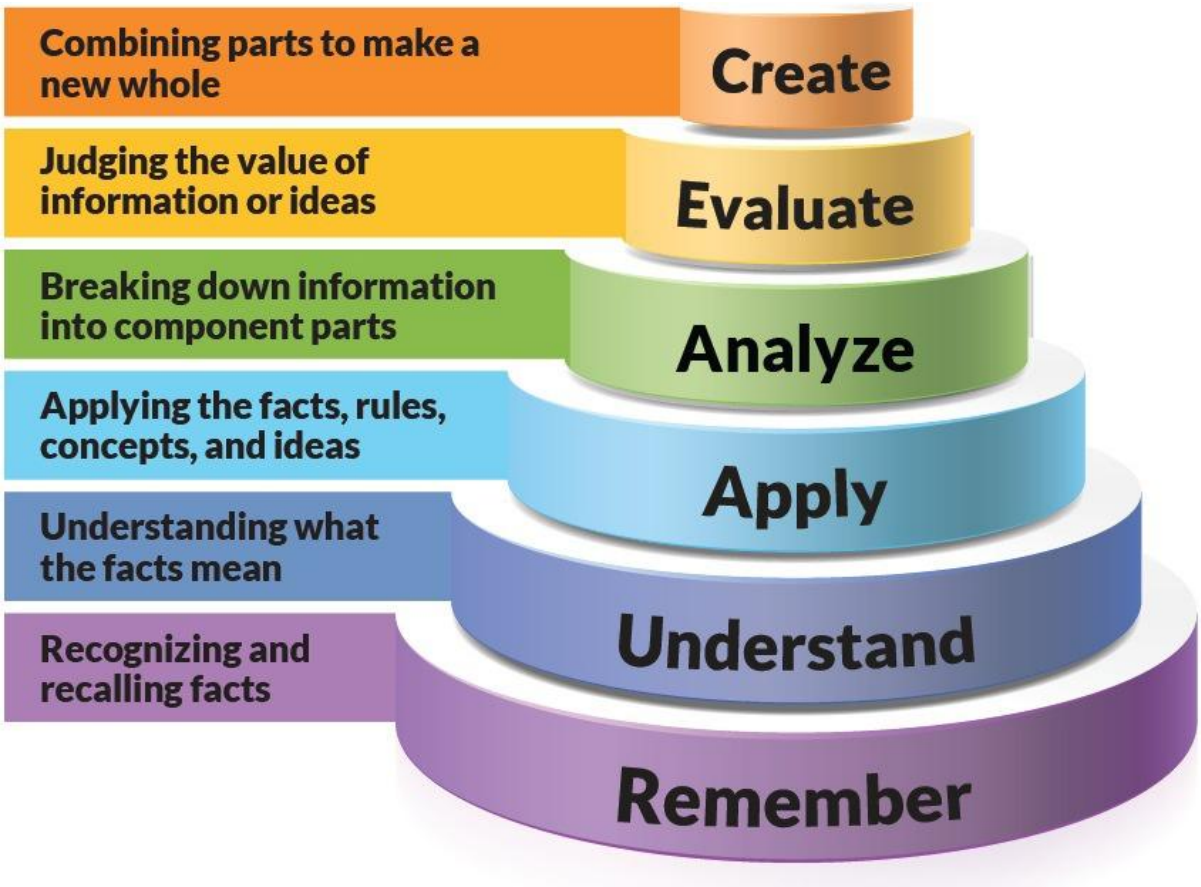
INSTITUTE OF AERONAUTICAL ENGINEERING

(Approved by AICTE, New Delhi, Accreditated by NBA, New Delhi & Affliated to JNTUH)

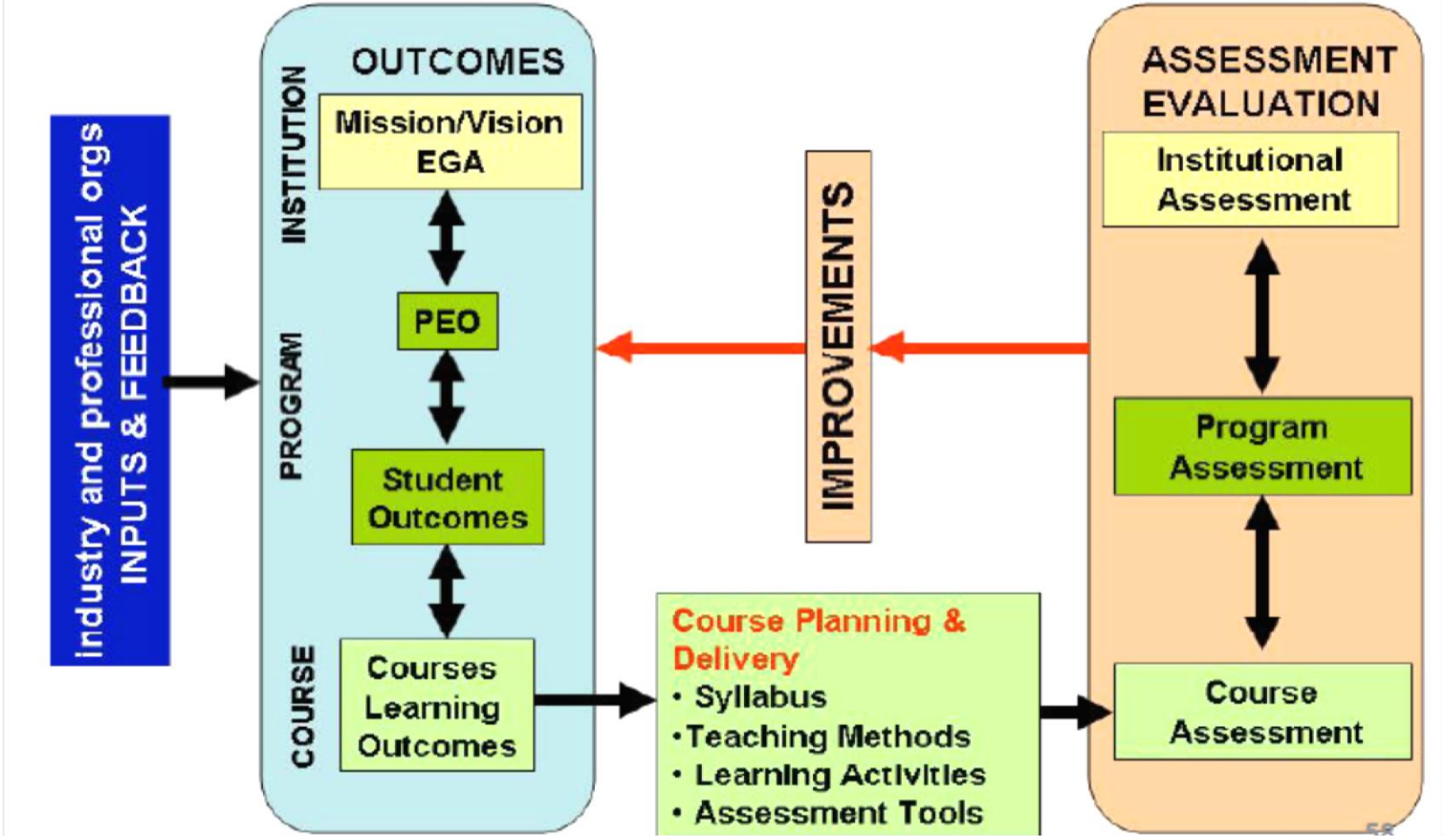
DEPARTMENT OF MECHANICAL ENGINEERING

OUTCOME BASED EDUCATION



2014-2015 Admitted Batches

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.

