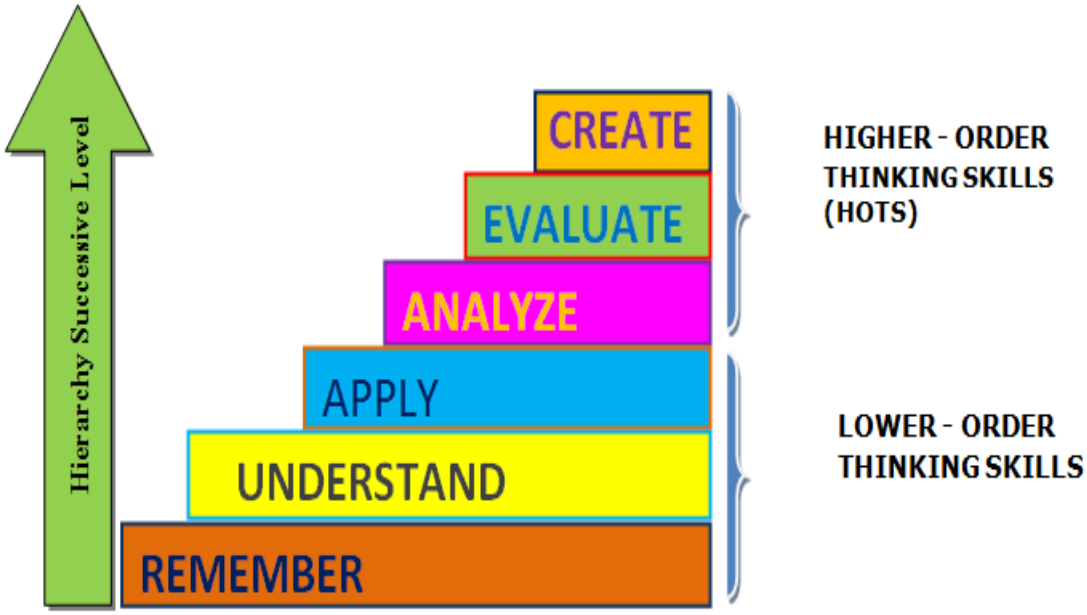
COURSE DESCRIPTOR BOOKLET

B.Tech

AERONAUTICAL ENGINEERING

(Accredited by NBA)

R-16 REGULATIONS



BLOOM'S TAXONOMY OF LEARNING OUTCOMES

.....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

I SEMESTER

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**ENGLISH FOR COMMUNICATION**				
Course Code	AHS001				
Programme	B.Tech				
Semester	I	AE | ME | CE			
	II	CSE | IT | ECE | EEE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	2	1
Chief Coordinator	Ms B Anand Lakshmi, Associate Professor				
Course Faculty	Dr Prudhvi Raju, Associate Professor Ms P B Esther Rani, Assistant Professor Ms Jayshree Naidu, Assistant Professor Ms Shirisha Deshpande, Assistant Professor Mr. Sudhakar Medi, Assistant Professor Mr Kondal, Assistant Professor				

I. COURSE OVERVIEW:

In view of the growing importance of English as a tool for global communication and the consequent emphasis on training students to acquire communicative competence, this Engineering English has been designed to develop linguistic and communicative competence of the students. In the classroom the focus should be on the skills of reading, writing, listening and speaking. The teacher can ask comprehension questions to stimulate discussion and based on the discussions students can be made to write short paragraphs/ essays etc.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Standard applicability of grammar and vocabulary

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
English for Communication	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 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	3	Term paper
PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	3	Seminar Listening Test Speaking Test Presentation (Technical / Review: Movie/Book)
PO 11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2	Five minutes video

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	-	-
PSO 2	**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	-	-
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	2	Seminar
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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Communicate in an intelligible English accent and pronunciation.
II	Use the four language skills i.e., Listening, Speaking, Reading and Writing effectively.
III	Develop the art of writing simple English with correct spelling, grammar and punctuation.

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
AHS001.01	CLO 1	Understand the value of English as an international language and try to improve the knowledge regarding language skills and elements to be perfect in their usage.	PO 10	1
AHS001.02	CLO 2	Develop the ability to listen effectively in order to analyze the language used in descriptions and narrations.	PO 9	2
AHS001.03	CLO 3	Paraphrase listening skills for different purposes with special emphasis on intensive listening.	PO 9	2
AHS001.04	CLO 4	Interpret how to contextualize the use of language for different purposes.	PO 9 PO 10	2
AHS001.05	CLO 5	Ability to comprehend speaking skills for different purposes with special emphasis on intensive listening	PO 9, PO 10, PO 11	3
AHS001.06	CLO 6	Express fluently without any grammatical mistakes and also give presentations with proper modulation.	PO 10	3
AHS001.07	CLO 7	Translate the importance of critical reading to get information from the context with the help of root words and contextual clues.	PO 10	3
AHS001.08	CLO 8	Grasp the importance of reading skills for focused and selective information at various levels of professional career.	PO 10	3
AHS00.09	CLO 9	Summarize the topic to write different types of argumentative, narrative, descriptive and persuasive paragraphs and essays.	PO 9, PO 10	3
AHS001.10	CLO 10	Infer the use of language for developing behavioral skills.	PO 9, PO 10, PO 11, PSO 3	2
AHS001.11	CLO 11	Translate the importance of reading techniques and applying it to literary texts.	PO 11	3
AHS001.12	CLO 12	Ability to learn and understand techniques of grammar to apply in the functions of English language	PO 10	2
AHS001.13	CLO 13	Remember to use the knowledge of grammar and vocabulary in writing more meaningfully.	PO 10	3
AHS001.14	CLO 14	Infer the importance of language and applying to learn to be sensitive according to the needs of the society.	PO 9, PO 10, PO 11, PSO 3	2
AHS001.15	CLO 15	Develop writing skills in order to apply in day to day life.	PO 9, PO 10	3
AHS001.16	CLO 16	Understand the importance of written communication for the future correspondence throw out the career of the students.	PO 9, PO 10	3
AHS001.17	CLO 17	Develop the ability to analyze the results of experiments and be competent in writing reports, work in teams in real time situations	PO 9, PO 10	3
AHS001.18	CLO 18	Understand the value of writing skills to be a responsive, attentive and empathetic writer in order to face the real-world situations	PO 9, PO 10	3
AHS001.19	CLO 19	Infer the importance of vocabulary and writing as an essential ability in the real-time situations for those who desire to advance their career.	PO 11, PSO 3	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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										1						
CLO 2									2							
CLO 3									2							
CLO 4									2	1						
CLO 5									3	3	1					
CLO 6										3						
CLO 7										3						
CLO 8										3						
CLO 9									3	3						
CLO 10									2	3	2				1	
CLO 11											3					
CLO 12										2						
CLO 13										3						
CLO 14									1	1	3				1	
CLO 15									3	3						
CLO 16									3	3						
CLO 17									3	3						
CLO 18									3	3						
CLO 19											2				2	

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 9, PO 10, PO11, PSO 3	SEE Exams	PO 9, PO 10, PO11, PSO 3	Assignments	-	Seminars	PO 10
Laboratory Practices	PO 9, PO 10, PO11, PSO 3	Student Viva	PO 10	Mini Project	-	Certification	-
Term Paper	PO 9						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

