OUTCOME BASED EDUCATION BOOKLET

AERONAUTICAL ENGINEERING

B.Tech

For the Batch of Students admitted during Academic Year 2016-17 & 2017-18

.....Moving Towards Perfection in Engineering

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Approved by AICTE, Affiliated to JNTUH and Accredited by NAAC with 'A' Grade

Dundigal, Hyderabad - 500 043

VISION

To build a strong community of dedicated graduates with expertise in the field of Aeronautical science and Engineering suitable for Industrial needs having a sense of responsibility, ethics and ready to participate in Aerospace activities of National and Global interest

MISSION

To actively participate in the Technological, Economic and Social development of the Nation through academic and professional contributions to Aerospace and Aviation areas, fostering academic excellence and scholarly learning among students of Aeronautical engineering

Contents

Program Education Objectives and Outcomes

As Per NBA Norms Post June, 2015

Semester: I-I,I-II ,II-I, II-II, III-I, III-II, IV-I,IV-II

Part – I A

PROGRAM EDUCATIONAL OBJECTIVES AND OUTCOMES

First version 22 July, 2013

Educational Objectives Outcomes and Assessment Criteria (Approved by Aeronautical faculty 02/6/2013,Approved by DAC Aeronautical Engineering 9/6/2013):

Aeronautical EngineeringDepartment Advisory Council: The Aeronautical Engineering Department Advisory Council (AEDAC) 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 Aeronautical 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 Aeronautical Engineering responds to the report indicating improvements and amendments to the program.

1. PROGRAM EDUCATIONAL OBJECTIVES, OUTCOMES AND ASSESSMENT CRITERIA

Outcome based education (OBE)

Outcome-based education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience, each student should have achieved the goal. There is no single specified style of teaching or assessment in OBE; instead, classes, opportunities, and assessments should all help students achieve the specified outcomes. The role of the faculty adapts into instructor, trainer, facilitator, and/or mentor based on the outcomes targeted.

2. B. TECH - AERONAUTICAL ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES

A graduate of Institute of Aeronautical Engineering in Aeronautical Engineering discipline should have a successful career in Aeronautical Engineering or a related field, and within three to five years, should attain the following:

PROGRAM EDUCATIONAL OBJECTIVES:

PEO1. Excellence in Career

To prepare and provide student with an academic environment for students to excel in postgraduate programs or to succeed in industry / technical profession and the life-long

learning needed for a successful professional career in Aeronautical Engineering and related fields (**Preparation & Learning Environment**).

PEO2. Professional Effectiveness and Contribution to Society

To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve engineering problems and also to pursue higher studies (**Core Competence**).

PEO3. Continuing Education

To train students with good scientific and engineering breadth so as to comprehend, analyze, design, and create novel products and solutions for the real life problems (**Breadth**).

PEO4. Exercising Leadership

To inculcate in students professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate engineering issues to broader social context (**Professionalism)**.

These objectives are quite broad by intention, as Aeronautical Engineering graduates may seek further education or work in diverse areas. To make these objectives meaningful, they may be demonstrated by performance, actions, or achievements.

i. To prepare and provide student with an academic environment for students to excel in postgraduate programs or to succeed in industry / technical profession and the life-long learning needed for a successful professional career in Aeronautical Engineering and related fields

- 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.

ii. To prepare the students who will be able to function professionally in an increasingly international and rapidly changing world due to the advances in technologies and concepts and Contribute to the needs of the society.

- 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. To train students with good scientific and engineering breadth so as to comprehend, analyze, design, and create novel products and solutions for the real life problems

- 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.

iv. To inculcate in students professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate engineering issues to broader social context

- Gives ample opportunity to work in diverse fields to acquire leadership roles in professional circles outside the workplace.
- Should keep in mind that the opportunities may change with the times.
- Should be prepared for creative solo and collaborative brainstorming sessions.
- Be able to inspire the team with selfless motivation and attitude to achieve success.
- Ability to think laterally or at-least have a flexibility of thought and make choices based on the requirement for situation.

3. B. TECH - AERONAUTICAL ENGINEERING PROGRAM OUTCOMES PROGRAM SPECIFIC OUTCOMES

A graduate of the Aeronautical Engineering Program Outcomes will demonstrate:

PROGRAM OUTCOMES:

PO1. Engineering knowledge

Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis

Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions

Design solutions for complex engineering problems and design system components or

processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems

Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage

Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society

Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability

Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics

Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work

Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication

Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance

Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning

Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES

PSO1. Professional skills
Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products

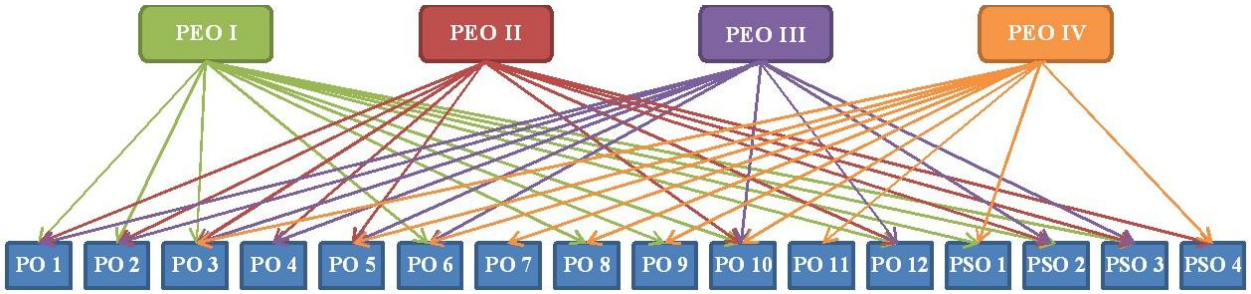
PSO2. Problem solving skills
Imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles

PSO3. Practical implementation and testing skills
Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies

PSO4. Successful career and entrepreneurship
To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats

4. MAPPING OF PROGRAM EDUCATIONAL OBJECTIVES TO PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

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



The following Table shows the correlation between the Program Educational Objectives and the Program Outcomes

	Program Educational Objectives	Program Outcomes
I	To prepare and provide student with an academic environment for students to excel in postgraduate programs or to succeed in industry / technical profession and the life-long learning needed for a successful professional career in Aeronautical Engineering and related fields	**PO1. Engineering knowledge** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. **PO2. Problem Analysis**

		Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. **PO3. Design/development of solutions** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. **PO6. The engineer and society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. **PO8. Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. **PO9. Individual and team work** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. **PO10. Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions **PO12. Life-long learning** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. **PSO.1 Professional skills** Imparted through simulation language skills and general purpose CAE packages to solve practical,

		design and analysis problems of components to complete the challenge of airworthiness for flight vehicles **PSO.3 Practical implementation and testing skills** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies **PSO.4 Successful career and entrepreneurship** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats
II	To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve engineering problems and also to pursue higher studies	**PO1. Engineering knowledge** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. **PO2. Problem Analysis** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. **PO3. Design/development of solutions** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. **PO4. Conduct investigations of complex problems** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. **PO5. Modern tool usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. **PO10. Communication**

		Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions **PO12. Life-long learning** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. **PSO.2 Professional skills** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products **PSO.3 Practical implementation and testing skills** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies **PSO.4 Successful career and entrepreneurship** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats
III	To train students with good scientific and engineering breadth so as to comprehend, analyze, design, and create novel products and solutions for the real life problems	**PO1. Engineering knowledge** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. **PO2. Problem Analysis** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. **PO3. Design/development of solutions** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

		PO4. Conduct investigations of complex problems Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. **PO5. Modern tool usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. **PO6. The engineer and society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. **PO10. Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions **PO12. Life-long learning** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change **PSO.2 Professional skills** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products **PSO.3 Practical implementation and testing skills** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies

IV	To inculcate in students professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate engineering issues to broader social context	**PO3. Design/development of solutions** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. **PO5. Modern tool usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. **PO6. The engineer and society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. **PO8. Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. **PO9. Individual and team work** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. **PO10. Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear **PO11. Project management and finance** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. **PSO.1 Professional skills** Imparted through simulation language skills and

		general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles **PSO.4 Successful career and entrepreneurship** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats

5. RELATION BETWEEN THE PROGRAM EDUCATIONAL OBJECTIVE AND THE OUTCOMES

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

POs → / PEOs ↓		(1) **Preparation & Learning Environment**	(2) **Core Competence.**	(3) **Breadth.**	(4) **Professionalism.**
PO1	Engineering knowledge	3	3	3	2
PO2	Problem Analysis	3	3	3	2
PO3	Design/development of solutions	3	3	3	3
PO4	Conduct investigations of complex problems	2	3	3	2
PO5	Modern tool usage	2	3	3	3
PO6	The engineer and society	3	2	3	3
PO7	Environment and sustainability	2	2	2	3
PO8	Ethics	3	2	2	3
PO9	Individual and team work	3	2	2	3
PO10	Communication	3	3	3	3
PO11	Project management and finance	2	2	2	3
PO12	Life-long learning	3	3	3	2

Relationships between program Educational objectives and program outcomes
Key: 3 = Highly Related; 2 = Medium; 1=Low

RELATION BETWEEN THE PROGRAM SPECIFIC OUTCOMES AND THE PROGRAM EDUCATIONAL OBJECTIVES

A broad relation between the program Educational Objectives and the Program Specific Outcomes are given in the following table:

PEOs → / PSOs ↓		(1) Preparation & Learning Environment	(2) Core Competence.	(3) Breadth.	(4) Professionalism.
PSO1	Professional skills	3	2	2	3
PSO2	Problem solving skills	2	3	3	2
PSO3	Practical implementation and testing skills	3	3	3	2
PSO4	Successful career and entrepreneurship	3	3	2	3

Relationship between Program Specific Outcomes and Program Educational Objectives
Key: H = Highly Related; 2 = Medium; 1=Low

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 etc.
- Frequency of assessment can be once in a semester and justified by the program coordinator.

6. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMESOF (B.Tech) AERONAUTICAL ENGINEERING GRADUATES

Graduates from accredited programs must achieve the following learning outcomes, defined by broad areas of learning. The outcomes are distributed within and among the courses within our curriculum, and our students are assessed for the achievement of these outcomes, as well as specific course learning objectives, through testing, surveys, and other faculty assessment instruments. Information obtained in these assessments is used in a short-term feedback and improvement loop.

Each Aeronautical Engineering student will demonstrate the following attributes by the time they graduate:

PO1. Engineering Knowledge

Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

Performance Criteria Definitions

- Identify the concepts and/or equations
- Execute the solution using a logic and structured approach
- Evaluate the solution of the problem

PO2. Problem Analysis

Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

Performance Criteria Definitions

- Identify an engineering problem
- Formulate appropriate theoretical basis for the analysis of a given problem
- Analyze an engineering problem
- Evaluate the appropriate solution to an engineering problem

PO3. Design/Development of Solutions

Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

Performance Criteria Definitions

- Awareness of global effects of the product / practice /event
- Understanding of economic factors
- Awareness of implications to society at large

PO4. Conduct Investigations of Complex Problems

Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

Performance Criteria Definitions

- Identify problem/purpose
- Prepare hypothesis
- Outline procedure
- List materials and equipment
- Conduct experiment
- Record observations, data and results
- Perform analysis
- Document conclusions

PO5. Modern Tool Usage

Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

Performance Criteria Definitions

- Use modern engineering tools for the system design, simulation and analysis
- Use software applications effectively to write technical reports and oral presentations
- Use modern equipment and instrumentation in the design process, analysis and troubleshooting

PO6. The Engineer and Society

Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

Performance Criteria Definitions

- Informal meetings on current issues
- Participation in public service extracurricular activities
- Required Humanities and Social Sciences (HSS) courses on contemporary issues

PO7. Environment and Sustainability

Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

Performance Criteria Definitions

- Develop a methodology to accomplish the design
- Select a solution from the potential solutions
- Implement the solution

PO8. Ethics

Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

Performance Criteria Definitions

- Demonstrate knowledge of professional code of ethics
- Understanding of ethical and professional issues
- Acknowledge the work of other in a consistent manner
- Exhibit honest behavior

PO9. Individual and Team Work

Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

Performance Criteria Definition

- Research and gather information
- Share responsibilities and duties
- Fulfill team role's duties
- listen to other teammates

PO10. Communication

Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

Performance Criteria Definitions

- Use appropriate format and grammatical structure
- Create a well organized document
- Present the results appropriately
- Demonstrate effective oral communication

PO11. Project Management and Finance

Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

Performance Criteria Definitions

- Awareness of global effects of the product / practice /event
- Understanding of economic factors
- Awareness of implications to society at large

PO12. Life-long Learning

Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Performance Criteria Definitions

- Find relevant sources of information
- Participate in school or professional seminars
- Participate in students or professional associations

PROGRAM SPECIFIC OUTCOMES OF (B.Tech) AERONAUTICAL ENGINEERING GRADUATES

PSO1. Professional skills

Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products.

Performance Criteria Definitions.

- Identify the concepts and/or equations
- Execute the solution using a logic and structured approach
- Evaluatethesolutionofthe problem

PSO2. Problem solving skills

Imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles.

Performance Criteria Definitions

- Identify an engineering problem
- Formulate appropriate theoretical basis for the analysis of a given problem
- Analyze an engineering problem
- Evaluate theappropriatesolutiontoanengineeringproblem

PSO3. Practical implementation and testing skills

Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies.

Performance Criteria Definitions

- Awareness about new technologies
- implications to appropriate methodologies
- Outline procedure
- List materials and equipment
- Conduct experiment
- Record observations, data and results
- Performanalysis

PSO4. Successful career and entrepreneurship

To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and 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.

Courses offered in Aeronautical Engineering Curriculum (IARE- R16) –Vs- Program Outcomes and Program Specific Outcomes Attained through course modules for I-I,I-II,II-I,II-II, III-I, III-II, IV-I, IV-II Semesters

I YEAR I SEMESTER																
Code	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
AHS001	English for Communication									✓	✓	✓				✓	
AHS002	Linear Algebra and Ordinary Differential Equations	✓	✓		✓									✓			
AHS005	Engineering Chemistry	✓	✓					✓						✓			
AHS007	Applied Physics	✓	✓		✓									✓			
AME001	Engineering Drawing	✓	✓	✓	✓	✓					✓		✓	✓	✓	✓	✓
AHS101	Communication Skills Laboratory						✓		✓	✓	✓		✓				✓
AHS103	Engineering Chemistry Laboratory	✓												✓	✓	✓	
ACS113	IT Workshop	✓				✓							✓	✓		✓	✓
AME101	Basic Workshop	✓				✓							✓	✓		✓	✓
I YEAR II SEMESTER																	
Code	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
AME002	Engineering Mechanics	✓	✓		✓									✓			
AHS003	Computational Mathematics and Integral Calculus	✓	✓		✓									✓			
AHS008	Modern Physics	✓	✓							✓							
AHS009	Environmental Studies	✓		✓		✓		✓						✓			
ACS001	Computer Programming	✓	✓	✓	✓	✓					✓		✓	✓	✓		✓
AHS102	Computational Mathematics Laboratory	✓	✓	✓	✓	✓							✓	✓	✓		✓
AHS105	Engineering Physics Laboratory	✓	✓							✓							
ACS101	Computer Programming Laboratory	✓											✓	✓			✓
AME102	Computer Aided Engineering Drawing Practice	✓	✓	✓	✓	✓	✓	✓		✓		✓		✓	✓	✓	

II YEAR III SEMESTER																
Code	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
AHS011	Mathematical Transform Techniques	✓	✓		✓									✓			
AAE001	Introduction to Aerospace Engineering	✓	✓	✓										✓			
AAE002	Theory of Structures	✓	✓		✓									✓			
AAE003	Fluid Mechanics and Hydraulics	✓	✓	✓	✓									✓			
AEE018	Basic Electrical and Electronics Engineering	✓	✓		✓									✓			
AHS017	Gender Sensitivity							✓	✓								
AAE101	Mechanics of Solids Laboratory	✓								✓			✓	✓		✓	
AAE102	Fluid Mechanics and Hydraulics Laboratory	✓								✓			✓	✓		✓	
AEE103	Basic Electrical and Electronics Engineering Laboratory	✓								✓				✓		✓	
II YEAR IV SEMESTER																	
Code	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
AHS004	Complex Analysis and Probability Distribution	✓	✓		✓									✓			
AME003	Thermodynamics	✓	✓	✓										✓			
AAE004	Low Speed Aerodynamics	✓	✓	✓	✓									✓	✓	✓	
AAE005	Aircraft Materials and Production	✓	✓	✓		✓								✓			
AAE006	Analysis of Aircraft Structures	✓	✓	✓										✓	✓	✓	
AAE103	Aerodynamics Laboratory	✓	✓	✓	✓					✓			✓	✓	✓	✓	✓
AAE104	Aerospace Structures Laboratory	✓	✓	✓	✓					✓			✓	✓	✓	✓	✓
AAE105	Aircraft Materials and Production Laboratory	✓	✓	✓	✓					✓			✓	✓	✓	✓	✓
III YEAR V SEMESTER																	
Code	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
AAE007	Aircraft Propulsion	✓	✓	✓	✓									✓	✓	✓	

AAE008	High Speed Aerodynamics	✓	✓	✓	✓									✓	✓	✓	
AAE009	Finite Element Methods	✓	✓	✓		✓								✓	✓		
AAE010	Aircraft Systems and Controls	✓	✓	✓										✓	✓	✓	
AAE011	Aircraft Performance	✓	✓	✓										✓	✓		
AAE523	Mechanism and Machine Design	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓	✓	✓
AAE515	Heat Transfer	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓	✓	✓
AAE106	Computer Aided Aircraft Engineering Drawing	✓		✓		✓				✓			✓	✓			✓
AAE107	Flight Controls Laboratory	✓											✓	✓			
AHS106	Research and Content Development Laboratory	✓								✓			✓				✓
III YEAR VI SEMESTER																	
Code	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
AAE012	Space Propulsion	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
AAE013	Computational Aerodynamics	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓
AAE014	Aircraft Stability and Control	✓	✓	✓	✓	✓	✓			✓	✓			✓	✓	✓	✓
AME552	Introduction to Automobile Engineering	✓		✓		✓	✓		✓					✓	✓	✓	
AME553	Introduction to Robotics	✓	✓	✓	✓									✓	✓	✓	✓
AAE551	Aerospace Propulsion and Combustion	✓	✓	✓										✓			
AAE108	Aerospace Propulsion Laboratory	✓					✓							✓		✓	
AAE109	Computational Aerodynamics Laboratory	✓	✓	✓	✓								✓	✓	✓	✓	✓
AAE110	Computer Aided Manufacturing Laboratory	✓		✓									✓	✓		✓	✓
IV YEAR VII SEMESTER																	
Code	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
AAE015	Aerospace Structural Dynamics	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓
AAE016	Space Mechanics	✓	✓	✓	✓	✓				✓	✓	✓		✓	✓	✓	✓
AAE017	Flight Vehicle Design	✓	✓	✓	✓	✓						✓	✓	✓	✓	✓	✓