S. No	CONTENTS	Page No.
	Part - I *Program Educational Objectives and Outcomes*	
1	Educational Objectives, Outcomes and Assessment Criteria	4
2	Program Educational Objectives	4
3	Program Outcomes	5
4	Program Specific Outcomes	6
5	PEO's Vs PO's	6
6	PEO's Vs PSO's	7
7	Mapping of Program Outcomes to Program Educational Objectives	8
8	Mapping of Program Specific Outcomes to Program Educational Objectives	8
9	Mapping of PO's Vs PEO's	9
10	Table-1, Relation between PEO's and PO's	10
11	Program Curriculum (R13)	12
12	Outcome Delivery and Assessment	17
13	Methods Of Measuring Program Outcomes	24
	Part - II *Writing and Assessing Course Outcomes*	
1	Expected Course Outcomes	28
2	Course Purpose	29
3	Expected Learning Outcomes	29
4	Writing Effective Learning Outcomes Statements	30
5	Table of Blooms Taxonomy	31
6	Tips for Developing Course Expected Learning Outcomes	32
7	Expected Course Outcomes Statements(R13)	32
8	An Overview of Assessment	35
9	Writing a Course Purpose	36
10	Writing Expected Learning Outcomes for a Course	37
11	References	38
12	Model Course Description Form	39

Part – I

I. Program Educational Objectives and Assessment Criteria :

Program Educational Objectives, Program Outcomes and Assessment Criteria (Approved by DAC MECH on 30/01/2015):

Mechanical Engineering Department Advisory Council: The Electronics and Communication 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	2. An Ability to analyze complex engineering

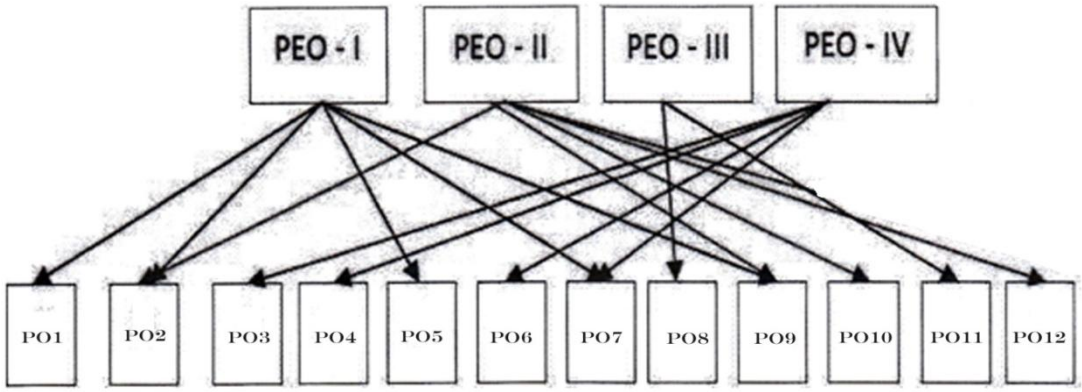
	industry that meet the needs of local, Indian and multinational companies.	problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering. 3. Competence to design a system, component or process to meet societal needs within realistic constraints. 5. An ability to formulate 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

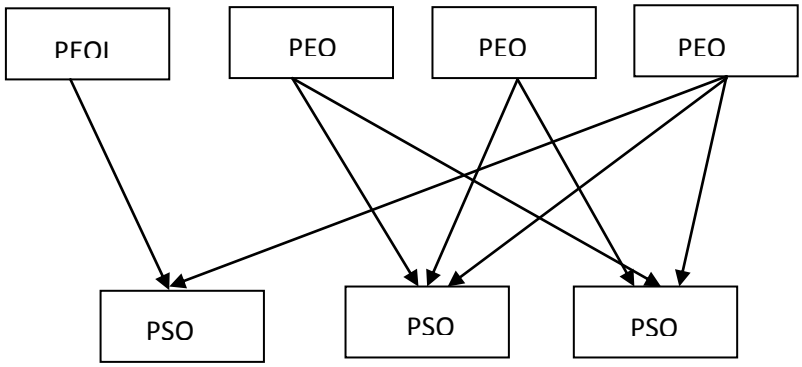
S. No	Program Educational Objectives	Program Specific Outcomes
PEO - I	To Provide students with a sound foundation in Mathematical, Scientific and Engineering fundamentals necessary to formulate, solve and analyze engineering problems.	PSO-1.To produce Engineering professional capable of synthesizing 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.	X			X
2. An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering.		X		X
3. Competence to design a system, component or process to meet societal needs within realistic constraints.	X	X		
4. To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.				X

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

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	S	M	S	S
2. Problem Analysis	S	S	S	S
3. Design/Development of Solutions	S	S	S	S
4. Conduct Investigations of Complex problems	S	M	S	M
5. Modern Tools usage	M	S	S	S

6. The Engineer and Society	M	M	S	M
7. Environment and Sustainability	M	M	S	M
8. Ethics	M	M	M	S
9. Individual and Teamwork	M	S	S	S
10. Communication	S	M	S	S
11. Project Management and Finance	M	S	S	M
12. Life-long Learning	S	S	S	S

Table 1- Relationships between program objectives and program outcomes
Key: S = Strong relationship; M = 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 extracurricularactivities

XI. A LIST OF COURSES OFFERED IN MECHANICAL ENGINEERING CURRICULUM (IARE-R13): FOR THE BATCHES ADMITTED DURING 2013
MAPPING OF COURSES TO PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

B.Tech (R13)

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**
A40312	Production Technology	X		X			X	X		X		X	X	X	X	X
A40309	Kinematics of Machinery	X	X	X	X	X	X	X		X			X	X	X	
A40313	Thermal Engineering-I	X	X	X	X	X	X	X		X			X	X	X	
A40112	Mechanics of Fluids and Hydraulic Machines	X	X	X	X	X	X	X		X			X	X	X	
A40310	Machine Drawing		X	X	X	X	X	X		X	X	X	X	X	X	X
A40006	Mathematics-II	X	X		X	X		X					X	X	X	
A40382	Production Technology Lab	X		X			X	X		X		X	X	X	X	X
A40188	Mechanics of Fluids & Hydraulic Machines Lab	X	X	X	X	X	X	X		X			X	X	X	X

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**
A50010	Managerial Economics and Financial Analysis	X	X				X	X	X	X	X	X	X		X	X
A50318	Engineering Metrology	X		X			X	X		X		X	X	X	X	X
A50317	Dynamics of Machinery	X	X	X	X	X	X	X		X			X	X	X	
A50321	Machine Tools	X		X			X	X		X		X	X	X	X	X
A50316	Design of Machine Members-I	X	X	X	X	X	X	X		X			X	X	X	X
A50326	Thermal Engineering-II	X	X	X	X	X	X	X		X			X	X	X	
A50384	Machine Tools & Metrology Lab	X		X			X	X		X		X	X	X	X	X
A50383	Thermal Engineering Lab	X	X	X	X	X	X	X		X			X	X	X	X
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**
A62405	Automobile Engineering	X	X	X	X	X	X	X		X			X	X	X	X
A60330	Finite Element Methods	X	X	X	X	X	X	X		X			X	X	X	X
A60334	Refrigeration and Air Conditioning	X	X	X	X	X	X	X		X			X	X	X	X