Unit-I	LISTENING SKILLS
Significance, essentials, barriers and effectiveness of listening; Listening to dialogues, conversation, discussions, monologues; Listening to sounds, silent letters, stressed syllables in English; Listening for the gist of the text, for identifying the topic, general meaning and specific information; Listening for multiple choice questions, positive and negative comments for interpretation. Note: instructions in theory and practice in the lab.	
Unit-II	**SPEAKING SKILLS**
Significance, essentials, barriers and effectiveness of speaking; Simple oral or casual interaction, dialogue, conversation; Debates: Differences between disagreeing and being disagreeable; Brief presentations; Role plays; Generating talks based on visual or written prompts; Addressing a small group or a large formal gathering; Speaking about present, past experiences and future plans; Arguing out a topic without verbal fights; Paper presentation. Note: instructions in theory and practice in the lab.	
Unit-III	**READING SKILLS**
Techniques of reading: Skimming, scanning, intensive and extensive reading; Reading comprehension: Exercises for multiple choice questions and contextual meaning- values in Dr. Kalam. Vocabulary enrichment and grammar exercises based on selective readings: Power of dreams- vision to mission- prose passage for intellectual and emotional comments; Reading for the gist of a text, for specific information, for information transfer and interpretation.	
Unit-IV	**WRITING SKILLS**
Significance, essentials and effectiveness of writing; Writing emails; Writing paragraphs: Comparing, contrasting, presentations with an introduction, body and conclusion; Writing formal and informal letters: Letter of invitation, accepting, declining, requesting, cover letter enclosing a CV.	
Unit-V	**GRAMMAR AND VOCABULARY**
Punctuation, parts of speech, articles, prepositions, tenses, concords, phrasal verbs; Forms of verbs: Regular and irregular, direct and indirect speech, change of voice; prefixes, suffixes, Synonyms, antonyms, one word substitutes, idioms and phrases, technical vocabulary.	
Text Books:	
1. Meenakshi Raman, Sangeetha Sharma, "Technical Communication Principles Practices", Oxford University Press, New Delhi, 3rd Edition , 2015.	
Reference Books:	
1. Norman Whitby, "Business Benchmark: Pre-Intermediate to Intermediate – BEC Preliminary", Cambridge University Press, 2nd Edition, 2008. 2. Devaki Reddy, Shreesh Chaudhary, "Technical English", Macmillan, 1st Edition, 2009. 3. Rutherford, Andrea J, "Basic Communication Skills for Technology", Pearson Education, 2nd Edition, 2010. 4. Raymond Murphy, " Essential English Grammar with Answers", Cambridge University Press, 2nd Edition 5. Dr. N V Sudershan, "President Kalam's Call to the Nation", Bala Bharathi Publications, Secunderabad, 1st Edition, 2003.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Explain the importance of English Language as a tool for global communication and emphasis to acquire communicative competence	CLO 1	T1:1.1
2	Recognize the importance of English as the global language.	CLO 1	T1:1.1
3	Identify the learning levels and their competencies	CLO 1	T1:1.1-1.5
4-7	Recall the functions of punctuation and practice exercises	CLO 6, CLO12	R3:5
8	Develop the ability to understand that speaking skills are essential to be a responsive, attentive and empathetic speaker in order to face the real-world situations.	CLO 5, CLO 14	R2:1.1
9-11	Apply the knowledge of preparation for oral presentation	CLO 6	R4:2.21
12	Identify common errors in the language through the concept of word formation	CLO 13, CLO 19	R4:60.1
13-15	Prepare the students to be aware of the importance of commonly used technical vocabulary	CLO 19	R4:1.1-2.1
16	Infer the concept of grammatical ambiguity & sentence construction	CLO 6, CLO 12	R4:4.2
17	Recognize the concept of "Subject-Verb agreement", to familiarize the students with the usage of "Concord"	CLO 6	R3:1.3
18-22	Identify and understand conventional signs, prefixes, suffixes, Synonyms, antonyms, one word substitutes used by writers to make their meaning clear to the reader	CLO 13	R4:47.1
23	Appraise the students in order to acquire the knowledge of sentence structure	CLO 6	R4:42.1
24-25	Learn to use the vocabulary in writing more meaningfully	CLO 13	R3:4.4
26-27	Infer the difference between phrases and idioms & learn to use them in sentences	CLO 13	R3:4.2
28	To make the students learn and identify commonly used technical vocabulary.	CLO 13	R4:1.3
29	Understand the significance, essentials, and effectiveness of reading	CLO 7, CLO 8	T1:2.4
30	Interpret derivatives, and standard abbreviations in English through reading skills	CLO 11	T1:27.2
31-33	Infer the gist of the text, for identifying the topic through reading skills	CLO 11	R4:5.8
34	Apply the general meaning and specific information through writing skills	CLO 16	T1:2.7
35	Analyze and Interpret multiple choice questions, positive and negative comments through comprehension passages	CLO 17	T1:2.6
36	Identify passage for intellectual and emotional comments; reading for the gist of a text.	CLO 11	T1:4.15
37	Associate the students to identify their common errors in the language	CLO 9	R2:3
38	Understand the importance of proper punctuation, creating coherence, organizing principles of paragraphs in documents to foster the writing skills of the students	CLO 17	R2:3
39	Evaluate Letter writing-formal and Informal writing and E-mail writing.	CLO 19	T1:4.13
40	To make learners aware of the selection of language to make presentations and prepare the students for an effective presentation giving them necessary inputs	CLO 18	T1:4.13
41	Distinguish writing skills such as describing, defining,	CLO 17	T1:4.13

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
	classifying, writing introduction and conclusion.		
42-43	Evaluate writing skills through creating coherence, organizing principles of paragraphs in documents.	CLO 9	T1:3.10
44-45	Understand the importance of vocabulary enrichment and grammar exercises to foster the writing skill of the students.	CLO 19	T1:4.13

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

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Construct basic and intermediate skills in English language.	Seminars	PO 10	PSO 3
2	Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work.	Seminars / NPTEL	PO 9	PSO 3
3	To build confidence for communicating in English and create interest for the life-long learning of English language.	Guest lecture	PO 10	PSO 3

Prepared by:
Ms. B Anand Lakshmi, Associate Professor

HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**LINEAR ALGEBRA AND ORDINARY DIFFERENTIAL EQUATION**				
Course Code	AHS002				
Programme	B.Tech				
Semester	I	AE | CSE | IT | ECE | EEE | ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Ms. P Rajani, Assistant Professor				
Course Faculty	Dr. M Anita, Professor Mr. J Suresh Goud, Assistant Professor Ms. P Srilatha, Assistant Professor Ms. C Rachana, Assistant Professor Ms. B Praveena, Assistant Professor				

I. COURSE OVERVIEW:

The course focuses on more advanced Engineering Mathematics topics which provide with the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes Types of matrices, difference calculus methods and differential equations. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Linear Algebra and Ordinary Differential Equations	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	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Seminar
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products.	1	Seminar
PSO 2	**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.	-	-
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.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Enrich the knowledge of probability on single random variables and probability distributions.
II	Apply the concept of correlation and regression to find covariance.
III	Analyze the given data for appropriate test of hypothesis.

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
AHS002.01	CLO 1	Demonstrate knowledge of matrix calculation as an elegant and powerful mathematical language in connection with rank of a matrix.	PO 1	1
AHS002.02	CLO 2	Finding rank by reducing the matrix to Echelon and Normal forms.	PO 1	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS002.03	CLO 3	Determine inverse of the matrix by Gauss Jordon Method.	PO 1	3
AHS002.04	CLO 4	Apply the method of LU Decomposition and solve the simultaneous equations.	PO 2	2
AHS002.05	CLO 5	Use the method of LU factorization real world problems such as circuit designing and solving complex circuits	PO 2	3
AHS002.06	CLO 6	Use the method of LU factorization real world problems such as economize and accumulate sums in double precision Computer Programme.	PO 2	2
AHS002.07	CLO 7	Interpret the Eigen values and Eigen vectors of matrix for a linear transformation and use properties of Eigen values	PO 4	1
AHS002.08	CLO 8	Understand the concept of Eigen values in real world problems of control field where they are pole of closed loop system.	PO 4	1
AHS002.09	CLO 9	Apply the concept of Eigen values in real world problems of mechanical systems where Eigen values are natural frequency and mode shape.	PO4	1
AHS002.10	CLO 10	Use the system of linear equations and matrix to determine the dependency and independency.	PO 2	2
AHS002.11	CLO 11	Determine a modal matrix, and reducing a matrix to diagonal form.	PO 1	3
AHS002.12	CLO 12	Evaluate inverse and powers of matrices by using Cayley-Hamilton theorem.	PO 1	3
AHS002.13	CLO 13	Solving differential equations of first order.	PO 1	3
AHS002.14	CLO 14	Finding orthogonal trajectories of Cartesian and polar equations.	PO 1, PO 2	2
AHS002.15	CLO 15	Apply the first order differential equations in real world problems such as Newton's Law of cooling and Law of natural growth and decay	PO 2	2
AHS002.16	CLO 16	Solving Second and higher order differential equations with constant coefficients.	PO 2	2
AHS002.17	CLO 17	Apply the second order differential equations for real world problems of electrical circuits and simple harmonic motion.	PO 4	1
AHS002.18	CLO 18	Apply the Mean value theorems for the single variable functions.	PO 1, PO 2	2
AHS002.19	CLO 19	Understand the basic concepts of Partial Differential equations.	PO 1, PO 2	2
AHS002.20	CLO 20	Determine Jacobian for the coordinate transformation	PO 1, PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHS002.21	CLO 21	Apply the technique of Jacobian and inverse Jacobian relation to real world problems such as kinematics and inverse kinematic solutions of robot manipulators.	PO 4	1
AHS002.22	CLO 22	Understand the techniques of multidimensional change –of –variables to transform the coordinates by utilizing the Jacobian.	PO 1	3
AHS002.23	CLO 23	Apply maxima and minima for functions of several variable's and Lagrange's method of multipliers	PO 1	3
AHS002.24	CLO 24	Understand the concept and acquire the knowledge for attempting the competitive exams	PO 4	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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	1												1			
CLO 2	2												1			
CLO 3	3												1			
CLO 4		2														
CLO 5		3														
CLO 6		2														
CLO 7				1									1			
CLO 8				1												
CLO 9				2									1			
CLO 10		2											1			
CLO 11	3															
CLO 12	3															
CLO 13	3															
CLO 14	1	2											1			
CLO 15		2														

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 16		2														
CLO 17				1									1			
CLO 18	1	2											1			
CLO 19	1	2											1			
CLO 20	1	2											1			
CLO 21				1												
CLO 22	3															
CLO 23	3															
CLO 24				1												

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2	SEE Exams	PO 1, PO2, PO 4	Assignments	-	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

Unit-I	THEORY OF MATRICES
Real Matrices**:** Symmetric, skew-symmetric and orthogonal matrices; Complex matrices: Hermitian, Skew-Hermitian and unitary matrices; Elementary row and column transformations, elementary matrix, finding rank of a matrix by reducing to Echelon form and normal form; Finding the inverse of a matrix using elementary row/column transformations: Gauss-Jordan method; Solving of linear system of equations by LU decomposition method.	
Unit-II	**LINEAR TRANSFORMATIONS**
Cayley-Hamilton theorem: Statement, verification, finding inverse and powers of a matrix; Linear dependence and independence of vectors; Linear transformation; Eigen values and eigen vectors of a matrix; Properties of eigen values and eigen vectors of real and complex matrices; Diagonalization of matrix.	