AAE111	Computational Structural Analysis Laboratory	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓
AAE112	Flight Vehicle Design Laboratory	✓	✓	✓									✓	✓	✓	✓	✓
AAE113	Aerospace composite structures laboratory	✓		✓		✓							✓	✓	✓	✓	✓
IV YEAR VIII SEMESTER																	
AAE018	Flights Controls Theory	✓	✓	✓	✓	✓					✓		✓	✓		✓	
AAE019	Aviation Management	✓	✓				✓	✓			✓		✓	✓	✓		✓
Group-I																	
AAE501	Advanced solid mechanics	✓	✓	✓	✓								✓	✓	✓		✓
AAE502	Experimental stress analysis	✓	✓	✓	✓	✓							✓	✓	✓		✓
AAE503	Fatigue and Fracture mechanics	✓	✓	✓	✓								✓	✓	✓	✓	✓
AAE504	Design and analysis of composite structures	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓
AAE505	Aeroelasticity	✓	✓	✓	✓								✓	✓	✓		
AAE506	Unmanned air vehicles	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓
Group-II																	
AAE507	Ground vehicle aerodynamics	✓	✓	✓	✓								✓	✓	✓	✓	✓
AAE508	Advanced computational aerodynamics	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓
AAE509	Experimental Aerodynamics	✓	✓	✓	✓								✓	✓	✓	✓	✓
AAE510	Hypersonic Aerodynamics	✓	✓	✓	✓								✓	✓	✓		✓
AAE511	High angle of attack aerodynamics	✓	✓	✓	✓								✓	✓	✓		✓
AAE512	Helicopter Aerodynamics	✓		✓									✓	✓			✓
Group-III																	
AAE513	Theory of combustion	✓	✓	✓	✓								✓	✓	✓	✓	✓
AAE514	Turbomachinery	✓	✓	✓	✓								✓	✓	✓	✓	✓
AAE515	Heat transfer	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓	✓	✓
AAE516	Cryogenics	✓	✓	✓	✓								✓	✓	✓	✓	✓
AAE517	Aero engine design	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓
AAE518	Rocket and Missiles	✓	✓	✓	✓								✓	✓	✓	✓	✓

Group IV																	
AAE519	Precision Engineering	✓	✓	✓		✓				✓			✓	✓			✓
AAE520	Non Destructive Testing	✓	✓	✓		✓		✓		✓				✓	✓		✓
AAE521	CAD / CIM	✓	✓	✓		✓		✓		✓			✓	✓	✓		
AAE522	Composites Fabrication and Machining	✓	✓		✓	✓							✓	✓			✓
AAE523	Mechanism and Machine Design	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓	✓	✓
AAE524	Production Design and Development	✓	✓	✓		✓		✓		✓			✓	✓	✓		✓
Group V																	
AAE525	Avionics and Instrumentation	✓	✓	✓						✓			✓	✓	✓		✓
AAE526	Air Transportation System	✓	✓	✓						✓			✓	✓		✓	✓
AAE527	Airport Planning and Management	✓	✓	✓						✓		✓	✓	✓		✓	✓
AAE528	Airworthiness and Certifications	✓	✓	✓						✓		✓	✓	✓			✓
AAE529	Flight Scheduling and Operations	✓	✓	✓						✓		✓	✓	✓			✓
AAE530	Airport Operations	✓	✓	✓						✓		✓	✓	✓			✓
Group VI																	
AAE531	Spacecraft Attitude and Control	✓	✓	✓	✓	✓							✓	✓	✓	✓	
AAE532	Automatic Control of Aircraft	✓	✓	✓	✓	✓								✓	✓	✓	✓
AAE533	Flight Simulation	✓	✓	✓	✓	✓					✓		✓	✓	✓	✓	✓
AAE534	Orbital Mechanics	✓	✓	✓							✓			✓	✓	✓	
AAE535	Space Dynamics	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓
AAE536	Atmospheric Re-entry Vehicle	✓	✓	✓	✓	✓					✓		✓	✓	✓	✓	✓

7. PROCEDURES FOR OUTCOME DELIVERY AND ASSESSMENT WITH RESPECT TO PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

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

The Courses covered by Individual Program Outcomes and Program Specific Outcomes

PO1: Engineering knowledge

Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution complex engineering problems.

Code	Subject	Code	Subject
I Semester			
AHS002	Linear Algebra and Ordinary Differential Equations	AHS103	Engineering Chemistry Laboratory
AHS005	Engineering Chemistry	ACS113	IT Workshop
AHS007	Applied Physics	AME101	Basic Workshop
AME001	Engineering Drawing		
II Semester			
AME002	Engineering Mechanics	AHS102	Computational Mathematics Laboratory
AHS003	Computational Mathematics and Integral Calculus	AHS105	Engineering Physics Laboratory
AHS008	Modern Physics	ACS101	Computer Programming Laboratory
AHS009	Environmental Studies	AME102	Computer Aided Engineering Drawing Practice
ACS001	Computer Programming		
III Semester			
AHS011	Mathematical Transform Techniques	AEE018	Basic Electrical and Electronics Engineering
AAE001	Introduction to Aerospace Engineering	AAE101	Mechanics of Solids Laboratory
AAE002	Theory of Structures	AAE102	Fluid Mechanics and Hydraulics Laboratory
AAE003	Fluid Mechanics and Hydraulics	AEE103	Basic Electrical and Electronics Engineering Laboratory
IV Semester			
AHS004	Complex Analysis and Probability Distribution	AAE006	Analysis of Aircraft Structures
AME003	Thermodynamics	AAE103	Aerodynamics Laboratory
AAE004	Low Speed Aerodynamics	AAE104	Aerospace Structures Laboratory
AAE005	Aircraft Materials and Production	AAE105	Aircraft Materials and Production Laboratory
V Semester			
AAE007	Aircraft Propulsion	AAE523	Mechanism and Machine Design
AAE008	High Speed Aerodynamics	AAE515	Heat Transfer
AAE009	Finite Element Methods	AAE106	Computer Aided Aircraft Engineering Drawing
AAE010	Aircraft Systems and Controls	AAE107	Flight Controls Laboratory
AAE011	Aircraft Performance	AHS106	Research and Content Development Laboratory

VI Semester			
AAE012	Space Propulsion	AAE551	Aerospace Propulsion and Combustion
AAE013	Computational Aerodynamics	AAE108	Aerospace Propulsion Laboratory
AAE014	Aircraft Stability and Control	AAE109	Computational Aerodynamics Laboratory
AME552	Introduction to Automobile Engineering	AAE110	Computer Aided Manufacturing Laboratory
AME553	Introduction to Robotics		
VII Semester			
AAE015	Aerospace Structural Dynamics	AAE111	Computational Structural Analysis Laboratory
AAE015	Aerospace Structural Dynamics	AAE112	Flight Vehicle Design Laboratory
AAE016	Space Mechanics	AAE113	Aerospace composite structures laboratory
AAE017	Flight Vehicle Design		
VIII Semester			
AAE018	Flights Controls Theory	AAE019	Aviation Management
Group I			
AAE501	Advanced solid mechanics	AAE504	Design and analysis of composite structures
AAE502	Experimental stress analysis	AAE505	Aeroelasticity
AAE503	Fatigue and Fracture mechanics	AAE506	Unmanned air vehicles
Group II			
AAE507	Ground vehicle aerodynamics	AAE510	Hypersonic Aerodynamics
AAE508	Advanced computational aerodynamics	AAE511	High angle of attack aerodynamics
AAE509	Experimental Aerodynamics	AAE512	Helicopter Aerodynamics
Group III			
AAE513	Theory of combustion	AAE516	Cryogenics
AAE514	Turbomachinery	AAE517	Aero engine design
AAE515	Heat transfer	AAE518	Rocket and Missiles
Group IV			
AAE519	Precision Engineering	AAE522	Composites Fabrication and Machining
AAE520	Non Destructive Testing	AAE523	Mechanism and Machine Design
AAE521	CAD / CIM	AAE524	Production Design and Development
Group V			
AAE525	Avionics and Instrumentation	AAE528	Airworthiness and Certifications

AAE526	Air Transportation System	AAE529	Flight Scheduling and Operations
AAE527	Airport Planning and Management	AAE530	Airport Operations
Group VI			
AAE531	Spacecraft Attitude and Control	AAE534	Orbital Mechanics
AAE532	Automatic Control of Aircraft	AAE535	Space Dynamics
AAE533	Flight Simulation	AAE536	Atmospheric Re-entry Vehicle

PO2: Problem Analysis

Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Code	Subject	Code	Subject
I Semester			
AHS002	Linear Algebra and Ordinary Differential Equations	AHS007	Applied Physics
AHS005	Engineering Chemistry	AME001	Engineering Drawing
II Semester			
AME002	Engineering Mechanics	AHS102	Computational Mathematics Laboratory
AHS003	Computational Mathematics and Integral Calculus	AHS105	Engineering Physics Laboratory
AHS008	Modern Physics	AME102	Computer Aided Engineering Drawing Practice
ACS001	Computer Programming		
III Semester			
AHS011	Mathematical Transform Techniques	AAE003	Fluid Mechanics and Hydraulics
AAE001	Introduction to Aerospace Engineering	AEE018	Basic Electrical and Electronics Engineering
AAE002	Theory of Structures		
IV Semester			
AHS004	Complex Analysis and Probability Distribution	AAE006	Analysis of Aircraft Structures
AME003	Thermodynamics	AAE103	Aerodynamics Laboratory
AAE004	Low Speed Aerodynamics	AAE104	Aerospace Structures Laboratory
AAE005	Aircraft Materials and Production	AAE105	Aircraft Materials and Production Laboratory
V Semester			
AAE007	Aircraft Propulsion	AAE011	Aircraft Performance
AAE008	High Speed Aerodynamics	AAE523	Mechanism and Machine Design
AAE009	Finite Element Methods	AAE515	Heat Transfer