A60329	Design of Machine Members-II	X	X	X	X	X	X	X		X			X	X	X	X
A60331	Heat Transfer	X	X	X	X	X	X	X		X			X	X	X	X
Open Elective																
A60117	Disaster Management	X	X				X	X	X	X	X	X	X	X	X	X
A60017	Intellectual Property Rights	X	X				X	X	X	X	X	X	X	X	X	X
A60018	Human Values and Professional Ethics	X	X				X	X	X	X	X	X	X	X	X	X
A60387	Heat Transfer Lab	X	X	X	X	X	X	X		X			X	X	X	X
A60086	Advanced English Communication Skills Lab	X									X		X			X
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**
A70352	Operations Research	X	X				X	X	X	X	X	X	X	X	X	X
A70353	Power Plant Engineering	X	X	X	X	X	X	X		X			X	X	X	X
A70328	CAD / CAM	X	X	X	X	X	X	X		X			X	X	X	X
A70343	Instrumentation and Control Systems	X		X			X	X		X		X	X	X	X	X
ELECTIVE-I																

A70355	Robotics	X	X	X	X	X	X	X		X			X	X	X	X
A70346	Mechanical Vibrations	X	X	X	X	X	X	X		X			X	X	X	
A70348	Mechatronics	X	X	X	X	X	X	X		X			X	X	X	X
A70347	Mechanics of Composite Materials	X	X	X	X	X	X	X		X			X	X	X	
A70332	Industrial Management	X	X				X	X	X	X	X	X	X	X	X	X
ELECTIVE-II																
A70359	Unconventional Machining Processes	X	X				X	X		X		X	X	X	X	X
A70337	CNC Technology	X	X	X	X	X	X	X		X			X	X	X	X
A70336	Automation in Manufacturing	X	X	X	X	X	X	X		X			X	X	X	X
A70339	Design for Manufacturing	X	X				X	X	X	X	X	X	X	X	X	X
A72909	Nano Technology	X		X			X	X		X		X	X	X		
A70390	Computer Aided Design & Manufacturing Lab	X	X	X	X	X	X	X		X			X	X	X	X
A70391	Production Drawing Practice and Instrumentation Lab	X	X	X	X	X	X	X		X	X	X	X	X	X	X
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
A80366	Production Planning and Control	X	X				X	X	X	X	X	X	X	X	X	X
ELECTIVE-III																
A80527	Artificial Neural Network	X	X	X	X	X	X	X		X			X	X		
A80367	Total Quality Management	X	X				X	X	X	X	X	X	X	X	X	
A80363	Maintenance and Safety Engineering	X	X				X	X	X	X	X	X	X	X	X	
A80365	Plant Layout & Material Handling	X	X				X	X	X	X	X	X	X	X	X	X
ELECTIVE-IV																
A80324	Renewable Energy Sources	X	X	X	X	X	X	X		X			X	X	X	
A80362	Jet propulsion & Rocket Engineering	X	X	X	X	X	X	X		X			X	X	X	
A80338	Computational Fluid Dynamics	X	X	X	X	X	X	X		X			X	X	X	X
A80361	Gas Dynamics	X	X	X	X	X	X	X		X			X	X	X	X
A80087	Industry oriented Mini Project	X	X	X	X	X		X		X		X	X	X	X	X
A80089	Seminar					X					X	X		X	X	
A80088	Project work	X	X	X	X	X		X		X		X	X	X	X	X

A80090	Comprehensive Viva					X					X	X			X	X

XII. Outcome Delivery and Assessment (R13)
(For batches admitted during 2013)

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

Program Outcome (1): Capability to apply knowledge of mathematics, science, engineering in the field of mechanical engineering			
A1001	Mathematics - I	A1324	Production Planning and Control
A1002	Engineering Physics	A1325	Design of Machine Members - II
A1003	Engineering Chemistry	A1326	Heat Transfer
Al202	Basic Electrical and Electronics Engineering	A1327	Finite Element Methods
A1010	Engineering Physics and Chemistry Lab	A1511	Database Management Systems (Interdepartmental Elective - I)
A1303	Engineering Drawing	A1610	Image Processing (Interdepartmental Elective - I)
A1006	Computational Techniques	A1453	Digital Electronics and Microprocessors (Interdepartmental Elective - I)
A1007	Mathematics - II	Al228	Energy Management (Interdepartmental Elective - I)
A1301	Engineering Mechanics	A1735	Fatigue and Fracture Mechanics (Interdepartmental Elective - I)
A1302	Engineering Workshop	A1148	Air Pollution and Control Methods (Interdepartmental Elective - I)
A1304	Advanced Engineering Drawing	A1328	Heat Transfer Lab
A1503	Data Structures through C	A1329	Metrology and Machine Tools Lab
A1306	Mechanics of Solids	A1330	Operations Research
A1307	Mechanics of Fluids	A1331	CAD/CAM
A1308	Thermodynamics	A1332	Instrumentation and Control Systems
A1309	Metallurgy and Material Science	A1333	Refrigeration and Air Conditioning
A1311	MOS/MMS Lab	A1017	Human Resource Management (Interdepartmental Elective - II)
A1014	Probability and Statistics	A1018	Entrepreneurship (Interdepartmental Elective - II)
A1215	Electrical Technology	A1019	Business Communication (Interdepartmental Elective - II)
A1312	Thermal Engineering - I	A1021	Project Planning and Management (Interdepartmental Elective - II)
A1313	Production Technology	A1334	Automobile Engineering (Professional Elective - I)
A1314	Hydraulic Machinery and Systems	A1335	Rapid Prototyping (Professional Elective - l)
A1315	Kinematics of Machinery	A1336	Mechatronics (Professional Elective -I)
A1216	Electrical and Electronics Engineering Lab	A1337	Robotics(Professional Elective - I)
A1317	Dynamics of Machinery	A1338	Composite Materials (Professional Elective - I)
A1318	Machine Tools	A1339	Un Conventional Machining Process (Professional Elective-I)
A1319	Thermal Engineering - II	A1340	CAD/CAM Lab
A1320	Design of Machine members - I	A1341	Production Drawing and Instrumentation Lab
A1321	Metrology and Surface Engineering	A1343	Power Plant Engineering
A1322	Thermal Engineering Lab	A1344	Nano Technology (Professional Elective - II)
A1350	Concurrent Engineering(Professional Elective - III)	A1345	Plant Engineering and Industrial Safety (Professional Elective - II)
A1351	Mechanical Vibrations(Professional	A1346	Computational Fluid Dynamics