Unit-III	DIFFERENTIAL EQUATIONS OF FIRST ORDER AND THEIR APPLICATIONS
Formation of a differential equation; Differential equations of first order and first degree: Exact, non exact, linear equations; Bernoulli equation; Applications of first order differential equations: Orthogonal trajectories; Newton's law of cooling; Law of natural growth and decay.	
Unit-IV	**HIGHER ORDINARY LINEAR DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS**
Linear differential equations of second and higher order with constant coefficients, non homogeneous term of the type $f(x)=e^{ax}, \sin ax, \cos ax$ and $f(x)=x^n, e^{ax}v(x), x^n v(x)$; Method of variation of parameters; Applications to electrical circuits and simple harmonic motion.	
Unit-V	**FUNCTIONS OF SINGLE AND SEVERAL VARIABLES**
Mean value theorems: Rolle's theorem, Lagrange's theorem, Cauchy's theorem and generalized mean value theorems-without proofs. Functions of several variables: Functional dependence, Jacobian, maxima and minima of functions of two variables without constraints and with constraints; Method of Lagrange multipliers.	
Text Books:	
1. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 9th Edition, 2014. 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 42nd Edition, 2012.	
Reference Books:	
1. RK Jain & SRK Iyengar, "Advanced Engineering Mathematics", Narosa Publishers, 5th Edition, 2016. 2. Ravish R Singh, Mukul Bhatt, "Engineering Mathematics-1", Tata Mc Graw Hill Education, 1st Edition, 2009. 3. Srimanthapal & Suboth C.Bhunia, "Engineering Mathematics", Oxford Publishers, 3rd Edition, 2015.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Theory of Matrices Introduction of matrices	CLO 1	T1:22.5 R1:2.3
2-3	Real and complex matrices	CLO 2	T1:22.5 R1:2.4
4-6	Find rank by echelon and normal form	CLO 2	T1:22.6 R1:2.6
7	Gauss-Jordan method	CLO 4	T1:22.7 R1:4.4
8	LU decomposition method	CLO 4	T1:22.7 R1:4.10
9-12	Cayley Hamilton theorem	CLO 7	T1:22.8 R1:4.15
13-16	Eigen values and Eigen vectors	CLO 9	T1:22.9 R1:5.4
17-18	Diagonalisation	CLO 9	T1:22.9 R1:5.8
19--22	Differential equations Introduction of first order differential equations	CLO 11	T1:23.10 R1:6.8
23-24	Orthogonal trajectories	CLO 11	T1:23.10 R1:6.13

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
25-26	Applications	CLO 13	T1:23.9 R1:7.5
27-30	Second and Higher order differential equations with constant coefficients	CLO 11	T1:23.10 R1:7.5
31-34	Method of variation of parameters	CLO 9	T1:23.10 R1:8.1
35-36	Applications of second order differential equations	CLO 14	T1:23.1 R1:9.2
37	Differential Calculus Methods Verification of Rolle's Theorem to the given functions	CLO 14	T1:23.1 R1:9.4
38-39	Verification of Lagrange's Mean value theorem to the given functions	CLO 14	T1:23.1 R1:9.9
40	Verification of Cauchy's mean value theorem to the given functions	CLO 14	T1:23.1 R1:9.10
41	Functional dependence for two and three functions	CLO 14	T2:27.5 R1:10.2
42-43	Maxima and minima of functions of two variables without constraints	CLO 17	T2:27.7 R1:11.3
44-45	Lagranges method of undetermined multipliers	CLO 17	T2:27.8 R1:11.6

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

S No	Description	Proposed actions	Relevance with P0s	Relevance with PSOs
1	To improve standards and analyze the concepts.	Guest lecture	PO 1	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO 1

Prepared by:
Ms. P Rajani, Assistant Professor

HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**ENGINEERING CHEMISTRY**				
Course Code	AHS005				
Programme	B. Tech				
Semester	I	AE | CIVIL | CSE | ECE | EEE | IT | ME			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	2	1
Chief Coordinator	Ms. V Anitha Rani, Associate Professor				
Course Faculty	Dr. C Mahendar, Professor Mr. M Praveen, Assistant Professor Mr. B Raju, Assistant Professor Ms. M Malathi, Assistant Professor Mr. G Mahesh Kumar, Assistant Professor Ms. T Mallika, Assistant Professor Ms. M Lakshmi Prasanna, Assistant Professor Ms. M Swathi, Assistant Professor				

I. COURSE OVERVIEW:

The primary objective of an Engineering Chemistry course is to introduce the students to the concepts and applications of chemistry in engineering. It should cultivate in them an ability to identify chemistry in each piece of finely engineered products used in households and industry. It aims to strengthen the fundamental concepts of chemistry and then builds an interface with their industrial applications. It deals with applied and industrially useful topics, such as water technology, engineering materials, electrode potential and cells, fuels, polymers and corrosion. Water and its treatment for various purposes, engineering materials such as plastics, composites, ceramic, abrasives, their preparation, properties and applications, conventional and non-conventional energy sources, nuclear, solar, various batteries, combustion calculations, corrosion and control of metallic materials.

II. COURSE PRE-REQUISITES:

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

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Engineering Chemistry	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.	2	Seminar
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	1	Seminar
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	2	Presentation on real-world problems

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.	1	Seminar
PSO 2	**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.	-	-
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.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Apply the electrochemical principles in batteries.
II	Understand the fundamentals of corrosion and development of different techniques in corrosion control.
III	Analysis of water for its various parameters and its significance in industrial, applications.
IV	Improve the fundamental science and engineering principles relevant to materials.

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
AHS005.01	CLO 1	Extrapolate the knowledge of electrolytic cell, electrochemical cell, electrode potential and reference electrodes.	PO 1	3
AHS005.02	CLO 2	Use of primary and secondary batteries in various fields such as automobiles, railways, medical devices, aircrafts and day to day life.	PO 1 PO 2	1
AHS005.03	CLO 3	Explain the characteristic factors of a metal and environment influencing the rate of corrosion.	PO 1 PO 7	2
AHS005.04	CLO 4	Use appropriate methods such as protective, metallic and organic coatings to control corrosion in metals.	PO 1 PO 7	2
AHS005.05	CLO 5	Evaluate the quality and utility of suitable water for industrial as well as domestic applications.	PO 1 PO 7	3
AHS005.06	CLO 6	Use innovative methods to improve the quality of soft water for Potable and industrial purpose at cheaper cost.	PO 1 PO 7	2
AHS005.07	CLO 7	Understand the concepts of polymers for viscoelastic nature of polymer materials in real-time application.	PO 1 PO 7	1
AHS005.08	CLO 8	Demonstrate the ability to use polymeric materials for engineering problems in different domains.	PO 1 PO 7	1
AHS005.09	CLO 9	Justify the immense importance of basic constructional material, Portland cement in civil engineering works.	PO 1	1
AHS005.10	CLO 10	Describe various instruments used for measuring various properties of lubricants in industries.	PO 1	3
AHS005.11	CLO 11	Understand refractory use in metallurgical furnaces, kilns and other equipments.	PO 1	2
AHS005.12	CLO 12	Demonstrate comprehensive knowledge of conventional fuel properties on engine performance.	PO 1	2
AHS005.13	CLO 13	Understand the importance of cracking, knocking in IC engines and operations involved in petroleum refining for real-time application.	PO 1 PO 2	2
AHS005.14	CLO 14	Describe the physical and chemical properties of alternate fuels like natural gas, LPG and CNG.	PO 1	1
AHS005.15	CLO 15	Determine efficiency of the fuel in terms of calorific value and combustion reactions of the fuel.	PO 1	2
AHS005.16	CLO 16	Understand the concepts of electro chemistry in solar cell, Fuel cells and batteries for real-time application.	PO 1	2
AHS005.17	CLO 17	Understand the concepts of corrosion control methods in pipeline leaks and ruptures as real-time application.	PO 1 PO 7	2
AHS005.18	CLO 18	Understand the concepts of water technology in applications of image recognition for real-time water level and surface velocity.	PO 1 PO 7	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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	1														
CLO 3	2						2									
CLO 4	2						2									
CLO 5	3						3									
CLO 6	2						2									
CLO 7	2						1									
CLO 8	1						1									
CLO 9	1															
CLO 10	3															
CLO 11	2															
CLO 12	2												1			
CLO 13	3	1											1			
CLO 14	1															
CLO 15	2												1			
CLO 16	2															
CLO 17	2						2									
CLO 18	2						2									

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1,PO 2, PO 7	SEE Exams	PO 1,PO 2 PO 7	Assignments	PO 2	Seminars	PO 1, PO 2
Laboratory Practices	PO 1	Student Viva	-	Mini Project	-	Certificatior	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

Unit-I	ELECTROCHEMISTRY AND BATTERIES

Electrochemistry: Basic concepts of electrochemistry; Conductance: Specific, equivalent and molar conductance and effect of dilution on conductance; Electrochemical cells: Galvanic cell (daniel cell); Electrode potential; Electrochemical series and its applications; Nernst equation; Types of electrodes: Calomel electrode, quinhydrone electrode; Batteries: Classification of batteries, primary cells (dry cells) and secondary cells (lead-acid battery, Ni-Cd cell), applications of batteries, numerical problems.