AAE010	Aircraft Systems and Controls		
VI Semester			
AAE012	Space Propulsion	AME553	Introduction to Robotics
AAE013	Computational Aerodynamics	AAE551	Aerospace Propulsion and Combustion
AAE014	Aircraft Stability and Control	AAE109	Computational Aerodynamics Laboratory
VII Semester			
AAE015	Aerospace Structural Dynamics	AAE112	Flight Vehicle Design Laboratory
AAE016	Space Mechanics	AAE018	Flights Controls Theory
AAE017	Flight Vehicle Design	AAE019	Aviation Management
AAE111	Computational Structural Analysis Laboratory		
Group I			
AAE501	Advanced solid mechanics	AAE504	Design and analysis of composite structures
AAE502	Experimental stress analysis	AAE505	Aeroelasticity
AAE503	Fatigue and Fracture mechanics	AAE506	Unmanned air vehicles
Group II			
AAE507	Ground vehicle aerodynamics	AAE510	Hypersonic Aerodynamics
AAE508	Advanced computational aerodynamics	AAE511	High angle of attack aerodynamics
AAE509	Experimental Aerodynamics		
Group III			
AAE513	Theory of combustion	AAE516	Cryogenics
AAE514	Turbomachinery	AAE517	Aero engine design
AAE515	Heat transfer	AAE518	Rocket and Missiles
Group IV			
AAE519	Precision Engineering	AAE522	Composites Fabrication and Machining
AAE520	Non Destructive Testing	AAE523	Mechanism and Machine Design
AAE521	CAD / CIM	AAE524	Production Design and Development
Group V			
AAE525	Avionics and Instrumentation	AAE528	Airworthiness and Certifications
AAE526	Air Transportation System	AAE529	Flight Scheduling and Operations
AAE527	Airport Planning and Management	AAE530	Airport Operations
Group VI			

AAE531	Spacecraft Attitude and Control	AAE534	Orbital Mechanics
AAE532	Automatic Control of Aircraft	AAE535	Space Dynamics
AAE533	Flight Simulation	AAE536	Atmospheric Re-entry Vehicle

PO3: Design/development of solutions

Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Code	Subject	Code	Subject
I Semester			
AME001	Engineering Drawing		
II Semester			
AHS009	Environmental Studies	AHS102	Computational Mathematics Laboratory
ACS001	Computer Programming	AME102	Computer Aided Engineering Drawing Practice
III Semester			
AAE001	Introduction to Aerospace Engineering	AAE003	Fluid Mechanics and Hydraulics
IV Semester			
AME003	Thermodynamics	AAE103	Aerodynamics Laboratory
AAE004	Low Speed Aerodynamics	AAE104	Aerospace Structures Laboratory
AAE005	Aircraft Materials and Production	AAE105	Aircraft Materials and Production Laboratory
AAE006	Analysis of Aircraft Structures		
V Semester			
AAE007	Aircraft Propulsion	AAE011	Aircraft Performance
AAE008	High Speed Aerodynamics	AAE523	Mechanism and Machine Design
AAE009	Finite Element Methods	AAE515	Heat Transfer
AAE010	Aircraft Systems and Controls	AAE106	Computer Aided Aircraft Engineering Drawing
VI Semester			
AAE012	Space Propulsion	AME553	Introduction to Robotics
AAE013	Computational Aerodynamics	AAE551	Aerospace Propulsion and Combustion
AAE014	Aircraft Stability and Control	AAE109	Computational Aerodynamics Laboratory
AME552	Introduction to Automobile Engineering	AAE110	Computer Aided Manufacturing Laboratory
VII Semester			

AAE015	Aerospace Structural Dynamics	AAE111	Computational Structural Analysis Laboratory
AAE016	Space Mechanics	AAE112	Flight Vehicle Design Laboratory
AAE017	Flight Vehicle Design	AAE113	Aerospace composite structures laboratory
VIII Semester			
AAE018	Flights Controls Theory		
Group I			
AAE501	Advanced solid mechanics	AAE504	Design and analysis of composite structures
AAE502	Experimental stress analysis	AAE505	Aeroelasticity
AAE503	Fatigue and Fracture mechanics	AAE506	Unmanned air vehicles
Group-II			
AAE507	Ground vehicle aerodynamics	AAE510	Hypersonic Aerodynamics
AAE508	Advanced computational aerodynamics	AAE511	High angle of attack aerodynamics
AAE509	Experimental Aerodynamics		
Group III			
AAE513	Theory of combustion	AAE517	Aero engine design
AAE514	Turbomachinery	AAE518	Rocket and Missiles
AAE516	Cryogenics		
Group IV			
AAE519	Precision Engineering	AAE521	CAD / CIM
AAE520	Non Destructive Testing	AAE524	Production Design and Development
Group V			
AAE525	Avionics and Instrumentation	AAE528	Airworthiness and Certifications
AAE526	Air Transportation System	AAE529	Flight Scheduling and Operations
AAE527	Airport Planning and Management	AAE530	Airport Operations
Group VI			
AAE531	Spacecraft Attitude and Control	AAE534	Orbital Mechanics
AAE532	Automatic Control of Aircraft	AAE535	Space Dynamics
AAE533	Flight Simulation	AAE536	Atmospheric Re-entry Vehicle

PO4: Conduct investigations of complex problems

Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Code	Subject	Code	Subject
I Semester			
AHS002	Linear Algebra and Ordinary Differential Equations	AME001	Engineering Drawing
AHS007	Applied Physics		
II Semester			
AME002	Engineering Mechanics	AHS102	Computational Mathematics Laboratory
AHS003	Computational Mathematics and Integral Calculus	AME102	Computer Aided Engineering Drawing Practice
ACS001	Computer Programming		
III Semester			
AHS011	Mathematical Transform Techniques	AAE003	Fluid Mechanics and Hydraulics
AAE002	Theory of Structures	AEE018	Basic Electrical and Electronics Engineering
IV Semester			
AHS004	Complex Analysis and Probability Distribution	AAE104	Aerospace Structures Laboratory
AAE004	Low Speed Aerodynamics	AAE105	Aircraft Materials and Production Laboratory
AAE103	Aerodynamics Laboratory		
V Semester			
AAE007	Aircraft Propulsion	AAE523	Mechanism and Machine Design
AAE008	High Speed Aerodynamics	AAE515	Heat Transfer
VI Semester			
AAE012	Space Propulsion	AME553	Introduction to Robotics
AAE013	Computational Aerodynamics	AAE109	Computational Aerodynamics Laboratory
AAE014	Aircraft Stability and Control		
VII Semester			
AAE015	Aerospace Structural Dynamics	AAE017	Flight Vehicle Design
AAE016	Space Mechanics	AAE111	Computational Structural Analysis Laboratory
VIII Semester			
AAE018	Flights Controls Theory		
Group-I			
AAE501	Advanced solid mechanics	AAE504	Design and analysis of composite structures
AAE502	Experimental stress analysis	AAE505	Aeroelasticity
AAE503	Fatigue and Fracture mechanics	AAE506	Unmanned air vehicles

Group-II			
AAE507	Ground vehicle aerodynamics	AAE510	Hypersonic Aerodynamics
AAE508	Advanced computational aerodynamics	AAE511	High angle of attack aerodynamics
AAE509	Experimental Aerodynamics		
Group-III			
AAE513	Theory of combustion	AAE517	Aero engine design
AAE514	Turbomachinery	AAE518	Rocket and Missiles
AAE516	Cryogenics		
Group-IV			
AAE522	Composites Fabrication and Machining		
Group-VI			
AAE531	Spacecraft Attitude and Control	AAE535	Space Dynamics
AAE532	Automatic Control of Aircraft	AAE536	Atmospheric Re-entry Vehicle
AAE533	Flight Simulation		

PO5: Modern tool usage

Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

Code	Subject	Code	Subject
I Semester			
AME001	Engineering Drawing	AME101	Basic Workshop
ACS113	IT Workshop		
II Semester			
AHS009	Environmental Studies	AHS102	Computational Mathematics Laboratory
ACS001	Computer Programming	AME102	Computer Aided Engineering Drawing Practice
IV Semester			
AAE005	Aircraft Materials and Production		
V Semester			
AAE009	Finite Element Methods	AAE515	Heat Transfer
AAE523	Mechanism and Machine Design	AAE106	Computer Aided Aircraft Engineering Drawing
VI Semester			
AAE012	Space Propulsion	AAE014	Aircraft Stability and Control

AAE013	Computational Aerodynamics	AME552	Introduction to Automobile Engineering
VII Semester			
AAE015	Aerospace Structural Dynamics	AAE111	Computational Structural Analysis Laboratory
AAE016	Space Mechanics	AAE113	Aerospace composite structures laboratory
AAE017	Flight Vehicle Design		
VIII Semester			
AAE018	Flights Controls Theory		
Group-I			
AAE502	Experimental stress analysis	AAE506	Unmanned air vehicles
AAE504	Design and analysis of composite structures		
Group-II			
AAE508	Advanced computational aerodynamics		
Group-III			
AAE517	Aero engine design		
Group-IV			
AAE519	Precision Engineering	AAE521	CAD / CIM
AAE520	Non Destructive Testing	AAE522	Composites Fabrication and Machining
Group-VI			
AAE531	Spacecraft Attitude and Control	AAE535	Space Dynamics
AAE532	Automatic Control of Aircraft	AAE536	Atmospheric Re-entry Vehicle
AAE533	Flight Simulation		