	Elective - Ill)		(Professional Elective - II)
A1352	Total Quality Management(Professional Elective - Ill)	A1347	Automation in Manufacturing (Professional Elective - II)
A1353	Non Conventional Sources of Energy (Professional Elective-III)	A1348	Reliability Engineering (Professional Elective - II)
A1354	Tribology (Professional Elective - Ill)	A1349	NDT Techniques (Professional Elective - II)
A1355	Advanced IC Engines (Professional Elective - Ill)		
Program Outcome (2): An ability to design and conduct experiments, as well as to synthesize, analyze and interpret data.			
Al202	Basic Electrical and Electronics Engineering	A1017	Human Resource Management (Interdepartmental Elective - II)
A1503	Data Structures through C	A1018	Entrepreneurship (Interdepartmental Elective - II)
A1307	Mechanics of Fluids	A1338	Composite Materials (Professional Elective - I)
A1309	Metallurgy and Material Science	A1344	Nano Technology (Professional Elective - II)
A1311	MOS/MMS Lab	A1349	NDTTechniques (Professional Elective - II)
A1215	Electrical Technology	A1323	Production Technology Lab
A1313	Production Technology	A1324	Production Planning and Control
A1314	Hydraulic Machinery and Systems	A1511	Database Management Systems (Interdepartmental Elective - I)
A1216	Electrical and Electronics Engineering Lab	A1453	Digital Electronics and Microprocessors (Interdepartmental Elective - I)
A1316	Fluid Mechanics and Hydraulic Machinery Lab	A1148	Air Pollution and Control Methods (Interdepartmental Elective - I)
Program Outcome (3): An ability to design a system, component, or process to meet desired needs within appropriate constraints for public Health, safety, cultural, societal and environmental considerations.			
A1501	Computer Programming	A1502	Computer Programming Lab
A1503	Data Structures through C	A1504	Data Structures through C lab
A1306	Mechanics of Solids	A1312	Thermal Engineering - I
A1307	Mechanics of Fluids	A1314	Hydraulic Machinery and Systems
A1308	Thermodynamics	A1316	Fluid Mechanics and Hydraulic Machinery Lab
A1319	Thermal Engineering - II	A1322	Thermal Engineering Lab
A1320	Design of Machine members - I	A1324	Production Planning and Control
A1324	Production Planning and Control	A1325	Design of Machine Members- II
A1325	Design of Machine Members - II	A1018	Entrepreneurship (Interdepartmental Elective - II)
A1326	Heat Transfer	A1019	Business Communication (Interdepartmental Elective - II)
A1327	Finite Element Methods	A1021	Project Planning and Management (Interdepartmental Elective - II)
A1511	Database Management Systems (Interdepartmental Elective - I)	A1334	Automobile Engineering (Professional Elective - I)
A1610	Image Processing (Interdepartmental Elective - I)	A1343	Power Plant Engineering
A1453	Digital Electronics and Microprocessors (Interdepartmental Elective - I)	A1354	Tribology(Professional Elective - III)
Al228	Energy Management (Interdepartmental Elective - I)	A1345	Plant Engineering and Industrial Safety (Professional Elective - II)
A1735	Fatigue and Fracture Mechanics (Interdepartmental Elective - I)	A1346	Computational Fluid Dynamics (Professional Elective - 11)
A1148	Air Pollution and Control Methods (Interdepartmental Elective - I)	A1351	Mechanical Vibrations (Professional Elective - III)
A1328	Heat Transfer Lab	A1352	Total Quality Management

			(Professional Elective - Ill)
A1355	Advanced IC Engines (Professional Elective -111)	A1353	Non Conventional Sources of Energy (Professional Elective - III)
Program Outcome (4): An ability to function on multidisciplinary teams as a member and leader			
A1306	Mechanics of Solids	A1325	Design of Machine Members - II
A1307	Mechanics of Fluids	A1327	Finite Element Methods
A1308	Thermodynamics	A1610	Image Processing (Interdepartmental Elective - I)
A1309	Metallurgy and Material Science	A1453	Digital Electronics and Microprocessors (Interdepartmental Elective - I)
A1311	MOS/MMS Lab	A1735	Fatigue and Fracture Mechanics (Interdepartmental Elective - I)
A1312	Thermal Engineering -1	A1331	CAD/CAM
A1314	Hydraulic Machinery and Systems	A1333	Refrigeration and Air Conditioning
A1316	Fluid Mechanics and Hydraulic Machinery Lab	A1016	Human Values and Ethics (Interdepartmental Elective-II)
A1319	Thermal Engineering - II	A1017	Human Resource Management (Interdepartmental Elective - II)
A1320	Design of Machine members - I	A1018	Entrepreneurship (Interdepartmental Elective - II)
A1322	Thermal Engineering Lab	A1019	Business Communication(Interdepartmental Elective - II)
A1021	Project Planning and Management (Interdepartmental Elective - II)	A1340	CAD/CAM Lab
A1334	Automobile Engineering (Professional Elective - I)	A1344	Nano Technology (Professional Elective - II)
A1335	Rapid Prototyping (Professional Elective - I)	A1346	Computational Fluid Dynamics (Professional Elective - II)
A1336	Mechatronics (Professional Elective - I)	A1347	Automation in Manufacturing (Professional Elective - II)
A1337	Robotics (Professional Elective - I)	A1349	NDT Techniques (Professional Elective - II)
A1338	Composite Materials (Professional Elective - I)	A1350	Concurrent Engineering (Professional Elective - Ill)
A1354	Tribology (Professional Elective - Ill)	A1355	Advanced IC Engines (Professional Elective - Ill)
Program Outcome (5): An ability to identify, analyze, formulate, and solve diverse mechanical engineering problems			
A1501	Computer Programming	A1503	Data Structures through C
A1202	Basic Electrical and Electronics Engineering	A1306	Mechanics of Solids
A1502	Computer Programming Lab	A1504	Data Structures through C lab
A1301	Engineering Mechanics	Al215	Electrical Technology
A1315	Kinematics of Machinery	A1317	Dynamics of Machinery
Al216	Electrical and Electronics Engineering Lab	A1320	Design of Machine members - I
A1324	Production Planning and Control	A1327	Finite Element Methods
A1325	Design of Machine Members-II	A1511	Database Management Systems (Interdepartmental Elective - I)
A1735	Fatigue and Fracture Mechanics (Interdepartmental Elective-I)	A1453	Digital Electronics and Microprocessors (Interdepartmental Elective - I)
A1331	CAD/CAM	A1335	Rapid Prototyping (Professional Elective - I)
A1018	Entrepreneurship (Interdepartmental Elective - II)	A1336	Mechatronics (Professional Elective - I)
A1019	Business Communication (Interdepartmental Elective -II)	A1337	Robotics (Professional Elective - **I)**
A1340	CAD/CAM Lab	A1346	Computational Fluid Dynamics (Professional Elective - II)

A1350	Concurrent Engineering (Professional Elective - Ill)	A1347	Automation in Manufacturing (Professional Elective - II)
A1354	Tribology (Professional Elective - Ill)	A1356	Theory of Machines Lab
Program Outcome (6): An understanding of professional, ethical, legal, security, social issues and responsibilities.			
A1004	Environmental Science	A1321	Metrology and Surface Engineering
A1324	Production Planning and Control	A1148	Air Pollution and Control Methods (Interdepartmental Elective - I)
A1332	Instrumentation and Control Systems	A1021	Project Planning and Management (Interdepartmental Elective - II)
A1016	Human Values and Ethics (Interdepartmental Elective - II)	A1018	Entrepreneurship (Interdepartmental Elective - II)
A1017	Human Resource Management (Interdepartmental Elective - II)	A1019	Business Communication (Interdepartmental Elective - **II)**
Program Outcome (7): An ability to use communication skills effectively.			
A1008	Technical English	A1009	English Language Communication Skills Lab
A1148	Air Pollution and Control Methods (Interdepartmental Elective - I)	A1016	Human Values and Ethics (Interdepartmental Elective - II)
A1019	Business Communication (Interdepartmental Elective - II)	A1017	Human Resource Management (Interdepartmental Elective - II)
Program Outcome (8): The broad education necessary to understand the local and global impact of engineering solutions in a economic, environmental, and societal context.			
A1004	Environmental Science	A1307	Mechanics of Fluids
A1310	Machine Drawing	A1314	Hydraulic Machinery and Systems
A1316	Fluid Mechanics and Hydraulic Machinery Lab	A1318	Machine Tools
A1321.	Metrology and Surface Engineering	A1015	Industrial Management and Psychology
Al228	Energy Management (Interdepartmental Elective - I)	A1329	Metrology and Machine Tools Lab
A1330	Operations Research	A1332	Instrumentation and Control Systems
A1020	Intellectual Property and Patent Rights (Interdepartmental Elective - II)	A1336	Mechatronics (Professional Elective - I)
A1021	Project Planning and Management (Interdepartmental Elective - II)	A1339	Un Conventional Machining Process (Professional Elective - I)
A1341	Production Drawing and Instrumentation Lab	A1343	Power Plant Engineering
A1345	Plant Engineering and Industrial Safety (Professional Elective-II)	A1348	Reliability Engineering (Professional Elective - II)
A1351	Mechanical Vibrations (Professional Elective-III)	A1353	Non Conventional Sources of Energy (Professional Elective-III)
A1352	Total Quality Management (Professional Elective-III)		
Program Outcome (12): A recognition of the need for and an ability to engage in life-long professional development			
A1501	Computer Programming	A1502	Computer Programming Lab
A1303	Engineering Drawing	A1304	Advanced Engineering Drawing
A1503	Data Structures through C	A1310	Machine Drawing
A1306	Mechanics of Solids	A1504	Data Structures through C lab
A1313	Production Technology	A1318	Machine Tools
A1320	Design of Machine members - I	A1323	Production Technology Lab
A1321	Metrology and Surface Engineering	A1324	Production Planning and Control
A1327	Finite Element Methods	A1325	Design of Machine Members - II
A1453	Digital Electronics and Microprocessors(Interdepartmental Elective - I)	A1148	Air Pollution and Control Methods (Interdepartmental Elective - I)
A1228	Energy Management(Interdepartmental Elective - I)	A1329	Metrology and Machine Tools Lab