Unit-II	CORROSION AND ITS CONTROL

Corrosion: Introduction, causes and effects of corrosion; Theories of corrosion: Chemical and electrochemical corrosion with mechanism; Factors affecting the rate of corrosion: Nature of the metal and nature of the environment; Types of corrosion: Waterline and crevice corrosion; Corrosion control methods: Cathodic protection- sacrificial anodic protection and impressed current cathodic protection; Surface coatings: Metallic coatings, methods of application of metallic coatings-hot dipping(galvanizing, tinning), electroplating(copper plating); Organic coatings: Paints, its constituents and their functions.

Unit-III	WATER TECHNOLOGY

Water: Sources and impurities of water, hardness of water, expression of hardness-units; Types of hardness: Temporary hardness, permanent hardness and numerical problems; Estimation of temporary and permanent hardness of water by EDTA method; Determination of dissolved oxygen by Winkler's method; Boiler troubles: Priming, foaming, scales, sludges and caustic embrittlement.

Treatment of water: Internal treatment of boiler feed water- carbonate, calgon and phosphate conditioning, softening of water by Zeolite process and Ion exchange process; Potable water-its specifications, steps involved in the treatment of potable water, sterilization of potable water by chlorination and ozonization, purification of water by reverse osmosis process.

Unit-IV	MATERIALS CHEMISTRY

Materials chemistry: Polymers-classification with examples, polymerization-addition, condensation and co-polymerization; Plastics: Thermoplastics and thermosetting plastics; Compounding of plastics; Preparation, properties and applications of polyvinyl chloride, Teflon, Bakelite and Nylon-6, 6; Rubbers: Natural rubber its process and vulcanization; Elastomers: Buna-s and Thiokol rubber; Fibers: Characteristics of fibers, preparation properties and applications of Dacron; Characteristics of fiber reinforced plastics; Cement: Composition of Portland cement, setting and hardening of Portland cement; Lubricants: Classification with examples; Properties: Viscosity, flash, fire, cloud and pour point; Refractories: Characteristics and classification with examples.

Unit-V	FUELS AND COMBUSTION

Fuel: Definition, classification of fuels and characteristics of a good fuels; Solid fuels: Coal; Analysis of coal: Proximate and ultimate analysis; Liquid fuels: Petroleum and its refining; Cracking: Fixed bed catalytic cracking; Knocking: Octane and cetane numbers; Gaseous fuels: Composition, characteristics and applications of natural gas, LPG and CNG; Combustion: Calorific value: Gross Calorific Value(GCV) and Net Calorific Value(NCV), calculation of air quantity required for complete combustion of fuel, numerical problems.

Text Books:

1. P. C. Jain and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company, 15th Edition, 2015.

2. Shashi Chawla, "Text Book of Engineering Chemistry" Dhanat Rai and Company, 1st Edition 2011
Reference Books:
1.B. Siva Shankar, "Engineering Chemistry", Tata McGraw Hill Publishing Limited, 3rd Edition, 2015. 2. S. S. Dara, Mukkanti, "Text of Engineering Chemistry", S. Chand & Co, New Delhi, 12th Edition, 2006. 3. C. V. Agarwal, C. P. Murthy, A. Naidu, "Chemistry of Engineering Materials", Wiley India, 5thEdition, 2013. 4.R. P. Mani, K. N. Mishra, "Chemistry of Engineering Materials", Cengage Learning, 3rd Edition, 2015.

XIV.COURSE PLAN:

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

Lecture No	Topics to be covered	CLOs	Reference
1	Understands the concept of electrochemistry. Differentiate the electronic conductors and electrolytes.	CLO 1	T1:5.1,6.3
2	Define the terms specific, equivalence and molar conductance. Explain the dilution effect on these conductance	CLO 1	T1:5.5
3	Understands the concept of specific, equivalence and molar conductance. Define the EMF of the cell. Demonstrate the Daniel cell.	CLO 1	T2:6.1,6.2, 6.3
4	Describe the construction and chemical reactions of different electrodes. Use the Calomel	CLO 1	T2:11,12.2.1
5	Quinhydrone electrodes in calculation of potential of the single electrode.	CLO 1	T1:6.7(4)
6	Derive the relation between cell reaction and emf of the single electrodes.	CLO 1	T2:3.4
7	Use the standard potential values of elements from electrochemical series.	CLO 1	T2:5,5.1
8	Define the battery; differentiate the primary and secondary batteries. Demonstrate the construction of the dry cell.	CLO 2	T2:16,17.1
9	Identify the anode, cathode and electrolyte in different types of secondary batteries. Employ the applications of different types of batteries.	CLO 2	T2:17.3
10	Identify the anode, cathode and electrolyte in different types of secondary batteries. Employ the applications of different types of batteries.	CLO 2	T2:17.4
11	Define corrosion and its disadvantages.	CLO 3	T2:1.1
12	Explain the mechanism of oxidation corrosion when dry gases attack on metal.	CLO 3	T2:2.1
13	Explain the mechanism of hydrogen evolution type and oxygen absorption type corrosion.	CLO 3	T2:2.2
14	Distinguish the types of corrosion.	CLO 3	T2:2.4.5
15	Analyze the effect of different factors on rate of corrosion.	CLO 3	T2:5,5.1,5.2
16	Explain the process of cathodic protection with examples.	CLO 4	T2:6.4
17	Use the methods of application of metallic coatings and Relate the galvanization and tinning	CLO 4	T1:17.1
18	Explain the process of electroplating. Apply the organic coatings for control of corrosion.	CLO 4	T1:8.6 T2:6.3.3
19	List the various sources of water, Differentiate the temporary and permanent hardness and give its units.	CLO 5	T2:3,4,5
20	Calculate the total, permanent and temporary hardness of	CLO 5	T2:6

Lecture No	Topics to be covered	CLOs	Reference
	sample hard water by using EDTA		
21	Calculate the dissolved oxygen in water by Winkler's method	CLO 5	T1:1.14(4)
22-23	Recognize the boiler troubles.	CLO 5	T2:9.2,9.5
24	Discuss the internal treatment methods of boiler feed water. Name the different chemicals used in internal treatment.	CLO 6	T2:12,12.4, 12.2,12.3
25	Explain the process of zeolite and analyze the advantages and disadvantages.	CLO 6	T2:11.2
26	Explain ion-exchange process.	CLO 6	T2:11.3,13
27	Demonstrate the treatment of potable water Purification of potable water. Describe the process of reverse osmosis	CLO 6	T2:13,14 (d)
28	Define monomer and polymer Explain the mechanism of different types of Chain and step growth polymerization.	CLO 7	T2:2,2.2,4,4.1,4.2,4.7
29	Distinguish the thermoplastic and thermo set plasitcs. Illustrate the compounding of plastics.	CLO 7	T1:3.14,3.13.12
30	Identify the preparation, properties and applications of different thermo and thermo set plastics.	CLO 8	T2:2.3,2.7,2.8
31	Identify the preparation, properties and applications of thermo set plastics. Explain about natural rubber.	CLO 8	T2:3,3.1,3.2, 3.3
32	Explain the preparation, properties and applications of synthetic rubbers.	CLO 8	T1:3.24 T2:4.2
33	Explain the preparation, properties and applications of fibers.	CLO 8	T1:3.28 R4:114
34	Generalize the process of setting and hardening reactions of cement	CLO 9	T2:9.3.2, 9.3.3
35	Define the term lubricant and it's classification.	CLO 10	T2:7.4
36	Compare the different types of lubricants based on their properties.	CLO 10	T2:7.5
37	Name the different types of refractories. Discuss the characteristics and applications of refractories.	CLO 11	T2:8.2,8.3
38	Define the fuel with examples. Categorize the different types of fuels.	CLO 12	T2:5.2,5.3
39	Analyze the different types of coals. Explain the significance of proximate analysis of coal.	CLO 12	T2:5.7,5.8,5.8.1
40	Explain the significance of Ultimate analysis of coal.	CLO 12	T2:5.8.2
41	Identify the chemical constituents of petroleum. Describe the refining of petroleum. Define the term cracking. Distinguish the fixed bed and catalytic cracking.	CLO 13	T1:2.18,2.19 2.19(a)
42	Evaluate the octane and cetane rating of the petrol and diesel.	CLO 13	T1:2.23
43	Identify the chemical constituents of the gaseous fuel. Discuss the characteristics of natural gas. Compare the LPG and CNG.	CLO 14	T1:2.28,2.26 T2:5.14.1 R4:247
44	Explain the combustion process of different chemical constituents present in the fuel. Differentiate the HCV and LCV.	CLO 15	T2:5.4,5.5
45	Evaluate the air quantity required for complete combustion of fuel.	CLO 15	T2:5.4.1, 6.5