PO6: The engineer and society

Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Code	Subject	Code	Subject
I Semester			
AHS101	Communication Skills Laboratory		
II Semester			
AME102	Computer Aided Engineering Drawing Practice		
V Semester			

AAE523	Mechanism and Machine Design	AAE515	Heat Transfer
VI Semester			
AAE012	Space Propulsion	AME552	Introduction to Automobile Engineering
AAE014	Aircraft Stability and Control		

PO7:Environment and Sustainability

Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Code	Subject	Code	Subject
I Semester			
AHS005	Engineering Chemistry		
II Semester			
AHS009	Environmental Studies	AME102	Computer Aided Engineering Drawing Practice
III Semester			
AHS017	Gender Sensitivity		
VI Semester			
AAE012	Space Propulsion		
VIII Semester			
AAE019	Aviation Management		
Group IV			
AAE520	Non Destructive Testing	AAE524	Production Design and Development
AAE521	CAD / CIM		

PO8: Ethics

Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Code	Subject	Code	Subject
I Semester			
AHS101	Communication Skills Laboratory		
III Semester			
AHS017	Gender Sensitivity		

PO9: Individual and team work

Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Code	Subject	Code	Subject
I Semester			
AHS001	English for Communication	AHS101	Communication Skills Laboratory
II Semester			
AHS008	Modern Physics	AME102	Computer Aided Engineering Drawing Practice
AHS105	Engineering Physics Laboratory		
III Semester			
AAE101	Mechanics of Solids Laboratory	AEE103	Basic Electrical and Electronics Engineering Laboratory
AAE102	Fluid Mechanics and Hydraulics Laboratory		
IV Semester			
AAE103	Aerodynamics Laboratory	AAE105	Aircraft Materials and Production Laboratory
AAE104	Aerospace Structures Laboratory		
V Semester			
AAE523	Mechanism and Machine Design	AAE106	Computer Aided Aircraft Engineering Drawing
AAE515	Heat Transfer		
VI Semester			
AAE014	Aircraft Stability and Control		
VI Semester			
AAE016	Space Mechanics		
Group IV			
AAE519	Precision Engineering	AAE521	CAD / CIM
AAE520	Non Destructive Testing		
Group V			
AAE526	Air Transportation System	AAE525	Avionics and Instrumentation
AAE527	Airport Planning and Management	AAE529	Flight Scheduling and Operations
AAE528	Airworthiness and Certifications	AAE530	Airport Operations

PO10: Communication

Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Code	Subject	Code	Subject

I Semester			
AHS001	English for Communication	AHS101	Communication Skills Laboratory
AME001	Engineering Drawing		
II Semester			
ACS001	Computer Programming		
VI Semester			
AAE013	Computational Aerodynamics	AAE014	Aircraft Stability and Control
VII Semester			
AAE016	Space Mechanics		
VIII Semester			
AAE018	Flights Controls Theory	AAE019	Aviation Management
Group VI			
AAE533	Flight Simulation	AAE536	Atmospheric Re-entry Vehicle
AAE534	Orbital Mechanics		

PO11: Project management and finance

Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Code	Subject	Code	Subject
I Semester			
AHS001	English for Communication		
II Semester			
AME102	Computer Aided Engineering Drawing Practice		
V Semester			
AAE523	Mechanism and Machine Design	AAE515	Heat Transfer
VI Semester			
AAE013	Computational Aerodynamics		
VII Semester			
AAE016	Space Mechanics	AAE017	Flight Vehicle Design
Group V			
AAE527	Airport Planning and Management	AAE529	Flight Scheduling and Operations
AAE528	Airworthiness and Certifications	AAE530	Airport Operations

PO12: Life-long learning

Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Code	Subject	Code	Subject
I Semester			
AME001	Engineering Drawing	ACS113	IT Workshop
AHS101	Communication Skills Laboratory	AME101	Basic Workshop
II Semester			
ACS001	Computer Programming	ACS101	Computer Programming Laboratory
AHS102	Computational Mathematics Laboratory		
III Semester			
AAE101	Mechanics of Solids Laboratory		Fluid Mechanics and Hydraulics Laboratory
IV Semester			
AAE103	Aerodynamics Laboratory	AAE105	Aircraft Materials and Production Laboratory
AAE104	Aerospace Structures Laboratory		
V Semester			
AAE523	Mechanism and Machine Design	AAE107	Flight Controls Laboratory
AAE515	Heat Transfer	AHS106	Research and Content Development Laboratory
AAE106	Computer Aided Aircraft Engineering Drawing		
VI Semester			
AAE012	Space Propulsion	AAE109	Computational Aerodynamics Laboratory
AAE013	Computational Aerodynamics	AAE110	Computer Aided Manufacturing Laboratory
VII Semester			
AAE015	Aerospace Structural Dynamics	AAE112	Flight Vehicle Design Laboratory
AAE017	Flight Vehicle Design	AAE113	Aerospace composite structures laboratory
AAE111	Computational Structural Analysis Laboratory		
VIII Semester			
AAE018	Flights Controls Theory	AAE019	Aviation Management
Group-I			
AAE102	Advanced solid mechanics	AAE504	Design and analysis of composite structures

AAE502	Experimental stress analysis	AAE505	Aeroelasticity
AAE503	Fatigue and Fracture mechanics	AAE506	Unmanned air vehicles
Group-II			
AAE507	Ground vehicle aerodynamics	AAE510	Hypersonic Aerodynamics
AAE508	Advanced computational aerodynamics	AAE511	High angle of attack aerodynamics
AAE509	Experimental Aerodynamics	AAE512	Helicopter Aerodynamics
Group-III			
AAE513	Theory of combustion	AAE517	Aero engine design
AAE514	Turbomachinery	AAE518	Rocket and Missiles
AAE516	Cryogenics		
Group-IV			
AAE519	Precision Engineering	AAE522	Composites Fabrication and Machining
AAE521	CAD / CIM	AAE524	Production Design and Development
Group-V			
AAE525	Avionics and Instrumentation	AAE528	Airworthiness and Certifications
AAE526	Air Transportation System	AAE529	Flight Scheduling and Operations
AAE527	Airport Planning and Management	AAE530	Airport Operations
Group-VI			
AAE531	Spacecraft Attitude and Control	AAE535	Space Dynamics
AAE533	Flight Simulation	AAE536	Atmospheric Re-entry Vehicle

The categorization of specific outcomes of the above Aeronautical engineering courses is grouped as follows:

PSO1: Professional skills: **Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products**			
Code	**Subject**	**Code**	**Subject**
I Semester			
AHS002	Linear Algebra and Ordinary Differential Equations	AHS103	Engineering Chemistry Laboratory
AHS005	Engineering Chemistry	ACS113	IT Workshop
AHS007	Applied Physics	AME101	Basic Workshop
AME001	Engineering Drawing		
II Semester			

AME002	Engineering Mechanics	AHS102	Computational Mathematics Laboratory
AHS003	Computational Mathematics and Integral Calculus	ACS101	Computer Programming Laboratory
AHS009	Environmental Studies	AME102	Computer Aided Engineering Drawing Practice
ACS001	Computer Programming		
III Semester			
AHS011	Mathematical Transform Techniques	AEE018	Basic Electrical and Electronics Engineering
AAE001	Introduction to Aerospace Engineering	AAE101	Mechanics of Solids Laboratory
AAE002	Theory of Structures	AAE102	Fluid Mechanics and Hydraulics Laboratory
AAE003	Fluid Mechanics and Hydraulics	AEE103	Basic Electrical and Electronics Engineering Laboratory
IV Semester			
AHS004	Complex Analysis and Probability Distribution	AAE006	Analysis of Aircraft Structures
AME003	Thermodynamics	AAE103	Aerodynamics Laboratory
AAE004	Low Speed Aerodynamics	AAE104	Aerospace Structures Laboratory
AAE005	Aircraft Materials and Production	AAE105	Aircraft Materials and Production Laboratory
V Semester			
AAE007	Aircraft Propulsion	AAE523	Mechanism and Machine Design
AAE008	High Speed Aerodynamics	AAE515	Heat Transfer
AAE009	Finite Element Methods	AAE106	Computer Aided Aircraft Engineering Drawing
AAE010	Aircraft Systems and Controls	AAE107	Flight Controls Laboratory
AAE011	Aircraft Performance		
VI Semester			
AAE012	Space Propulsion	AAE551	Aerospace Propulsion and Combustion
AAE013	Computational Aerodynamics	AAE108	Aerospace Propulsion Laboratory
AAE014	Aircraft Stability and Control	AAE109	Computational Aerodynamics Laboratory
AME552	Introduction to Automobile Engineering	AAE110	Computer Aided Manufacturing Laboratory
AME553	Introduction to Robotics		
VII Semester			
AAE015	Aerospace Structural Dynamics	AAE111	Computational Structural Analysis Laboratory
AAE016	Space Mechanics	AAE112	Flight Vehicle Design Laboratory
AAE017	Flight Vehicle Design	AAE113	Aerospace composite structures laboratory