A1735	Fatigue and Fracture Mechanics (Interdepartmental Elective - I)	A1021	Project Planning and Management (Interdepartmental Elective - II)
A1017	Human Resource Management (Interdepartmental Elective - II)	A1339	Un Conventional Machining Process (Professional Elective - I)
A1018	Entrepreneurship (Interdepartmental Elective - II)	A1341	Production Drawing and Instrumentation Lab
A1019	Business Communication (Interdepartmental Elective - II)	A1342	Project Work (Stage - I)
A1343	Power Plant Engineering	A1351	Mechanical Vibrations (Professional Elective - Ill)
A1345	Plant Engineering and Industrial Safety (Professional Elective - II)	A1352	Total Quality Management (Professional Elective - Ill)
A1346	Computational Fluid Dynamics (Professional Elective - II)	A1353	Non Conventional Sources of Energy (Professional Elective - III)
A1357	Technical Seminar	A1354	Tribology (Professional Elective - Ill)
A1358	Comprehensive Viva	A1342	Project Work (Stage - II)
A1359	Mini Project		
Program Outcome (9): A knowledge of contemporary issues and Technology up-gradations.			
A1004	Environmental Science	A1312	Thermal Engineering - I
A1307	Mechanics of Fluids	A1313	Production Technology
A1308	Thermodynamics	A1314	Hydraulic Machinery and Systems
A1316	Fluid Mechanics and Hydraulic Machinery Lab	A1315	Kinematics of Machinery
A1013	Managerial Economics and Financial Analysis	A1319	Thermal Engineering - II
A1317	Dynamics of Machinery	A1322	Thermal Engineering Lab
A1326	Heat Transfer	A1323	Production Technology Lab
Al228	Energy Management (Interdepartmental Elective - I)	A1017	Human Resource Management (Interdepartmental Elective - II)
A1148	Air Pollution and Control Methods (Interdepartmental Elective - I)	A1018	Entrepreneurship (Interdepartmental Elective - II)
A1328	Heat Transfer Lab	A1019	Business Communication (Interdepartmental Elective - II)
A1333	Refrigeration and Air Conditioning	A1021	Project Planning and Management (Interdepartmental Elective - II)
A1343	Power Plant Engineering	A1334	Automobile Engineering (Professional Elective - I)
A1345	Plant Engineering and Industrial Safety(Professional Elective - II)	A1351	Mechanical Vibrations (Professional Elective -III)
A1355	Advanced IC Engines (Professional Elective - Ill)	A1352	Total Quality Management (Professional Elective - Ill)
A1356	Theory of Machines Lab	A1353	Non Conventional Sources of Energy (Professional Elective - Ill)
Program Outcome (10): An ability to use the current techniques, skills, and modern engineering tools necessary for Mechanical Engineering practice.			
A1501	Computer Programming	A1502	Computer Programming Lab
A1503	Data Structures through C	A1504	Data Structures through C lab
A1326	Heat Transfer	A1453	Digital Electronics and Microprocessors (Interdepartmental Elective - I)
A1327	Finite Element Methods	A1331	CAD/CAM
A1148	Air Pollution and Control Methods (Interdepartmental Elective - I)	A1021	Project Planning and Management (Interdepartmental Elective - II)
A1328	Heat Transfer Lab	A1335	Rapid Prototyping(Professional Elective - I)
A1337	Robotics(Professional Elective - I)	A1342	Project Work (Stage - l)
A1340	CAD/CAM Lab	A1346	Computational Fluid Dynamics (Professional Elective-II)
A1350	Concurrent Engineering	A1347	Automation in Manufacturing

	(Professional Elective - Ill)		(Professional Elective - II)
A1357	Technical Seminar	A1359	Mini Project
A1358	Comprehensive Viva	A1342	Project Work (Stage - II)
Program Outcome (11): Ability to acquire professional competence for facing competitive examinations for successful employment in Mechanical Engineering.			
A1301	Engineering Mechanics	A1312	Thermal Engineering - I
A1306	Mechanics of Solids	A1314	Hydraulic Machinery and Systems
A1307	Mechanics of Fluids	A1315	Kinematics of Machinery
A1308	Thermodynamics	A1316	Fluid Mechanics and Hydraulic Machinery Lab
A1013	Managerial Economics and Financial Analysis	A1319	Thermal Engineering - II
A1317	Dynamics of Machinery	A1320	Design of Machine members - I
A1322	Thermal Engineering Lab	A1015	Industrial Management and Psychology
A1325	Design of Machine Members - II	A1735	Fatigue and Fracture Mechanics (Interdepartmental Elective - I)
A1326	Heat Transfer	A1328	Heat Transfer Lab
A1327	Finite Element Methods	A1330	Operations Research
A1020	Intellectual Property and Patent Rights (Interdepartmental Elective -II)	A1341	Production Drawing and Instrumentation Lab
A1021	Project Planning and Management (Interdepartmental Elective - II)	A1342	Project Work (Stage - I)
A1346	Computational Fluid Dynamics (Professional Elective - II)	A1348	Reliability Engineering (Professional Elective - II)
A1354	Tribology(Professional Elective - Ill)	A1357	Technical Seminar
A1355	Advanced IC Engines (Professional Elective - Ill)	A1358	Comprehensive Viva
A1356	Theory of Machines Lab	A1359	Mini Project

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 defidencies 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, VCE. 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 dass' 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 programme. 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 programme?
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 programme.

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	Brea kdown	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
Poi nt	Generalize	Examine	Outline Poi nt	Judge	Group
Quote	Give examples	Graph	out Relate	Justify	Integrate
Read	Infer	Interpolate	Select	Measure	Modify
Recall	Paraphrase	Mani pulate	Separate	Rank	Order
Recite	Predict	Modify	Subdivide	Rate	Organize
Recognize	Rewrite	Operate	Utilize	Support	Plan
Record	Summa rize	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.
- Create statements that are student-centered rather than faculty-centered (e.g., "upon completion of this course students will be able to list the names of all Data Mining techniques " versus "one objective of this course is to teach the names of all Data Mining techniques").
- 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 (R09)

