measurement	PO1,PO6	3
AME019.13	CLO 13	Apply the basic principles and characteristics for force in engineering applications	PO1,PO3	2
AME019.14	CLO 14	Understand the instrumentation for force measurement in various fields of engineering	PO6	2
AME019.15	CLO 15	Visualize the concept of torque and power in various equipment in engineering applications	PO1,PO2,PO3	3
AME019.16	CLO 16	Apply the principles to gather the data regarding measurement of torque and power	PO1,PO2,PO3	2
AME019.17	CLO 17	Comprehend the instrumentation techniques in solving the engineering measuring applications for torque	PO1, PO2,PO6	3
AME019.18	CLO18	Apply the techniques used for measurement of power and evaluate the power for general requirements of engineering	PO2,PO6	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME019.19	CLO19	Understand the control systems for instrumentation in various practical applications	PO3	2
AME019.20	CLO20	Classify the control systems with their advantages and limitations	PO3	3

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)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3		3										2		
CLO 2	3		3										2		
CLO 3		3	3											2	
CLO 4			3										3		
CLO 5		2	2										2		
CLO 6		2											2		
CLO 7			3			3								2	
CLO 8	2		2										2		
CLO 9		3													
CLO 10	3					3								3	
CLO 11	2	2												2	
CLO 12	3					3							2		
CLO 13	2		2											2	
CLO 14						3								2	
CLO 15	3	2	3										2	3	
CLO 16	3	2	3											2	
CLO 17	3	3				3								2	
CLO 18		2				2								2	

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 19			2												
CLO 20			3										3		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES-DIRECT

CIE Exams	PO1, PO 2, PO 3, PO 6	SEE Exams	PO 1, PO 2, PO 3, PO 6	Assignments	PO 1	Seminars	PO 2
Laboratory Practices	PO 3	Student Viva	PO 1	Mini Project	-	Certification	-

XII. ASSESSMENT METHODOLOGIES–INDIRECT

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

XIII. SYLLABUS:

UNIT -I	PRINCIPLES OF MEASUREMENT	Classes:09
Definition – Basic principles of measurement – Measurement systems, generalized configuration and functional descriptions of measuring instruments – examples. Dynamic performance characteristics – sources of error, Classification and elimination of error.		
UNIT -II	**MEASUREMENT OF DISPLACEMENT, TEMPERATURE, PRESSURE**	**Classes:09**
Measurement of Displacement: Theory and construction of various transducers to measure displacement – Piezo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers, Calibration procedures. Measurement of Temperature: Classification – Ranges – Various Principles of measurement – Expansion, Electrical Resistance – Thermistor – Thermocouple – Pyrometers – Temperature Indicators. Measurement of Pressure: Units – classification – different principles used. Manometers, Piston, Bourdon pressure gauges, Bellows – Diaphragm gauges. Low pressure measurement – Thermal conductivity gauges – ionization pressure gauges, Mcleod pressure gauge.		
UNIT-III	**MEASUREMENT OF LEVEL, FLOW, SPEED, ACCELERATION AND VIBRATION**	**Classes:09**
Measurement of Level: Direct method – Indirect methods – capacitative, ultrasonic, magnetic, cryogenic fuel level indicators – Bubler level indicators. Flow Measurement: Rotameter, magnetic, Ultrasonic, Turbine flow meter, Hot – wire anemometer, Laser Doppler Anemometer (LDA). Measurement of Speed: Mechanical Tachometers – Electrical tachometers – Stroboscope, Noncontact type of tachometer.Measurement of Acceleration and Vibration: Different simple instruments – Principles of Seismic instruments – Vibrometer and accelerometer using this principle.		
UNIT -IV	**MEASUREMENT OF STRESS–STRAIN, HUMIDITY, FORCE, TORQUE AND POWER**	**Classes:09**
Stress Strain Measurements: Various types of stress and strain measurements – electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains – usage for measuring torque, Strain gauge Rosettes.		

Measurement of Humidity: Moisture content of gases, sling psychrometer, Absorption psychrometer, Dew point meter. Measurement of Force, Torque and Power: Elastic force meters, load cells, Torsion meters, Dynamometers.		
UNIT -V	**ELEMENTS OF CONTROL SYSTEMS**	**Classes:09**
Elements of Control Systems: Introduction, Importance – Classification – Open and closed systems Servomechanisms–Examples with block diagrams–Temperature, speed & position control systems.		
Text Books:		
1. D S Kumar, "Measurement Systems: Applications & Design", Anuradha Agencies, 1st Edition, 2013. 2. C Nakra& K. K. Choudhary, "Instrumentation, Measurement & Analysis", Tata McGraw-Hill, 4th Edition, 2010.		
Reference Books:		
1. K Padma Raju, Y J Reddy, "Instrumentation and Control Systems", McGraw Hill Education1st Edition, 2016. 2. S W. Bolton, "Instrumentation and Control Systems", Newnes Publisher, 1st Edition, 2004. 3. K Singh, "Industrial Instrumentation and Control", McGraw Hill Education, 3rd Edition, 2015.		