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Galvanic cell, batteries-lead acid cells, Crevice corrosion, cathodic protection, galvanizing, Electroplating.	Seminars / Guest Lectures / NPTEL	PO 1	PSO 1
2	Softening techniques, plastics, cement, refining of petroleuim.	Seminars / Guest Lectures / NPTEL	PO 1	PSO 1
3	Thiokol rubber, EDTA method, Dissolved oxygen, Viscosity, P^H meter.	Assignments / Laboratory Practices	PO 1	PSO 1

Prepared by:
Ms. V Anitha Rani, Associate Professor

HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	APPLIED PHYSICS				
Course Code	AHS007				
Programme	B.Tech				
Semester	I	AE | ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. Rizwana, Professor				
Course Faculty	Mr. K Saibaba, Assistant Professor				

I. COURSE OVERVIEW:

The course matter is divided into five units covering duly-recognized areas of theory and study. This course develops abstract and critical reasoning by studying mathematical and logical proofs and assumptions as applied in basic physics and to make connections between physics and other branches of sciences and technology. The topics covered include dielectric and magnetic properties, acoustics of buildings, ultrasonic and equilibrium of system of forces, friction and dynamics of rigid bodies. The course helps students to gain knowledge of basic principles and appreciate the diverse applications in technological fields in respective branches and also in their lives.

II. COURSE PRE-REQUISITES:

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

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Applied Physics	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.	2	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Seminar
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products.	2	Seminar
PSO 2	**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.	-	-
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.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Develop the strong fundamentals of system of forces and friction.
II	Strengthen the knowledge of theoretical and technological aspects of dynamics of rigid bodies.
III	Correlate principles with applications of the dielectric and magnetic materials.
IV	Enrich knowledge in acoustics and ultrasonic.

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
AHS007.01	CLO 1	Recall the basic principles of physics.	PO 1 , PO 2	3
AHS007.02	CLO 2	Apply the concepts and principles in solving the problems of physics.	PO 1 , PO 4	2
AHS007.03	CLO 3	Acquire knowledge of basic terms related to dielectric materials and different polarization mechanisms.	PO 1 , PO 4	2
AHS007.04	CLO 4	Review properties of different magnetic materials and magnetization based on orientation of domains.	PO 1 , PO 2	2
AHS007.05	CLO 5	Recollect basic principles of acoustics of buildings and modern architectural acoustic techniques.	PO 1 , PO 2	2
AHS007.06	CLO 6	Explain production, properties and applications of ultrasonic waves	PO 1 , PO 2	2
AHS007.07	CLO 7	Review the basic concepts of system of forces.	PO 1 , PO 4	1
AHS007.08	CLO 8	Analyze different law of forces and condition of equilibrium.	PO 2 , PO 4	1
AHS007.09	CLO 9	Discuss different types and laws of friction.	PO 2 , PO 4	1
AHS007.10	CLO 10	Interpret applications of friction.	PO 1 , PO 2	2
AHS007.11	CLO 11	Describe rotational motion of rigid bodies and moment of inertia of some of the regular shapes.	PO 1 , PO 4	2
AHS007.12	CLO 12	Identify and apply theorems of moment of inertia.	PO 1 , PO 2	3
AHS007.13	CLO 13	Correlate different concept of physics with day to day life applications.	PO 1	2
AHS007.14	CLO 14	Understand the technical importance of moment of inertia of regular and irregular bodies.	PO 2	2
AHS007.15	CLO 15	Identify the modern engineering devices based on basic principles of forces and friction.	PO 4	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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	2											2			
CLO 2	2			2									1			
CLO 3	3			1									2			
CLO 4	1	3														
CLO 5	3	2														
CLO 6	2	2											2			
CLO 7	2			1									2			

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 8		2		1												
CLO 9		1		1									2			
CLO 10	3	2											1			
CLO 11	2			1												
CLO 12	3	2											2			
CLO 13	2															
CLO 14		2											1			
CLO 15				1												

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1,PO2	SEE Exams	PO1,PO4	Assignments	PO4	Seminars	PO2
Laboratory Practices	PO1,PO2	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

Unit-I	DIELECTRIC AND MAGNETIC PROPERTIES
Dielectric Properties: Basic definitions, electronic, ionic and orientation polarizations-qualitative; Internal field in solids. Magnetic Properties: Basic definitions, origin of magnetic moment, Bohr magneton, classification of dia, para and ferro magnetic materials on the basis of magnetic moment, domain theory of ferro magnetism on the basis of hysteresis curve.	
Unit-II	ACOUSTICS AND ULTRASONICS
Acoustics: Reverberation, reverberation time, Sabine's formula (qualitative), absorption coefficient, measurement of absorption coefficient, factors affecting acoustics of an auditorium and their remedies; Ultrasonics: Introduction; Generation of ultrasonic waves; Magnetostriction method, piezoelectric method, properties, applications.	
Unit-III	**EQUILIBRIUM OF SYSTEM OF FORCES**
Introduction, basic concepts, system of forces, coplanar concurrent forces, force systems in plane, parallel forces in plane; Force systems in space, couples, resultant, Lami's theorem, triangle law of forces, polygon law of forces, condition of equilibrium.	

Unit-IV	FRICTION
Friction: Types of friction, limiting friction, laws of friction, angle of repose, equilibrium of body laying on rough inclined plane, Application of friction: ladder friction, wedge friction, screw friction.	
Unit-V	**DYNAMICS OF RIGID BODIES - MOMENT OF INERTIA**
Rotational motion, torque, angular momentum, relation between torque and angular momentum, angular momentum of system of particles, moment of inertia, expression for moment of inertia, radius of gyration, theorems on moment of inertia, moment of inertia of thin rod, rectangular lamina, circular disc.	

Text Books:

1. Dr. K. Vijaya Kumar, Dr. S. Chandralingam, "Modern Engineering Physics", Chand & Co. New Delhi, 1st Edition, 2010.
2. R. C Hibbler, "Engineering mechanics", Prentice Hall, 12th Edition, 2009.

Reference Books:

1. R. K. Gaur, S. L. Gupta, "Engineering Physics", Dhanpat Rai Publications, 8th Edition, 2001.
2. Timoshenko, D. H. Young, "Engineering mechanics", Tata Mc Graw Hill, 5th Edition, 2013.
3. Hitendra K Malik, A. K. Singh, "Engineering Physics", Mc Graw Hill Education, 1stEdition,2009.
4. S. S. Bhavikatti, "A text book of Engineering mechanics", New age international, 1st Edition, 2012.

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Acquire knowledge of basic terms related to dielectric materials.	CLO 1	T1:13.5 R1:1.3
2	Discuss different polarization mechanisms in dielectrics	CLO 2	T1:13.5 R1:1.3
3-4	Derive expression for total electric field at a given point inside dielectrics.	CLO 32	T1:13.5 R1:1.3
5	Acquire knowledge of basic terms related to magnetic materials.	CLO 3	T1:14.7 R1:3.4
6	Describe magnetic moment in an atom in terms of Bohr Magneton	CLO 3	T1:15.7 R1:4.10
7-8	Classify different magnetic materials based on electron theory.	CLO 4	T1:16.8 R1:4.15
9	Examine the spontaneous magnetization in ferromagnets based on orientation of domains	CLO 4	T1:16.9 R1:5.4
10	Explain the basic terms related to acoustics of buildings	CLO 5	T1:17.9 R1:5.8
11	Analyze the Sabine's formula of reverberation time	CLO 5	T1:18.10 R1:6.8
12	Calculate the absorption coefficient of a surface	CLO 6	T1:19.10 R1:6.13
13	Identify remedies for factors affecting architectural acoustics	CLO 6	T1:19.9 R1:7.5
14-15	Recall basics of ultrasonics	CLO 5	T1:23.10 R1:7.5
16	Explain the production of ultrasonics by Magnetostriction method	CLO 6	T1:23.10 R1:8.1
17	Explain the production of ultrasonics by Piezoelectric method	CLO 6	T1:23.1 R1:9.2
18-19	Review the properties of ultrasonics	CLO 6	T1:23.1 R1:9.4