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

ENGINEERING MECHANICS	
Course Objectives	**Course Outcomes**
1. Students should develop the ability to work comfortably with basic engineering mechanics concepts required for analyzing static structures. 2. Identify an appropriate structural system to studying a given problem and isolate it from its Environment, model the problem using good free-body diagrams and accurate equilibrium equations. 3. Identify and model various types of loading and support conditions that act on structural systems, apply pertinent mathematical, physical and engineering mechanical principles to the system to solve and analyze the problem 4. Understand the meaning of centre of gravity (mass)/centroid and moment of Inertia using integration methods and method of moments. 5. To solve the problem of equilibrium by using the principle of work and energy, impulse momentum and vibrations for preparing the students for higher level courses such as ,Mechanics of Solids, Mechanics of Fluids, Mechanical Design and Structural Analysis etc...	1. Students will be able to describe position, forces, and moments in terms of vector forms in two and three dimensions. 2. Students will be able to draw complete free body diagrams and write appropriate equilibrium equations from the free body 3. diagram, including the support reactions for analyzing the forces. 4. Students will be able to calculate moments, centroids and centers of mass for discrete particles: a body of arbitrary shape, a body having axial symmetry and the moments of Inertia. 5. Students will be able to apply the concepts of Principle of work and energy, impulse momentum and vibrations.
ENGINEERING DRAWING	
Course Objectives	**Course Outcomes**
1. To have the knowledge of interpretation of dimensions of different quadrant projections. 2. To understand the basic principles of engineering drawing. 3. To understand the construction of scales. 4. To have the knowledge of generating the pictorial views. **5.** 5. To understand intricate details of components through sections and to develop its surfaces	1. Ability to discuss the conventions and methods of engineering drawing. 2. Ability to demonstrate drafting practices, visualization and projection skills useful for conveying ideas, design and production of components and assemblies in engineering applications. 3. Ability to perform basic sketching techniques of engineering components. 4. Ability to draw the orthographic and pictorial views of a given engineering component. 5. Ability to increasingly use architectural and engineering scales.
THERMODYNAMICS	
1. To get the basic concepts of thermodynamics, temperature measurement, first law and also ability to determine the heat, work in various flow & non-flow processes. 2. To gain the knowledge about second law of thermodynamics and determine the change in entropy, availability in various processes. 3. To get the knowledge various phases of pure substance and calculate its properties using steam tables and to determine properties of perfect gases in various processes. 4. To develop to learn the concepts of mixture of gases and to calculate the property values during	1. Demonstrate knowledge of energy transfer and work done and heat equation in different processes, power cycles and thermodynamic laws. 2. Demonstrate knowledge of ability to identify & apply fundamentals to solve problems like system properties, amount of work transfer and heat during various processes, steam properties at different temperatures and pressures using steam tables. 3. Demonstrate their knowledge & ability to design the thermal related components in various fields of energy transfer equipments. 4. An ability to design a system, component or

an any process. 5. To get the knowledge about the working of different types of cycles and their performance.	process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, and safety manufacturability and sustainability related thermal fields like I.C engines, different types of power plants etc. 5. The ability to use modern engineering tools, software and equipment to analyze energy transfer in required applications. 6. A knowledge of impact of engineering solutions on the society and also on contemporary issues related to different types of power cycles. 7. Recognition of the need for, and an ability to engage in self education and life-long learning.
KINEMATICS OF MACHINERY	
Course Objectives	**Course Outcomes**
1. To understand the basic principles of Kinematics and the related terminology of machines. 2. Discriminate mobility; enumerate links and joints in the mechanisms. 3. Formulate the concept of analysis of different mechanisms. 4. To understand the working of various straight line mechanisms, gears, gear trains, steering gear Mechanisms, cams and Hooke's joint. 5. Analyze a mechanism for displacement, velocity and acceleration of links in a machine.	1. Be familiar with different machine elements which accomplish similar results. 2. Calculate mobility and enumerate rigid links and types of joints in mechanisms. 3. Able to create a schematic drawing of real world mechanisms. 4. Able to conduct a complete translational and rotational mechanism for the velocity and acceleration analysis. 5. Able to design mechanisms of basic cam systems for different machinery.
THERMAL ENGINEERING-I	
Course Objectives	**Course Outcomes**
1. To introduce basic principles of operation of IC engines compressors and refrigeration systems. 2. To understand the procedures of testing and evaluating the performance of these machines. 3. To know the maintenance details and procedures. 4. Teach students to conduct experiments in laboratories and analyze the results with theoretical ones.	1. Understand main idea and importance behind the 2 - S and 4 - S IC engines. 2. To analyze the working of the basic components in the IC engines, Compressors and Refrigeration systems. 3. Understand the combustion process and also how it does affect the performance of the IC engines. 4. Apply the thermodynamic principles in the design of an IC engines, compressors and refrigeration system. 5. Formulate and perform the procedures required for the maintenance and operation of IC engines, compressors and refrigeration systems. **6.** Compare different IC engines, compressors and refrigeration systems and develop a system which meets the requirements.
PRODUCTION TECHNOLOGY	
Course Objectives	**Course Outcomes**
1. Practical orientation of Manufacturing Processes 2. Knowledge on different kinds of Production Processes and practices available for shaping or molding several daily used parts for industries 3. Equipment selection for various Manufacturing Processes will be understood	1. To acquire the knowledge about the modern manufacturing processes 2. To know about latest fabrication technologies 3. Enhancement of product manufacturing knowledge 4. Capability to get ideas for product establishment as an entrepreneur 5. Knowledge on economics of production
DESIGN OF MACHINE MEMBERS-II	
1. In design and analysis of load transmitting elements and selection of suitable materials and manufacture of these components. 2. Analyzing the forces acting on various	1. Ability to identify design variables and performance factors in the study machine elements. 2. Ability to identify different types of fastener and

components and their design. 3. Applying the theories of failure and select optimum design size for various machine elements. 4. Understanding need for joints and their application for different purposes in transmission of static loads. 5. Theory of failures and application for design of components subjected to various types of loads.	their basic features, related terminology and designations. 3. Ability to select various types of joints for given application. 4. Awareness of the basic features of springs, and means of transfer of motion commonly used in mechanical engineering. 5. Acquaintance with the terminology and basic kinematics concepts associated with design of shafts. 6. Ability to analyze and design all types of couplings for given application. 7. Ability in using and obtaining information from engineering data handbooks.

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 make 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

XI. REFERENCES

1. Farin, Gerald; Hoschek, Josef and Kim, Myung-Soo (2002). Handbook of computer aided geometric design [electronic resource]. Elsevier. ISBN 978-0-444-51104-1.
2. "3D Feature-based, Parametric Solid Modeling". engineershandbook.com.
3. "History of CAD/CAM". CADAZZ. 2004.
4. Pillers, Michelle (March 1998). "MCAD Renaissance of the 90's". Cadence Magazine. Archived from the original on 2007-04-22.
5. Bozdoc, Martian (2003). "The History of CAD". iMB.
6. Susskind, Alfred K.; McDonough, James O. (March 1953). "Numerically Controlled Milling Machine" (PDF). Review of Input and Output Equipment Used in Computing Systems. International Workshop on Managing Requirements Knowledge. New York City: American Institute of Electrical Engineers. p. 136. LCCN 53-7874. Retrieved 2015-02-24.
7. Ross, Douglas T. (17 March 1961). Computer-Aided Design: A Statement of Objectives. MIT USAF 8436-TM-4.
8. Hurst, J. (1989) Retrospectives II: The Early Years in Computer Graphics, pp. 39–73 in SIGGRAPH 89 Panel Proceedings, ACM New York, NY, USA, ISBN 0-89791-353-1 doi:10.1145/77276.77280
9. Lincoln Writer, Scopewriter pp. 3–17 Weisberg, David E. The Engineering Design Revolution.
10. Yares, Evan (February 13, 2013) 50 Years of CAD. DesignWorld
11. "Looking Back: The TX-2 Computer and Sketchpad 82" (PDF). Lincoln Laboratory Journal 19 (1). 2012. Archived from the original (PDF) on 2012-11-07.
12. "MCS Founder: Patrick J. Hanratty, Ph.D., President and Founder". mcsaz.com. Archived from the original on 2005-02-09.
13. Akeley, Kurt (1981) Issues and Directions for Graphics Hardware Accelerators. Eurographics Digital Laboratory, diglib.eg.org.
14. http://www.cademia.de/frontend/index.php?folder_id=296