XIV. COURSE PLAN:

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

Lecture No	Topic's to be covered	Course Learning Outcomes (CLOs)	Reference
1	Introduction	CLO 1	T1: 1.1- 1.16
2	Definition – Basic principles of measurement	CLO 1	T1: 1.1- 1.16
3	Measurement systems	CLO 1	T1: 1.1- 1.16
4-5	generalized configuration and functional descriptions of measuring instruments – examples	CLO 1	T1: 1.1- 1.16
6-8	Dynamic performance characteristics	CLO 1.	T1: 1.1- 1.16
9	sources of error	CLO 1	T1: 1.1- 1.16
10	Classification and elimination of error	CLO1	T1: 1.1- 1.16
11	Theory and construction of Piezo electric, Inductive transducer for measurement of displacement.	CLO2	T1: 14.1- 14.2
12	Theory and construction of capacitance transducer for measurement of displacement.	CLO2	T1: 14.1- 14.2
13-14	Theory and construction of Resistance transducers to measure displacement.	CLO2	T1: 14.1- 14.2
15	Theory and construction of ionization and photo electric transducer for measurement of displacement.	CLO3	T1: 14.1- 14.2
16	Calibration procedure	CLO3	T1: 14.1- 14.2
17	Measurement of Temperature: Classification – Ranges	CLO3 CLO4	T1: 20.1- 20.3
18	Various principles of measurement – Expansion, Electrical Resistance	CLO3 CLO4	T1: 20.1- 20.3
19	Thermistor – Thermocouple	CLO3 CLO4	T1: 20.1- 20.3

Lecture No	Topic's to be covered	Course Learning Outcomes (CLOs)	Reference
20	Pyrometers – Temperature Indicators	CLO3 CLO4	T1: 20.1- 20.3
21	Measurement of Pressure: Units – classification – different principles used	CLO5	T1: 18.1- 18.3
22	Manometers, Piston	CLO5	T1: 18.1- 18.3
23	Bourdon pressure gauges, Bellows – Diaphragm gauges. Low pressure measurement	CLO6	T1: 18.1- 18.3
24	Thermal conductivity gauges	CLO6	T1: 18.1- 18.3
25	ionization pressure gauges, Mcleod pressure gauge	CLO6	T1: 18.1- 18.3
26	Measurement of Level: Direct method – Indirect methods	CLO7	T1: 24.1- 24.2
27	Capacitive, ultrasonic level measurement	CLO7	T1: 24.1- 24.2
28	Magnetic, cryogenic fuel level indicators	CLO7,	T1: 24.1- 24.2
29	Bubbler level indicators	CLO7	T1: 24.1- 24.2
30	Flow Measurement: Rotameter, magnetic flow meter	CLO8	T1: 21.1- 21.2
31	Ultrasonic, Turbine flow meter	CLO8	T1: 21.1- 21.2
32	Hot – wire anemometer	CLO8	T1: 21.1- 21.2
33	Laser Doppler Anemometer (LDA)	CLO8	T1: 21.1- 21.2
34	Measurement of Speed: Mechanical Tachometers	CLO9	T1: 15.1 - 15.3
35	Electrical tachometers	CLO9	T1: 15.1 - 15.3
36	Stroboscope	CLO9	T1: 15.1 - 15.3
37	Noncontact type of tachometer	CLO9	T1: 15.1 - 15.3
38	Measurement of Acceleration and Vibration: Different simple instruments	CLO10	T1: 16.1- 16.2
39	Principles of Seismic instruments	CLO10	T1: 16.1- 16.2
40-41	Vibrometer and accelerometer using this principle	CLO10	T1: 16.1- 16.2
42-44	Stress Strain Measurements: Various types of stress and strain measurements	CLO11	T1: 9.1- 9.5
45	Electrical strain gauge	CLO11	T1: 9.1- 9.5
46	gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains	CLO11	T1: 9.1- 9.5
47	usage for measuring torque, Strain gauge Rosettes	CLO11	T1: 9.1- 9.5
48	Measurement of Humidity: Moisture content of gases, sling psychrometer	CLO12	T1: 10.1- 10.6
49	Absorption psychrometer, Dew point meter	CLO12	T1: 10.1- 10.6

Lecture No	Topic's to be covered	Course Learning Outcomes (CLOs)	Reference
50	Measurement of Force, Torque and Power: Elastic force meters	CLO13	T1: 10.1- 10.6
51	Measurement of Force, Torque and Power: Elastic force meters	CLO14 CLO15	T1: 11.1- 11.5
52	load cells, Torsion meters	CLO16 CLO17	T1: 11.1- 11.5
53-54	Dynamometers	CLO18	T1: 11.1- 11.5
55	Elements of Control Systems: Introduction, Importance, Classification	CLO19	T1: 11.1- 11.5
56	Open and closed systems	CLO19	T1: 28.1- 28.16
57-58	Servomechanisms–Examples with block diagrams	CLO20	T1: 28.1- 28.16
59	Temperature control systems, Speed control system	CLO20	T1: 28.1- 28.16
60	position control systems	CLO20	T1: 28.1- 28.16

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

NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Advances in Designing processes	Seminars and Laboratory Practice	PO2	PSO1
2	Advanced topics	Guest Lectures and Laboratory Practice	PO3	PSO2
3	Recommended practices in design and analysis using software's.	Seminars and Laboratory Practice	PO3	PSO1

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HOD, ME

A MEASURE OF SUCCESS

THE INFLUENCE OF CURRICULUM-BASED MEASUREMENT ON EDUCATION