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
20	Discuss the applications of ultrasonics	CLO 6	T1:23.1 R1:9.9
21	Identify the principle of forces	CLO 7	T1:23.1 R1:9.10
22	Recall different system of forces	CLO 7	T2:27.5 R1:10.2
23	Acquire knowledge of force systems in space	CLO 7	T2:27.7 R1:11.3
24-25	Analyze parallel forces in plane	CLO 8	T2:27.8 R1:11.6
26	Correlate couples in systems	CLO 8	T2:27.12 R1:11.7
27-28	Apply Lami's theorem to problems	CLO 8	T2:27.12 R1:11.8
29	Analyze triangle law of forces	CLO 8	T2:27.12 R1:11.9
30	Analyze polygon law of forces	CLO 7	T2:27.12 R1:11.10
31-32	Recognize condition of equilibrium	CLO 9	T2:27.14 R1:12.3
33	Understand friction	CLO 9	T2:27.1 R1:12.7
34-35	Discuss limiting friction	CLO 9	T2:27.17 R1:12.15
36	Analyze laws of friction	CLO 10	T2:27.18 R1:12.19
37-38	Describe angle of repose	CLO 10	T2:27.19 R2:14.4
39	Identify equilibrium of body laying on rough inclined plane	CLO 10	T2:27.20 R2:14.5
40-41	Solve problems on friction	CLO 10	T2:30.19 R2:14.5
42-43	Understand ladder friction	CLO 10	T2:30.20 R2:15.5
44-45	Discuss wedge friction	CLO 10	T2:32.19 R2:16.5
46-47	Describe screw friction	CLO 10	T2:32.20 R2:16.5
48-49	Explain basic concept rotational motion	CLO 11	T2:33.1 R2:16.6
50-51	Derive relation between torque and angular momentum	CLO 11	T2:34.1 R2:17.1
52-53	Acquire the knowledge of moment of inertia	CLO 12	T2:35.2 R2:17.2
54-55	Examine radius of gyration	CLO 11	T2:36.1 R2:18.1
56-57	Understand theorems on moment of inertia	CLO 12	T2:38.19 R2:16.5
58-59	Calculate moment of inertia of thin rod, Rectangular lamina	CLO 12	T2:39.19 R2:16.5
60	Calculate moment of inertia of circular disc	CLO 12	T2:40.19 R2:16.5

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

S No	Description	Proposed Actions	Relevance With Pos	Relevance With Psos
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	Guest lecture	PO 2	PSO 1

Prepared by:
Mr. K Saibaba, Assistant Professor

HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	ENGINEERING DRAWING				
Course Code	AME001				
Program	B.Tech				
Semester	I	AE| ME|CE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	2		4	3	4
Chief Coordinator	Prof. B.V. S. N. Rao, Professor				
Course Faculty	Mr. S. Devaraj, Assistant Professor, Mr. T. Mahesh Kumar, Assistant Professor				

I. COURSE OVERVIEW:

One of the best ways to communicate one's ideas is through some form of picture or drawing. This is especially true for the engineer. An engineering drawing course focuses on usage of drawing instruments, lettering, construction of geometric shapes, etc. Students study use of dimensioning, shapes and angles or views of such drawings. Dimensions feature prominently, with focus on interpretation, importance and accurate reflection of dimensions in an engineering drawing. Other areas of study in this course may include projected views, pictorial projections and development of surfaces. This course also gives basic concepts for studying machine drawing, building drawing, circuit drawings etc.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS002	I	Linear Algebra and Differential Equations	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Engineering Drawing	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 SEE is conducted for 70 marks of 3 hours duration. 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. All the drawing related courses are evaluated in line with laboratory courses. The distribution shall be 30 marks for internal evaluation (20 marks for day–to–day work, and 10 marks for internal tests) and 70 marks for semester end lab examination. There shall be ONE internal test for 10 marks in each semester.

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.

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.	2	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	Term paper, Seminars
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Assignments

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	Lecture, Assignments.
PSO 2	**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	-	-
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	-	-

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the basic principles of engineering drawing and construction of curves used in engineering field
II	Apply the knowledge of interpretation of projection in different quadrants.
III	Understand the projections of solids, when it is inclined to both planes simultaneously
IV	Convert the pictorial views into orthographic view and vice versa.
V	Create intricate details of components through sections and develop its surfaces.

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
AME001.01	CLO 1	Understand the BIS conventions of engineering drawing with basic concepts, ideas and methodology	PO 1	3
AME001.02	CLO 2	Recognize the need of single stroke lettering in defining the components	PO 1	3
AME001.03	CLO 3	Understand the different line types according to BIS standards to engineering drawings.	PO 1	3
AME001.04	CLO 4	Sketch the various types of polygons for applying in solid modeling	PO 2	2
AME001.05	CLO 5	Discuss the various types of scales for engineering application like maps, buildings, bridges.	PO 2	2
AME001.06	CLO 6	Visualize parabolic and elliptical profiles in buildings and bridges	PO 2	2
AME001.07	CLO 7	Visualize cycloidal and involute profiles in developing new products like gears and other engineering applications.	PO 4	1
AME001.08	CLO 8	Solve specific geometrical problems in plane geometry involving points and lines.	PO 4	1
AME001.09	CLO 9	Understand the theory of projection in planes located in various quadrants and apply in manufacturing processes.	PO 2	2
AME001.10	CLO 10	Understand the orthographic projection concepts in solid modeling and apply the concepts in the areas of design.	PO 2	2
AME001.11	CLO 11	Apply the terminology of development of surfaces in the area of chimneys and chutes.	PO 1	3
AME001.12	CLO 12	Visualize the components by isometric projection by representing three dimensional objects in two dimensions in technical and engineering drawings.	PO 1	3
AME001.13	CLO 13	Interpret plumbing drawings typically found in construction by using transformation of projection.	PO 1	3
AME001.14	CLO 14	Convert the orthographic views into pictorial views by using transformation of projection.	PO 1, PO 2	3
AME001.15	CLO 15	Convert the pictorial views into orthographic views by using transformation of projection..	PO 2	2

3 = High; 2 = Medium; 1 = Low

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

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

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

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

XII. ASSESSMENT METHODOLOGIES-INDIRECT

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

XIII. SYLLABUS

UNIT-I	FUNDAMENTALS OF ENGINEERING DRAWING, SCALES AND CURVES
Introduction to engineering drawing: Drawing instruments and accessories, types of line, lettering	

practice and rules of dimensioning, geometrical constructions, basic geometrical shapes; Scales: Types of scales, units of length and their conversion, construction of scales, plain scale, diagonal scale, vernier scale; Curves used in engineering practice and their constructions; Conic sections, construction of ellipse parabola and hyperbola, special curves, construction of cycloid, epicycloids, hypocycloid and involutes..	
UNIT-II	**ORTHOGRAPHIC PROJECTION, PROJECTION OF PLANES**
Orthographic projection: Principles of orthographic projections, conventions, first and third angle projections, projection of points, projection of lines, lines inclined to single plane, lines inclined to both the planes, true lengths and traces; Projection of planes: Projection of regular planes, planes inclined to one plane, planes inclined to both planes, projection of planes by auxiliary plane projection method.	
UNIT-III	**PROJECTION OF SOLIDS**
Projection of solids: Projections of regular solid, prisms, cylinders, pyramids, cones. Solids inclined to one plane, solids inclined to both planes, projection of solid by auxiliary Page | 5 plane projection method.	
UNIT-IV	**DEVELOPMENT OF SURFACES, ISOMETRIC PROJECTIONS**
Development of surfaces: Development of lateral surface of right regular solids, prisms, cylinders, pyramids and cones; Isometric projections: Principle of isometric projection, isometric scale, isometric projections and isometric views, isometric projections of planes, prisms, cylinders, pyramids, and cones.	
UNIT-V	**TRANSFORMATION OF PROJECTIONS**
Transformation of projections: Conversion of isometric views to orthographic views and conversion of orthographic views to isometric views..	
Text Books:	
1. N. D. Bhatt, "Engineering Drawing", Charotar Publications, 49thEdition, 2012. 2. C. M. Agrawal, Basant Agrawal, "Engineering Drawing'', Tata McGraw Hill, 2ndEdition, 2013.	
Reference Books:	
1. K.Venugopal, "Engineering Drawing and Graphics", New Age Publications, 2ndEdition, 2010. 2. K. C. John, "Engineering Drawing", PHI Learning Private Limited", 2nd Edition, 2009. 3. Dhananjay. A. Johle, "Engineering Drawing", Tata McGraw Hill, 1st Edition, 2008.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Principles of engineering drawing – various drawing instruments and their uses. (General exercises).	CLO 1	T1:1.1
2	Conventions in Drawing–Lettering –BIS.	CLO 2	T1:1.1
3	Geometrical constructions.	CLO 2	T1: 2.1
4	Construction of various scales for engineering use-Plain and diagonal.	CLO 2	T1:2.2 R1: 2.2.3
5	Construction of various scales for engineering use-Vernier scales	CLO 1	T1: 2.3
6	Construction of various curves.-general method.	CLO 2	T1: 3.1
7	Construction of various curves- ellipse, parabola and hyperbola.	CLO1	T1:3.3
8	Construction of various curves cycloid, epicycloids, hypocycloid and involutes.	CLO 2	T1:3.4, R1: 4.1
9	Projection of points and lines inclined to single plane.	CLO 2	T1: 4.1
10	Projection of lines inclined to both planes.	CLO1	T1: 4.3
11	Projection of planes-simple position.	CLO 1	T1: 4.3.2
12	Projection of planes- inclined to a both planes.	CLO1	T1:4.3
13	Projection of solids inclined to single plane.	CLO 2	T1: 4.4
14	Projection of solids inclined to a both planes.	CLO 2	T1: 5.2
15	Projection of solids Auxiliary plane method.	CLO 2	T1: 5.2.3
16	Draw the development of surfaces.	CLO 1	T1: 6.1