XII. MODEL COURSE DESCRIPTION FORM

INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTION FORM

Department	:	**MECHANICAL ENGINEERING**			
Course Code	:	**R31803**			
Course Title	:	**METALLURGY AND MATERIAL SCIENCE**			
Course Category	:	CORE			
Course Structure	:	Lectures	Tutorials	Practical's	Credits
		4	1	-	4
Course Coordinator	:	Dr. K G K Murti			
Team of Instructors	:	Dr. K Sammaiah			

I. Course Overview :

Metallurgy and material science subject is backbone to mechanical engineering discipline.The students are given inputs on fundamentals of crystallography, microstructures and relation to properties of materials. Also students acquire knowledge on phase diagrams, heat treatment which will enable them to select materials for industrial applications .Inputs are also planned on ceramics, glasses, polymers and composites as present day designs are based on many advanced materials.

II. Prerequisites :

Level	Credits	Periods / Week	Prerequisites
UG	4	5	Physics, Chemistry, Mathematics, Drawing

III. Course Assessment Methods :

Marks Distribution :

Sessional Marks	University End Exam Marks	Total Marks
There shall be 2 midterm examinations. Each midterm examination consists of one objective paper, one subjective paper and one assignment. The objective paper is for 10 marks and subjective paper is for 10 marks, with duration of 1 hour 20 minutes (20 minutes for objective and 60 minutes for subjective paper). Objective paper is set for 20 bits of – multiple choice questions, fill-in the blanks, 10 marks. Subjective paper contains of 4 full questions (one from each unit) of which, the student has to answer 2 questions, each question carrying 5 marks. First midterm examination shall be conducted for 1-4 units of syllabus and	75	100

second midterm examination shall be conducted for 5-8 units. 5 marks are allocated for Assignments (as specified by the concerned subject teacher) – first Assignment should be submitted before the conduct of the first mid, and the second Assignment should be submitted before the conduct of the second mid. The total marks secured by the student in each midterm examination are evaluated for 25 marks, and the average of the two midterm examinations shall be taken as the final marks secured by each candidate		

IV Evaluation Scheme :

S. No.	Component	Duration	Marks
1	I Mid Examination	1 hour 20 min	20
2	I Assignment lot		5
		Total	**25**
3	II Mid Examination	1 hour 20 min	20
4	II Assignment lot		5
		Total	**25**
MID Examination marks to be considered as average of above 2 MID's TOTAL			
5	External Examination	3 hours	75
		GRAND TOTAL	**100**

V. Course Objectives :

The objectives of the course are to enable the student ;

I. To understand metallurgical engineering concepts and properties
II. To analyze microstructures of metals and alloys and relationship to heat treatment
III. To compare properties of ceramics, glasses, composites and polymers for industrial applications

V. Course Outcomes :

1. Able to relate properties of metals to micro structures.
2. Able to apply the principles of heat treatment for improving properties.
3. An ability to select metals and alloys for engineering applications.
4. An ability to understand various advantages and limitations of non-metals.
5. Ability to identify suitable metals,non-metals for various industrial products

VI. How course outcomes are assessed :

	Program Outcomes	Level	Proficiency assessed by
1	Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	H	Assignments, Practicals, Midterm and University examinations
3	Competence to design a system, component or process to meet societal needs within realistic constraints.	H	Assignments, Practicals, Midterm and University examinations
4	To design and conduct research oriented	H	Assignments,

Program Outcomes		Level	Proficiency assessed by
	experiments as well as to analyze and implement data using research methodologies.		Practicals, Midterm and University examinations
5	An ability to formulate solve complex engineering problem using modern engineering and information Technology tools.	H	Assignments, Practicals, Midterm and University examinations
6	To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.	S	Practicals, Projects
7	To understand impact of engineering solutions in the societal context and demonstrate the knowledge for sustainable development.	S	Practicals, Projects
8	An understanding and implementation of professional and ethical responsibilities.	S	Practicals, Projects
9	To function as an effective individual and as a member or leader in multi disciplinary environment and adopt in diverse teams.	S	Practicals, Midterm and University examinations, Projects, Technical activites.
10	An ability to assimilate, comprehend, communicate, give & receive instructions to present effectively with engineering community and society.	S	Practicals, Midterm and University examinations, Projects, Technical activites.
11	An ability to provide leadership in managing complex engineering projects at multidisciplinary environment and to become a Technocrat.	H	Practicals, Midterm and University examinations, Projects, Technical activites.
12	Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.	H	Practicals, Midterm and University examinations, Projects, Technical activites.

VII. How Program Outcomes are assessed :

Program Outcomes		Level	Proficiency assessed by
1	Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	H	Assignments, Practicals, Midterm and University examinations
2	An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	H	Assignments, Practicals, Midterm and University examinations
3	Competence to design a system, component or process to meet societal needs within realistic constraints.	H	Assignments, Practicals, Midterm and University examinations

VIII. Syllabus :

UNIT-I

Structure of metals : Crystallography, Miller indices, Packing efficiency, Density calculations, Grains and grain boundaries. Effect of grain size on the properties. Determination of grain size by different methods.

Constitution of alloys : Necessity of alloying, Types of solid solutions, Hume-Rothery rules, Intermediate alloy phases

UNIT-II

Phase Diagrams : Construction and interpretation of phase diagrams, Phase rule, Lever rule. Binary phase diagrams, Isomorphous, Eutectic and Eutectoid transformations with examples.

UNIT-III

Engineering Materials-I Steels : Iron –Carbon phase diagram and heat treatment : Study of iron-iron carbide phase diagram, Construction of TTT diagrams, Annealing, Normalizing, Hardening and Tempering of steels, Hardenabilty, Alloy steels.

UNIT-IV

Engineering Materials –II : Cast Irons : Structure and properties of White cast iron, Malleable cast iron Grey cast iron. Engineering materials –III :Non-ferrous metals and alloys : Structure and properties of copper and its alloys, Al-Cu phase diagram, Titanium and its alloys.

UNIT-V

Engineering materials – IV: Ceramics, Polymers and composites : Crystalline ceramics, glasses, cermets : Structure, properties and applications. Classification, properties and applications of composites, Classification properties and applications of polymers.

TEXT BOOKS :

T1. Material science and Metallurgy /Kodgire
T2. Essentials of Material science and engineering/Donald R Askeland/Thomson

REFERENCE BOOKS :

R1. Introduction to Physical Metallurgy/Sidney H Avner.
R2. Material science and Engineering/William and Callister
R3. Elements of Material science/V Raghavan
R4. Engineering Materials and Metallurgy/Er.Amandeep Singh Wadhva
Material science for Engineering students-Traugott Fisher 2009Edition.

VIII. Course Plan :

The course plan is meant as a guideline. There may probably be changes.