VIII Semester			
AAE018	Flights Controls Theory	AAE019	Aviation Management
Group-I			
AAE501	Advanced solid mechanics	AAE504	Design and analysis of composite structures
AAE502	Experimental stress analysis	AAE505	Aeroelasticity
AAE503	Fatigue and Fracture mechanics	AAE506	Unmanned air vehicles
Group-II			
AAE507	Ground vehicle aerodynamics	AAE510	Hypersonic Aerodynamics
AAE508	Advanced computational aerodynamics	AAE511	High angle of attack aerodynamics
AAE509	Experimental Aerodynamics	AAE512	Helicopter Aerodynamics
Group-III			
AAE513	Theory of combustion	AAE517	Aero engine design
AAE514	Turbomachinery	AAE518	Rocket and Missiles
AAE516	Cryogenics		
Group-IV			
AAE519	Precision Engineering	AAE522	Composites Fabrication and Machining
AAE520	Non Destructive Testing	AAE524	Production Design and Development
AAE521	CAD / CIM		
Group-V			
AAE525	Avionics and Instrumentation	AAE528	Airworthiness and Certifications
AAE526	Air Transportation System	AAE529	Flight Scheduling and Operations
AAE527	Airport Planning and Management	AAE530	Airport Operations
Group-VI			
AAE531	Spacecraft Attitude and Control	AAE534	Orbital Mechanics
AAE532	Automatic Control of Aircraft	AAE535	Space Dynamics
AAE533	Flight Simulation	AAE536	Atmospheric Re-entry Vehicle

PSO2: Problem solving skills: **Imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles**			
I Semester			
AME001	Engineering Drawing	AHS103	Engineering Chemistry Laboratory

II Semester			
ACS001	Computer Programming	AME102	Computer Aided Engineering Drawing Practice
AHS102	Computational Mathematics Laboratory		
IV Semester			
AAE004	Low Speed Aerodynamics	AAE104	Aerospace Structures Laboratory
AAE006	Analysis of Aircraft Structures	AAE105	Aircraft Materials and Production Laboratory
AAE103	Aerodynamics Laboratory		
V Semester			
AAE007	Aircraft Propulsion	AAE011	Aircraft Performance
AAE008	High Speed Aerodynamics	AAE523	Mechanism and Machine Design
AAE009	Finite Element Methods	AAE515	Heat Transfer
AAE010	Aircraft Systems and Controls		
VI Semester			
AAE012	Space Propulsion	AME552	Introduction to Automobile Engineering
AAE013	Computational Aerodynamics	AME553	Introduction to Robotics
AAE014	Aircraft Stability and Control	AAE109	Computational Aerodynamics Laboratory
VII Semester			
AAE015	Aerospace Structural Dynamics	AAE111	Computational Structural Analysis Laboratory
AAE016	Space Mechanics	AAE112	Flight Vehicle Design Laboratory
AAE017	Flight Vehicle Design	AAE113	Aerospace composite structures laboratory
VIII Semester			
AAE019	Aviation Management		
Group-I			
AAE501	Advanced solid mechanics	AAE504	Design and analysis of composite structures
AAE502	Experimental stress analysis	AAE505	Aeroelasticity
AAE503	Fatigue and Fracture mechanics	AAE506	Unmanned air vehicles
Group-II			
AAE507	Ground vehicle aerodynamics	AAE510	Hypersonic Aerodynamics
AAE508	Advanced computational aerodynamics	AAE511	High angle of attack aerodynamics
AAE509	Experimental Aerodynamics		
Group-III			

AAE513	Theory of combustion	AAE517	Aero engine design
AAE514	Turbomachinery	AAE518	Rocket and Missiles
AAE516	Cryogenics		
Group-IV			
AAE513	Theory of combustion	AAE517	Aero engine design
AAE514	Turbomachinery	AAE518	Rocket and Missiles
AAE516	Cryogenics		
Group-IV			
AAE520	Non Destructive Testing	AAE524	Production Design and Development
AAE521	CAD / CIM		
Group-V			
AAE525	Avionics and Instrumentation		
Group-VI			
AAE531	Spacecraft Attitude and Control	AAE534	Orbital Mechanics
AAE532	Automatic Control of Aircraft	AAE535	Space Dynamics
AAE533	Flight Simulation	AAE536	Atmospheric Re-entry Vehicle

PSO3: Practical implementation and testing skills:

Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies

Code	Subject	Code	Subject
I Semester			
AHS001	English for Communication	ACS113	IT Workshop
AME001	Engineering Drawing	AME101	Basic Workshop
AHS103	Engineering Chemistry Laboratory		
II Semester			
AME102	Computer Aided Engineering Drawing Practice		
III Semester			
AAE101	Mechanics of Solids Laboratory	AEE103	Basic Electrical and Electronics Engineering Laboratory
AAE102	Fluid Mechanics and Hydraulics Laboratory		
IV Semester			
AAE004	Low Speed Aerodynamics	AAE104	Aerospace Structures Laboratory

AAE006	Analysis of Aircraft Structures	AAE105	Aircraft Materials and Production Laboratory
AAE103	Aerodynamics Laboratory		
V Semester			
AAE007	Aircraft Propulsion	AAE523	Mechanism and Machine Design
AAE008	High Speed Aerodynamics	AAE515	Heat Transfer
AAE010	Aircraft Systems and Controls		
VI Semester			
AAE012	Space Propulsion	AME553	Introduction to Robotics
AAE013	Computational Aerodynamics	AAE108	Aerospace Propulsion Laboratory
AAE014	Aircraft Stability and Control	AAE109	Computational Aerodynamics Laboratory
AME552	Introduction to Automobile Engineering	AAE110	Computer Aided Manufacturing Laboratory
VII Semester			
AAE015	Aerospace Structural Dynamics	AAE111	Computational Structural Analysis Laboratory
AAE016	Space Mechanics	AAE112	Flight Vehicle Design Laboratory
AAE017	Flight Vehicle Design	AAE113	Aerospace composite structures laboratory
VIII Semester			
AAE018	Flights Controls Theory		
Group-I			
AAE503	Fatigue and Fracture mechanics	AAE506	Unmanned air vehicles
AAE504	Design and analysis of composite structures		
Group-II			
AAE508	Advanced computational aerodynamics	AAE509	Experimental Aerodynamics
Group-III			
AAE513	Theory of combustion	AAE517	Aero engine design
AAE514	Turbomachinery	AAE518	Rocket and Missiles
AAE516	Cryogenics		
Group-V			
AAE526	Air Transportation System	AAE527	Airport Planning and Management
Group-VI			
AAE531	Spacecraft Attitude and Control	AAE534	Orbital Mechanics
AAE532	Automatic Control of Aircraft	AAE535	Space Dynamics
AAE533	Flight Simulation	AAE536	Atmospheric Re-entry Vehicle

PSO4: Successful career and entrepreneurship:

To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats

Code	Subject	Code	Subject
I Semester			
AME001	Engineering Drawing	ACS113	IT Workshop
AHS101	Communication Skills Laboratory	AME101	Basic Workshop
II Semester			
ACS001	Computer Programming	ACS101	Computer Programming Laboratory
AHS102	Computational Mathematics Laboratory		
IV Semester			
AAE103	Aerodynamics Laboratory	AAE105	Aircraft Materials and Production Laboratory
AAE104	Aerospace Structures Laboratory		
V Semester			
AAE523	Mechanism and Machine Design		Computer Aided Aircraft Engineering Drawing
AAE515	Heat Transfer	AAE106	Research and Content Development Laboratory
VI Semester			
AAE012	Space Propulsion	AME553	Introduction to Robotics
AAE013	Computational Aerodynamics	AAE109	Computational Aerodynamics Laboratory
AAE014	Aircraft Stability and Control	AAE110	Computer Aided Manufacturing Laboratory
VII Semester			
AAE015	Aerospace Structural Dynamics	AAE111	Computational Structural Analysis Laboratory
AAE016	Space Mechanics	AAE112	Flight Vehicle Design Laboratory
AAE017	Flight Vehicle Design	AAE113	Aerospace composite structures laboratory
VIII Semester			
AAE019	Aviation Management		
Group-I			
AAE501	Advanced solid mechanics	AAE504	Design and analysis of composite structures
AAE502	Experimental stress analysis	AAE506	Unmanned air vehicles
AAE503	Fatigue and Fracture mechanics		
Group-II			
AAE507	Ground vehicle aerodynamics	AAE510	Hypersonic Aerodynamics
AAE508	Advanced computational aerodynamics	AAE511	High angle of attack aerodynamics

AAE509	Experimental Aerodynamics	AAE512	Helicopter Aerodynamics
Group-III			
AAE513	Theory of combustion	AAE517	Aero engine design
AAE514	Turbomachinery	AAE518	Rocket and Missiles
AAE516	Cryogenics		
Group-IV			
AAE519	Precision Engineering	AAE522	Composites Fabrication and Machining
AAE520	Non Destructive Testing	AAE524	Production Design and Development
Group-V			
AAE525	Avionics and Instrumentation	AAE528	Airworthiness and Certifications
AAE526	Air Transportation System	AAE529	Flight Scheduling and Operations
AAE527	Airport Planning and Management	AAE530	Airport Operations
AAE532	Automatic Control of Aircraft	AAE535	Space Dynamics
AAE533	Flight Simulation	AAE536	Atmospheric Re-entry Vehicle

8. METHODS OF MEASURING LEARNING OUTCOMES AND VALUE ADDITION

There are many different ways to assess student learning. In this section, we present the different types of assessment approaches available and the different frameworks to interpret the results.

i. Mid Semester Course Evaluation
ii. End-of Semester Course Evaluation
iii. Continuous Evaluation of Classroom Performance
iv. Course Objective Surveys
v. Course Instructor's Evaluations
vi. Graduating Senior's survey
vii. Alumni Survey
viii. Employer Survey
ix. Laboratory and Project Works
x. Balanced Composition in Curriculum
xi. DAC and Faculty Meetings
xii. Professional Societies

The above assessment indicators are detailed below:

i. Mid Semester Course Evaluation

Aeronautical Engineering department conducts mid-semester reviews for all courses. All departmental students are encouraged to fill out a brief survey on the state of the courses they are currently taking, and space is provided for a written comment. Faculty are strongly encouraged to review these evaluations, and draft a brief response on how they will react to

correct any deficiencies noted by the students. The results are reviewed by departmental faculty (all faculty have permission to read results for all courses).