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
17	Draw the isometric projections	CLO 2	T1: 8.1
18	Convert the pictorial views to orthographic views	CLO 2	T1:8.1.2

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Increase ability to communicate with people.	Seminars	PO 1, PO 2,	PSO 1
2	Learn to take data and transform it into graphic drawings	Guest Lectures	PO4, PO 5	PSO 2
3	Students will become familiar with office practices and standards.	Assignments / Laboratory Practices	PO9, PO10	PSO 3

Prepared by:
Mr. S. Devaraj, Assistant Professor, **HOD, AE**

II SEMESTER

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**COMPUTER PROGRAMMING**				
Course Code	ACS001				
Programme	B.Tech				
Semester	I	CSE | IT| ECE | EEE			
	II	AE | CE| ME			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	4	2
Chief Coordinator	Dr. K Srinivasa Reddy, Professor & HOD, IT				
Course Faculty	Ms N Jayanthi Dr. G Ramu Dr. J Sirisha Devi Dr. K Suvarchala Ms. B Rekha Ms. B Padmaja Ms. G Geetha Reddy Ms. K Laxmi Narayanamma Mr. R M Norullah				

I. COURSE OVERVIEW:

The course covers the basics of programming and demonstrates fundamental programming techniques, customs and terms including the most common library functions and the usage of the preprocessor. This course helps the students in gaining the knowledge to write simple C language applications, mathematical and engineering problems. This course helps to undertake future courses that assume this programming language as a background in computer programming. Topics include variables, data types, functions, control structures, pointers, strings, arrays and dynamic allocation principles. This course in reached to student by power point presentations, lecture notes, and lab involve the problem solving in mathematical and engineering areas.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic Mathematics and Logical Thinking

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Computer Programming	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 fiveunits 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, engineeringfundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Assignments
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complexengineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	3	Assignments
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	Seminars, Viva
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	5 minutes video

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	Projects
PSO 2	**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	3	Lectures, Assignments
PSO 3	**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.	1	5 minutes video

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Learn adequate knowledge by problem solving techniques.
II	Understand programming skills using the fundamentals and basics of C Language.
III	Improve problem solving skills using arrays, strings, and functions.
IV	Understand the dynamics of memory by pointers.
V	Study files creation process with access permissions

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
ACS001.01	CLO 1	Identify and understand the working of key components of a computer system.	PO 1, PO 4	2
ACS001.02	CLO 2	Analyze a given problem and develop an algorithm to solve the problem.	PO 2, PO 3	3
ACS001.03	CLO 3	Describe the fundamental programming constructs and articulate how they are used to develop a program with a desired runtime execution flow.	PO 2, PO 4	2
ACS001.04	CLO 4	Gain knowledge to identify appropriate C language constructs to write basic programs.	PO 1, PO 3	3
ACS001.05	CLO 5	Identify the right data representation formats based on the requirements of the problem.	PO 2,PO 3	3
ACS001.06	CLO 6	Describe the operators, their precedence and associativity while evaluating expressions in program statements..	PO 1, PO 4	2
ACS001.07	CLO 7	Understand branching statements, loop statements and use them in problem solving.	PO 1,PO 4	2
ACS001.08	CLO 8	Learn homogenous derived data types and use them to solve statistical problems.	PO 2, PO 3	3
ACS001.09	CLO 9	Understand procedural oriented programming using functions.	PO 2	3
ACS001.10	CLO 10	Understand how recursion works and write programs using recursion to solve problems.	PO 1, PO 2	3
ACS001.11	CLO 11	Differentiate call by value and call by reference parameter passing mechanisms.	PO 2	3
ACS001.12	CLO 12	Understand pointers conceptually and apply them in C programs.	PO 1	3
ACS001.13	CLO 13	Distinguish homogenous and heterogeneous data types and apply them in solving data processing applications.	PO 3	2
ACS001.14	CLO 14	Explain the concept of file system for handling data storage and apply it for solving problems.	PO 1, PO 3	3
ACS001.15	CLO 15	Differentiate text files and binary files and write the simple C programs using file handling functions. Searching, Sorting.	PO 2	3
ACS001.16	CLO 16	Apply the concepts to solve real-time applications using the features of C language.	PO 2	3
ACS001.17	CLO 17	Possess the knowledge and skills for employability and to succeed in national and international level competitive examinations.	PO 1, PO 4	2

3 = High; 2 = Medium; 1 = Low

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

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

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO2, PO 3, PO 4	SEE Exams	PO 1, PO2, PO 3, PO 4	Assignments	PO 2	Seminars	PO 3
Laboratory Practices	PO 1	Student Viva	PO 3	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 computers: Computer systems, computing environments, computer languages, creating and running programs, algorithms, flowcharts; Introduction to C language: History of C, basic structure of C programs, process of compiling and running a C program, C tokens, keywords, identifiers, constants, strings, special symbols, variables, data types; Operators and expressions: Operators, arithmetic, relational and logical, assignment operators, increment and decrement operators, bitwise and conditional operators, special operators, operator precedence and associativity, evaluation of expressions, type conversions in expressions, formatted input and output.	
UNIT-II	**CONTROL STRUCTURES**
Control structures: Decision statements; if and switch statement; Loop control statements: while, for and do while loops, jump statements, break, continue, goto statements; Arrays: Concepts, one dimensional arrays, declaration and initialization of one dimensional arrays, two dimensional arrays, initialization and accessing, multi dimensional arrays; Strings concepts: String handling functions, array of strings.	
UNIT-III	**ARRAYS AND FUNCTIONS**
Functions: Need for user defined functions, function declaration, function prototype, category of functions, inter function communication, function calls, parameter passing mechanisms, recursion, passing arrays to functions, passing strings to functions, storage classes, preprocessor directives. Pointers: Pointer basics, pointer arithmetic, pointers to pointers, generic pointers, array of pointers, pointers and arrays, pointers as functions arguments, functions returning pointers.	
UNIT-IV	**STRUCTURES, UNIONS AND POINTERS**
Structures and unions: Structure definition, initialization, accessing structures, nested structures, arrays of structures, structures and functions, passing structures through pointers, self referential structures, unions, bit fields, typedef, enumerations; Dynamic memory allocation: Basic concepts, library functions.	
UNIT-V	**FILE HANDLING AND BASICALGORITHMS**
Files: Streams, basic file operations, file types, file opening modes, file input and output functions, file status functions, file positioning functions, command line arguments.	
Text Books:	
1. Stephen G. Kochan, "Programming in C", Addison-Wesley Professional, 4th Edition, 2014. 2. B. A. Forouzan, R. F. Gillberg, "C Programming and Data Structures", Cengage Learning, India, 3rd Edition, 2014.	
Reference Books:	
1. W. Kernighan Brian, Dennis M. Ritchie, "The C Programming Language", PHI Learning, 2nd Edition, 1988. 2. Yashavant Kanetkar, "Exploring C", BPB Publishers, 2nd Edition, 2003. 3. E. Balagurusamy, "Programming in ANSI C", Mc Graw Hill Education, 6th Edition, 2012. 4. Schildt Herbert, "C: The Complete Reference", Tata Mc Graw Hill Education, 4th Edition, 2014. 5. R. S. Bichkar, "Programming with C", Universities Press, 2nd Edition, 2012. 6. Dey Pradeep, Manas Ghosh, "Computer Fundamentals and Programming in C", Oxford University Press, 2nd Edition, 2006.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1 – 2	Introduction to Computers: computer systems, computing environments.	CLO 1	T2:1.1-1.2
3 – 4	Computer languages, creating and running programs, program development.	CLO 1	T2:2.1-2.2
5 – 6	Algorithms, flowcharts	CLO 2	T2:1.4-1.5
7 – 8	Introduction to C Language: background, C programs.	CLO 3	T2:2.1-2.2
9 – 10	Identifiers, data types, Input/output, variables, constants, Operators (arithmetic, relational, logical, bitwise etc).	CLO 3	T2: 2.3- 2.6,7
11 – 12	Expressions, precedence and associativity, expression evaluation, type conversions	CLO 6	T2:3.1-3.5
13 – 14	Statements - selection statements (making decisions) – if statement, switch statement.	CLO 7	T2: 5.2-5.3
15 – 16	Repetition statement (loops)-while, dowhile statements, for statements, loop examples	CLO 7	T2: 6.1-6.6
17 – 18	Other statements related to looping – break, continue, go to, simple C program examples.	CLO 7	T2: 6.7
19 – 20	Arrays- Concepts, using arrays in C, declaration and initialization of one dimensional array, C program example. Two dimensional arrays, initialization and accessing, multi dimensional arrays, C program example.	CLO 8	T2: 8.1-8.3,8.7-8.8
21-22	Strings – Strings concepts: String handling functions, array of strings, C program examples.	CLO 8	T2: 11.1-11.5
23-- 24	Functions- Need for user defined functions, function declaration, function prototype. Category of functions, inter function communication, function calls, parameter passing mechanisms.	CLO 9	T2: 4.1-4.5
25	Recursion, passing arrays to functions, passing strings to functions, Storage classes and preprocessor commands.	CLO 10	T1:7 T2:6.9 T2:G.1
26-27	Pointer basics, pointer arithmetic, pointers to pointers, generic pointers. Pointer applications-Arrays and pointers, pointer arithmetic and arrays, passing an array to a function.	CLO 12	T1:1.0
28 – 29	Array of pointers, pointers and arrays, pointers as functions arguments, functions returning pointers	CLO 12	T2:10.3-10.5
30 – 31	Structures – declaration, initialization, accessing structures, operations on structures.	CLO 13	T1:8
32 – 33	Complex structures, structures and functions, passing structures through pointers, self-referential structures.	CLO 13	T2: 12.3-12.4
34 – 35	Unions, C programming examples, Bit fields, typedef, enumerations.	CLO 13	T2:12.4 T2:12.1- 12.2
36 -- 38	Dynamic memory allocation: Basic concepts, library functions	CLO 13	T2:2.1-2.2
39 – 40	Files: Concept of a file, streams, types of files and file opening modes.	CLO 14	R3:12.1-12.3
41 – 42	File input/output functions (standard input/output functions for files).	CLO 14	R3:12.4