Lecture No.	Course Learning Outcomes	Topics to be covered	Reference
1-2	**Identify** potential areas of applications in mechanical engineering	**UNIT-I** **Introduction to Metallurgy and Material Science** **Importance to Various Engineering disciplines**	T2
3	**Define** various branches and compare metals and non-metals	Branches of Metallurgy , chemical , physical , Mechanical Engineering , Metals , Non-metals, composites , nano-materials	T1, T2
4	**Compare** various crystal structures	Atomic structure , bonding in solids , different bonds and examples Crystal structure , unit cell , 7	T1

		crystal systems , 14 Bravais lattices , Miller indices , crystallographic planes of refrigeration	
5-7	**Examine** various factors of crystal structures	Atomic radius , Coordination number , Atomic packing factor , Density calculation	T1, T2
8-12	**Compare** puremetals and alloys	Crystallization of pure metals ; solidification of pure metals , alloys Grains , Grain boundary , ASTM grain size no	T1
13	**Describe** defects in crystals	Crystal imperfections - Defects ; point , line , planar defects	T2
14	**Describe** Phase diagrams	**UNIT-II Phase diagrams : Phase rule**	T1, T2
15	**Explain** Cu-Ni Phase diagram	Binary alloys – phase diagrams: Isomorphous system. Cu-Ni	T1
16-17	**Analyze** types of cooling	Chemical composition of phases , Lever rule , Equilibrium cooling , Non - Equilibrium cooling	T1, T2
18-19	**Describe** Bi-Cd and Pb-Sn system	Eutectic system . I Bi-Cd , Hypo , Hyper II Pb-Sn system	T2
20-21	**Describe** the Pt-Ag system ,and explain various eutectoid and peritectoid reactions	Peritictic system Pt-Ag, Euctectoid reaction Peritectoid reaction	T1, T2
22-23	**Categorize & Describe** steels	**UNIT-III** **Engineering Materials – 1 steels :**	T1
24-26	**Explain** Fe-C diagram	Steels :Fe – C ; Allotropy of Fe	T1
27	**State** peritectic reaction	Peritictic transformation	T1, T2
28	**Explain** eutectoid reaction	Eutectoid transformation	T1
29	**Describe** Hyper eutectoid transformation	Hyper eutectoid transformation	T1
30	**Discuss** heat treatment	Heat treatment , Annealing Normalizing , Hardening , Tempering	T2
31-32	**Evaluate** hardenabilty	Hardenability	T1, T2
33	**Describe** the effect of alloying elements	Alloy steels – Effect of alloying elements	T1, T2
34	**Explain** types of alloy steels	Low alloy steels , stainless steels , Tool steels	T2, T1
35-38	**Explain** Types of cast irons	**UNIT-IV: Engineering Materials – II&III :**	T1, T2
39-40	**Describe** various cast irons	White Cast Iron , Malleable CI , Grey CI , SG Iron	T2, T1
41-49	**Examine** classification of aluminium alloys	Engg.materials III :Non ferrous alloys – classification	T1, T2
50-51	**Discuss** the properties of copper alloys	Copper alloys	T2, T1

52-56	**Describe** Al alloys	Al-alloys	T1, T2
57-58	**Describe** the properties of titanium alloys	Titanium alloys	T2, T1
68	**Explain** ceramics	**UNIT V:Engineering materials – IV:**Ceramics , Types , properties , applications	T2
69-70	**Describe** glasses	Glasses , Types , Properties , applications	T2
71-72	**Explain** cermets	Cermets , Types , Properties , applications	T2
73-74	**Describe** composites	Composites , Types , Properties , applications	T2
75-76	**Explain** polymers	Polymers , Types , Properties , applications	T2

XII. Mapping course objectives leading to the achievement of the program outcomes and program specific outcomes:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I	S						H			H				H	H
II			S				H			H			S	H	H
III							H			H				H	H

S = Supportive **H = Highly Related**

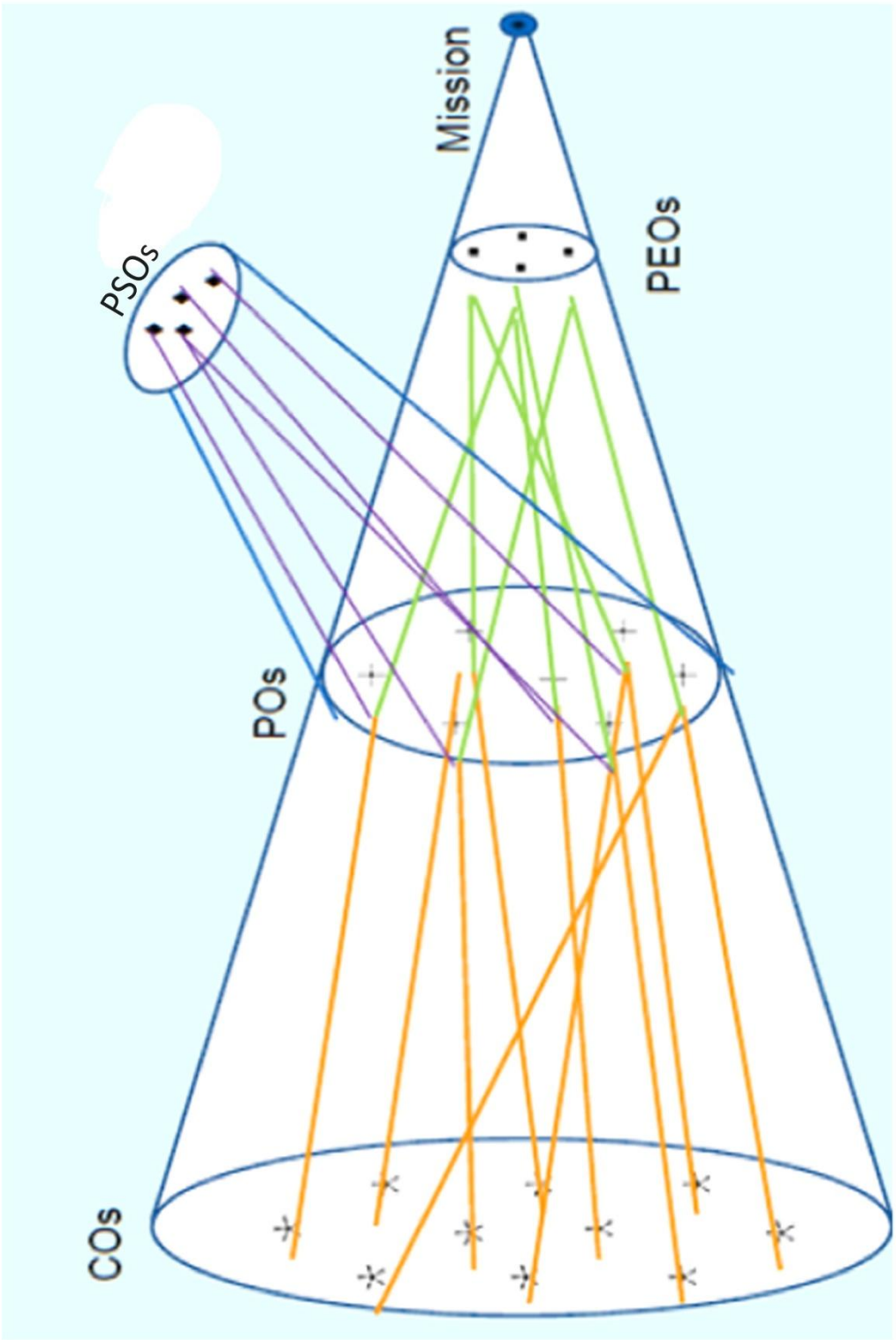
XIII. Mapping course outcomes leading to the achievement of the program outcomes and program specific outcomes:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I		S						H						S	H
II				S							H		S	H	S
III				S				H						H	H
IV				S									S	S	S
V	H			H										H	S

S = Supportive **H = Highly Related**

Prepared By : Dr.K G K MURTI. Prof. Mechanical

HOD, MECHANICAL ENGINEERING


Mission
PEOs
PSOs
POs
COs

A MEASURE OF SUCCESS

THE INFLUENCE OF CURRICULUM-BASED MEASUREMENT ON EDUCATION