ii. End-of Semester Course Evaluation

The end-of semester course reviews are conducted, feedback taken from students and remedial measures will be taken up such that the student gets benefited before going for the university end exams. The positive and negative comments made by the students about the course are recorded and submitted to the departmental academic council (DAC) and to the Principal for taking necessary actions to better the course for subsequent semesters.

iii. Continuous Evaluation of Classroom Performance

Students are encouraged and motivated to participate actively in the classroom proceedings by way of interactive teaching by the instructor. Surprise class tests comprising of short answer questions, quiz based discussions, multiple-choice, true-false, and matching tests are conducted to strengthen the teaching-learning process. Apart from teac her control and covering content, the teacher also act a safe licitator and students discover things for themselves, enabling them to be more independent and becoming life – long learners exploring student-centric educational philosophy..

iv. Course Objective Surveys

Students are encouraged to fill-out a brief survey on the fulfillment of course objectives. The data is reviewed by the concerned course faculty and the results are kept open for the entire faculty. Based on this, alterations or changes to the course objectives are undertaken by thorough discussions in faculty and DAC meetings.

v. Course Instructor's Evaluations

The course coordinator will collect the course portfolios from the respective instructors of each course offered in a given semester at the beginning of the semester as well as at the end of the semester. They remain on file for verification and study by the entire faculty. This helps the course coordinator and faculty to understand how effectively we can teach the given course. Betterment can be achieved from time to time and continuous improvement can be shown in handling courses in the subsequent semesters.

vi. Graduating Senior's Suvery

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

vii. Alumni Survey

The survey asks former students of the department about the status of their employment and further education, perceptions of institutional emphasis, estimated gains in knowledge and skills, involvement a sunder graduate students, and continuing involvement with Institute of

Aeronautical Engineering. This survey is administered every three years. The data obtained will be analyzed and used in continuous improvement.

viii. Employer Survey

The main purpose of this employer questionnaire is to know employer's views about the skills they require of employees compared to the skills actually possessed by them. The purpose e is also to identify gaps in technical and vocational skills, need for required training practices to fill these gaps and criteria for hiring new employees. These employer surveys are reviewed by the College Academic Council (CAC) to affect the present curriculum to suit the requirement so the employer.

ix. Laboratory and Project Works

The laboratory work is continuously monitored and assessed to suit the present demands of the industry. Students are advised and guided to do project works giving solutions to research / industrial problems to the extent possible by the capabilities and limitations of the student. The results of the assessment of the individual projects and laboratory work can easily be conflated in order to provide the students with periodic reviews of their overall progress and to produce terminal marks and grading.

x. Balanced Composition in Curriculum

The undergraduate program in electronics and communication engineering is designed to prepare students for successful careers in engineering and related fields by providing a balanced education, that prepares students to apply analytical, computational, experimental, and methodological tools to solve engineering problems; a strong foundation in mathematics and physical sciences; abroad and balanced general education in the humanities, arts, social sciences, and interdisciplinary studies; sufficient training and development of skills for effective communication and teamwork; a proper understanding of an engineer's professional and ethical responsibilities in relation to engineering fields and society; and recognition of the need for lifelong learning. The student's intellectual and ethical development is assessed continuously in relation to the balanced composition in curriculum.

xi. Department Academic committee and Faculty meetings

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

xii. Professional Societies

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

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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 already equipped with course objectives or competencies, it reflects proximity to have reached the 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) course outline.

Expected Learning Outcomes:
After reading and completing this, individuals will be able to:

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

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

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

Classroom Assessment Technique (CAT): Angelo and Cross (1993) developed a variety of techniques/activities than can be used to assess students' learning. These CATs are often done anonymously and are not graded. These activities check on the class' learning while students are still engaged in the learning process. An example of a CAT is a non-graded quiz given a few weeks before the first exam.

Course description:
Formal description of material expected for coverage in the course.

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

Expected learning 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 judgment about quality of student 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, and End Semester Examination etc. The assessment methods are used to identify how the well students have acquired the learning outcomes for the course.

1. COURSE PURPOSE

Primitive step in identifying expected learning outcomes for a course is identifying the basic objective of teaching the course. By clarifying the purpose of course, faculty can help discover main topics or themes related to students' learning. These themes help to outline the expected learning outcomes for a specified course.

The course purpose involves the following:

1. What role does this course play within the program?
2. How is the course unique/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, and "Course Purpose" goes beyond to describe how this course fits into the student's educational experience of the program.

2. 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 etcetera 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).

3. TO DEFINE EFFECTIVE LEARNING OUTCOME 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, and 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 Computational Fluid Dynamicstechniques.
- The students will appreciate knowledge discovery from Computational Fluid Dynamics techniques.

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” Computational Fluid Dynamics techniques?
- 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 Conceptual Design of Flight Vehicles.
- The students will be able to identify the characteristics of Classification techniques from other Computational Fluid Dynamics techniques.

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. RANEntly, 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 conclusions regarding cause and effect, interpreting motives, making inferences, or finding evidence to support statements/arguments.

5. **Evaluate** – being able to judge the value of information and/or sources of information based on personal values or opinions.

6. **Create** – the ability to creatively or uniquely apply prior knowledge and/or skills to produce new and original thoughts, ideas, processes, etc. At this level, students are involved in creating their own thoughts and ideas.

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
Choose	Classify	Apply	Analyze	Agree	Adapt
Define	Compare	Build	Assume	Appraise	Build
Find	Contrast	Choose	Categorize	Assess	Change
How	Demonstrate	Construct	Classify	Award	Choose
Label	Explain	Develop	Compare	Choose	Combine
List	Extend	Experiment with	Conclusion	Compare	Compile
Match	Illustrate	Identify	Contrast	Conclude	Compose
Name	Infer	Interview	Discover	Criteria	Construct
Omit	Interpret	Make use of	Dissect	Criticize	Create
Recall	Outline	Model	Distinguish	Decide	Delete
Relate	Relate	Organize	Divide	Deduct	Design
Select	Rephrase	Plan	Examine	Defend	Develop
Show	Show	Select	Function	Determine	Discuss
Spell	Summarize	Solve	Inference	Disprove	Elaborate
Tell	Translate	Utilize	Inspect	Estimate	Estimate
What			List	Evaluate	Formulate
When			Motive	Explain	Happen
Where			Relationships	Importance	Imagine

Which Who Why			Simplify Survey Take part in Test for Theme	Influence Interpret Judge Justify Mark Measure Opinion Perceive Prioritize Prove Rate Recommend Rule on Select Support Value	Improve Invent Make up Maximize Minimize Modify Original Originate Plan Predict Propose Solution Solve Suppose Test Theory

4. 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.

5. SAMPLE EXPECTED LEARNING OUTCOMES STATEMENTS

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

Computer Programming:
Students who complete this course should be able to:

- Demonstrate an understanding of computer programming language concepts.
- Demonstrate an understanding of the major programming domains and the knowledge of the most appropriate computer programming language for each domain.
- To be able to develop C programs on at least two platforms.
- Demonstrate an understanding of ethical and legal issues for computing professionals and the impact of computing technology in society.
- Able to implement the algorithms and draw flowcharts for solving Mathematical and small Engineering problems.
- Ability to design and develop Computer programs, analyze, and interpret the concept of pointers, declarations, initialization, operations on pointers and their usage.

- Able to define structure data types and use them in simple data processing applications also he/she must be able to use the concept of array of structures. Student must be able to define union and enumeration user defined data types.
- Able to demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks like Graphics and real time applications.
- Able to learn opening of data files and learn input/ output of file data. Also he must learn to write programs for reading, writing and appending data to sequential data Files.
- Develop confidence for self education and ability for life-long learning needed for Computer language.

Aerospace Vehicle Structures:
After completing this course, the student will be able to:

- Get clear understanding of Different structural members.
- Understand the different kind of loads acting on different types of structures.
- Analyze various structural members subjected to different loads.
- Perform different analysis like stress analysis, buckling analysis etc.
- Determine the loads acting on different structural components.
- Choose the Structural Member for a component for various applications.
- Estimate loads and stresses acting on different aircraft structural components.
- Use this course as prerequisite to understand the more advanced courses like ASD, AE, ACS, etc.

6. 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 exercises 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. JVR 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. JVR now has the opportunity to (1) inform the students that there is some confusion and (2) make adjustments 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%, is 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 class 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 questioner to students about their learning (or lack thereof) and
    - Adjust their teaching methods and/or students' learning behaviors to ensure greater student learning (Maki, 2004).

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).

7. DESCRIPTION OF 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 program (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 IEEE / ACM / AICTE Model Curriculum

The earliest curriculum was published in 1968 for computer science (CS) by the Association for Computing Machinery (ACM), and in 1977 the Computer Society of the Institute for Electrical and Electronic Engineers (IEEE-CS) provided its first curriculum recommendations. In the late 1980's the ACM and the IEEE-CS together formed a task force to create curricula for computer science and computer engineering. The core curriculum covers classes in computer science curriculum, and subsequently separate curricula reports were issued for information systems, software engineering and computer engineering

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 IEEE / ACM / 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?

8. PROCEDURE FOR DEVELOPMENT OF 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:

- 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 program outcomes
- Mapping course outcomes leading to the achievement of the program outcomes

9. REFERENCES

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Annexure-A: Sample Course Description (As Per NBA Norms post June, 2015)

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**FINITE ELEMENT METHODS**				
Course Code	AAE009				
Programme	B.Tech				
Semester	V	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Ms. Ch Ragha Leena, Assistant Professor				
Course Faculty	Ms. Ch. Ragha Leena, Assistant Professor Mr. S.Devaraj , Assistant Professor				

I. COURSE OVERVIEW:

The Finite Element Method (FEM) is widely used in industry for analyzing and modeling structures and continua, whose physical behavior is described by ordinary and partial differential equations. The FEM is particularly useful for engineering problems that are too complicated to be solved by classical analytical methods. The main objective of this course is to introduce the mathematical concepts of the Finite Element Method for obtaining an approximate solution of ordinary and partial differential equations. In this course you will attend lectures on the fundamentals of the Finite Element Method. The learning process will be enhanced by completing assignments using mathematical software. You will also be introduced to a commercial Finite Element software package.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS002	1	Linear Algebra and Ordinary Differential Equations	4
UG	AAE002	III	Theory of structures	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Finite Element Methods	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V. EVALUATION METHODOLOGY:

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

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

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

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

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Assignments
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Real time applications
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Assignments
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	1	Real time applications

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	2	Assignments
PSO2	**Problem-solving Skills:** Imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles.	2	Real time applications
PSO 3	**Practical implementation and testing skills:** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies	-	-
PSO 4	**Successful career and entrepreneurship:** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aeronautical/aerospace allied systems to become technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the theoretical basics of governing equations and convergence criteria of finite element method.
II	Use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems.
III	Discuss the accurate Finite Element Solutions for the various field problems.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AAE009.01	CLO 1	Understand the numerical methods and development of mathematical models for physical system.	PO 1	3
AAE009.02	CLO 2	Identify mathematical model for solution of common engineering problems in the field of aeronautical, mechanical and civil	PO 2	2
AAE009.03	CLO 3	Understand the concepts of shape functions for one dimensional and quadratic elements, stiffness matrix and boundary conditions	PO 1 PO 2	2
AAE009.04	CLO 4	Remember the steps involved in finite element methods while solving the model of physical problem	PO 1	3
AAE009.05	CLO 5	Apply numerical methods for solving one dimensional bar problems	PO 2	2
AAE009.06	CLO 6	Identify the mathematical models for two dimensional, three dimensional truss and beam elements.	PO 1 PO 2	2
AAE009.07	CLO 7	Solve the equations of truss and beam elements	PO 2	2
AAE009.08	CLO 8	Calculate stress strain and strain energy for common engineering problems	PO 2	2
AAE009.09	CLO 9	Derive element matrix by different methods by applying basic laws in mechanics and integration by parts	PO 1 PO 2	2
AAE009.10	CLO 10	Demonstrate the ability to evaluate and interpret FEA analysis results for design and development purposes	PO 3 PO 5	2
AAE009.11	CLO 11	Formulate simple and complex problems into finite elements and solve structural and thermal problems	PO 2	2
AAE009.12	CLO 12	Derive the element stiffness matrices for triangular elements and axi- symmetric solids and estimate the load vector and stresses.	PO 2	2
AAE009.13	CLO 13	Understand the concepts of steady state heat transfer analysis for one dimensional slab, fin and thin plate.	PO 1 PO 2	2
AAE009.14	CLO 14	Understand the concepts of mass and spring system and derive the equations for various structural problems	PO 1 PO 2	2
AAE009.15	CLO 15	Calculate the mass matrices; Eigen values Eigen vectors and natural frequency for dynamic problems.	PO 2	2

AAE009.16	CLO 16	Model multi-dimensional structural and heat transfer problems by using automatic and fully automatic software such as ANSYS, NISA, NASTRAN.	PO 5	2

3 = High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3															
CLO 2		2												2		
CLO 3	3	2														
CLO 4	3												2			
CLO 5		2														
CLO 6	3	2														
CLO 7		2												1		
CLO 8	2	2														
CLO 9			3		1								2			
CLO 10			2		1											
CLO 11		2														
CLO 12		2												2		
CLO 13	2	2														
CLO 14	2	2											2			
CLO 15		2														
CLO 16					2											

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2, PO 3, PO 5	SEE Exams	PO 1, PO 2, PO 3, PO 5	Assignments	PO 1, PO 3	Seminars	PO 1
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

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

XIII. SYLLABUS

Unit-I	**INTRODUCTION**
Introduction to Finite Element Method for solving field problems. Stress and Equilibrium. Boundary conditions. Strain - displacement relations. Stress-strain relations for 2-D and3-D elastic problems. One Dimensional Problems: Finite element modeling coordinates and shape functions. Assembly of Global stiffness matrix and load vector. Finite element equations – Treatment of boundary conditions, Quadratic shape functions.	
Unit-II	**ANALYSIS OF TRUSSES AND BEAMS**
Analysis of Trusses: Stiffness matrix for plane Truss Elements, stress calculations and problems. Analysis of beams: Element stiffness matrix for two noded, two degrees of freedom per node beam element and simple problems.	
Unit-III	**CONTINUUM ELEMENTS**
Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Estimation of load vector and stresses. Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements Two dimensional four noded isoparametric elements and problems.	
Unit-IV	**STEADY STATE HEAT TRANSFER ANALYSIS**
Steady state Heat Transfer Analysis: one dimensional analysis of slab, fin and two dimensional analysis of thin plate. Analysis of a uniform shaft subjected to torsion.	
Unit-V	**DYNAMIC ANALYSIS**
Dynamic Analysis: Formulation of finite element model, element –Mass matrices, evaluation of Eigen values and Eigen Vectors for a stepped bar, truss. Finite element-formulation to 3D problems in stress analysis, convergence requirements, mesh generation, techniques such as semi automatic and fully automatic use of software such as ANSYS,NISA,NASTRAN etc.	
Text Books:	
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XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Introduction to Finite element method for solving field problems	CLO 1	T1:1.2 T2:1.4
2	Stress and equilibrium	CLO 8	T1:1.4
3	Stress and equilibrium, boundary conditions	CLO 8	T1:1.4
4	Strain – displacement relations	CLO 8	T1:1.7
5	Stress-strain relations for 2-d and 3-d elastic problems	CLO 8	T1:1.7
6	One dimensional problems: finite element modeling coordinates and shape functions	CLO 3	T1:3.1-3.3 T2:1.6
7	Assembly of global stiffness matrix and load vector	CLO 3	T1:3.4
8-9	Problems on one dimensional elements	CLO 5	T1:3.4
10	Quadratic shape functions	CLO 3	T1:3.9
11	Introduction to truss and beams	CLO 6	T1:4.1-4.2 T2:9.1
12-13	Analysis of trusses: stiffness matrix for plane truss elements	CLO 7	T1:4.2 T2:9.2
14	Stiffness matrix for plane truss elements	CLO 7	T1:4.2 T2:9.2
15	Stress calculations and problems on truss elements	CLO 8	T1:4.2 T2:9.2
16	Problems on truss elements	CLO 7	T1:4.2 T2:9.2
17	Analysis of beams: Introduction	CLO 6	T1:8.2 T2:9.3
18-19	Element stiffness matrix for two noded two degrees of freedom per node beam element	CLO 6	T1:8.3 T2:9.3
20-21	Problems on beam elements	CLO 7	T1:8.3 T2:9.3
22	Finite element modeling of two dimensional stress analysis with constant strain triangles	CLO 12	T1:5.2
23	Two dimensional stress analysis with constant strain triangles and treatment of boundary conditions	CLO 12	T1:5.3
24	Stress analysis of constant strain triangles	CLO 12	T1:5.3
25-26	Estimation of load vector and stresses	CLO 12	T1:5.3
27	Introduction to finite element modeling of axisymmetric solids	CLO 12	T1:6.2
28	Axi-symmetric solids subjected to axi-symmetric Loading with triangular elements	CLO 12	T1:6.3
29-30	Load vector for axi symmetric solids	CLO 12	T1:6.3 T2:13-3
31	Two dimensional four noded isoparametric elements	CLO 12	T1:7.2
32-33	Problems on axisymmetric solids	CLO 12	T1:10.8
34	Numerical integration and problems	CLO 09	T1:7.3
35-36	Introduction to steady state heat transfer analysis	CLO 11	R2:10.1 T2:13-2
37	One dimensional analysis of slab and problems	CLO 13	T1:10.2 T2:13-3
38	Fin and two dimensional analysis of thin plate	CLO 13	T1:10.2 T2:13-1
39	Fin and two dimensional analysis of thin plate and problems	CLO 08	T1:10.2 R1:13-2
40-41	Problems on fins and thin plate	CLO 13	T1:10.2 T2:14-1
42	Analysis of a uniform shaft subjected to torsion	CLO 13	T1:10.3 T2:14-2
43	Introduction to dynamic analysis	CLO 15	T1:11.1

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
			T2:12.1
44-45	Formulation of finite element model	CLO 13	T1:11.2 R1:12.2
46-47	Derivation of element mass matrices	CLO 14	T1:11.3 T2:12.3
48-49	Evaluation of eigen values and eigen vectors for a stepped bar	CLO 15	T1:11.3 T2:12.3
50-51	Evaluation of eigen values and eigen vectors for truss	CLO 15	T1:11.4 T2:12.3
52-53	Finite element formulation to 3d problems in stress analysis	CLO 15	T1:12.1
54	Convergence requirements	CLO 16	T1:12.2 R1:22.1
55-56	Mesh generation, techniques such as semi automatic and fully automatic use of software such as ANSYS,NISA,NASTRAN etc.	CLO 16	T1:12.2 T2:22.2

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Gain information about space frames used in the modeling of car body and bicycle frames	Guest Lecture/Seminar	PO1,PO2	PSO 2
2	Encourage students to perform analysis on composite materials using FEM applications	NPTEL/Projects	PO 5	PSO 2, PSO 3

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