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
43 – 44	File status functions (error handling), positioning functions, C program examples.	CLO 15	R3:12.5
45	Command-line arguments.	CLO 15	R3:12.7

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Updating latest version and new features of the C language	Laboratory Sessions	PO5	PSO2
2	Familiarizing the role of C language in developing system level programs.	Assignments / Industrial visits	PO1,PO2	PSO2
3	Familiarizing different areas where C language can be used.	Seminars	PO12	PSO3
4	Solving different problems and Practicing various debugging strategies to become a good programmer	Extra Lab Sessions, Participating in Coding contests	PO2	PSO3

Prepared by:
N Jayanthi, Assistant Professor

HOD, CSE

INSTITUTE OF AERONAUTICAL ENGINEERING

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Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**COMPUTATIONAL MATHEMATICS AND INTEGRAL CALCULUS**				
Course Code	AHS003				
Programme	B.Tech				
Semester	I	CSE | IT| ECE | EEE			
	II	AE| ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Ms. V Subba Laxmi Assistant Professor				
Course Faculty	Dr. S Jagadha, Professor Ms. L Indira, Assistant Professor Mr. Ch Somashekar, Assistant Professor Ms. P Rajani, Assistant Professor Ms. B Praveena, Assistant Professor				

I. COURSE OVERVIEW:

The course focuses on more advanced Engineering Mathematics topics which provide with the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes types of interpolation, curve fitting, numerical solutions of ordinary differential equations, multiple integrals, vector calculus and special functions. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Differentiation, integration and properties of vectors

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Computational Mathematics and Integral calculus	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	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Seminar
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills**: Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products.	1	Seminar
PSO 2	**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	-	-
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 build the nation, by imparting technological inputs and managerial skills to become Technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Enrich the knowledge of solving algebraic, transcendental equations by numerical methods.
II	Apply multiple integration to evaluate mass, area and volume of the plane.
III	Analyze gradient, divergence and curl to evaluate the integration over a vector field.
IV	Understand the Bessel's equation to solve them under special conditions with the help of series solutions.

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
AHS003.01	CLO 1	Solve the algebraic and transcendental equations using bisection method, method of false position and Newton-Raphson method.	PO 1	3
AHS003.02	CLO 2	Apply numerical methods to interpolate the functions of values for equal intervals using finite differences.	PO2	3
AHS003.03	CLO 3	Understand the Newton-Raphson method to the real-world problem for a finite barrier quantum well.	PO 4	1
AHS003.04	CLO 4	Evaluate the functional value by using Lagrange's interpolation formula for unequal intervals.	PO2	2
AHS003.05	CLO 5	Understand the Lagrange's interpolation in real-world problem for neural network learning.	PO 4	1
AHS003.06	CLO 6	Apply method of least squares to fit linear and non linear curves.	PO1, PO 2	2
AHS003.07	CLO 7	Solve differential equation using single step method- Taylor‟s series.	PO 1	3
AHS003.08	CLO 8	Solve differential equation using multi step methods- Euler's, Modified Euler's and Runge Kutta methods.	PO 2	2
AHS003.09	CLO 9	Understand the multistep methods in real-worl problem for real time Aircraft dynamics.	PO 4	1
AHS003.10	CLO 10	Understand the Runge-Kutta method in real-world problem for embedding the sensor signals into the iterative computation.	PO 4	1
AHS003.11	CLO 11	Evaluate double integral and triple integrals .	PO 1	2
AHS003.12	CLO 12	Utilize the concept of change order of integration to evaluate double integrals.	PO 1,PO2	2
AHS003.13	CLO 13	Determine the area and volume of a given curves using double and triple integration.	PO 2	3
AHS003.14	CLO 14	Understand transformation of co-ordinate system from plane to plane.	PO 1	3
AHS003.15	CLO 15	Analyze scalar and vector fields and compute the gradient, divergence and curl.	PO 2	3
AHS003.16	CLO 16	Understand integration of vector function .	PO 1	2
AHS003.17	CLO 17	Evaluate line, surface and volume integral of vectors.	PO 1	3
AHS003.18	CLO 18	Use Vector integral theorems to facilitate vector integration .	PO 2	2
AHS003.19	CLO 19	Analyze the concept of vector calculus in real-world problem for fluid dynamics.	PO 4	1
AHS003.20	CLO 20	Solve the Differential Equations by series solutions.	PO 1	3
AHS003.21	CLO 21	Understand Gamma function to evaluate improper integrals.	PO 1	2
AHS003.22	CLO 22	Analyze Bessel's function and study its properties	PO 1	3
AHS003.23	CLO 23	Analyze Bessel's function as a Solution to Schrödinger equation in a cylindrical function of the second kind.	PO 4	1
AHS003.24	CLO 24	Understand gamma function to find application diverse areas as quantum physics.	PO 4	1
AHS003.25	CLO 25	Possess the knowledge and skills for employability and to succeed in national and international level competitive examinations.	PO 4	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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												1			
CLO 2		3											1			
CLO 3				1									1			
CLO 4		2														
CLO 5				1												
CLO 6	2	2														
CLO 7	3															
CLO 8	2															
CLO 9				1									1			
CLO 10				1									1			
CLO 11	2															
CLO 12	2	2														
CLO 13		3														
CLO 14	3												1			
CLO 15		3														
CLO 16	2															
CLO 17	3												1			
CLO 18		2											1			
CLO 19				1									1			
CLO 20	3												1			
CLO 21		2														
CLO 22	3															
CLO 23				1												
CLO 24				1												
CLO 25				1												

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

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

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

UNIT-I	ROOT FINDING TECHNIQUES AND INTERPOLATION
Root finding techniques: Solving algebraic and transcendental equations by Bisection method, Method of False position, Newton-Raphson method; Interpolation: Finite differences, forward differences, backward differences and central differences; Symbolic relations; Newton's forward interpolation, Newton's backward interpolation; Gauss forward central difference formula, Gauss backward central difference formula; Interpolation of unequal intervals: Lagrange,'s interpolation .	
UNIT -II	**CURVE FITTING AND NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**
Fitting a straight line; Second degree curves; Exponential curve, power curve by method of least squares; Taylor's series method; Step by step methods: Euler's method, modified Euler's method and Runge-Kutta method for first order differential equations .	
UNIT -III	**MULTIPLE INTEGRALS**
Double and triple integrals; Change of order of integration. Transformation of coordinate system; Finding the area of a region using double integration and volume of a region using triple integration.	
UNIT -IV	**VECTOR CALCULUS**
Scalar and vector point functions; Gradient, divergence, curl and their related properties; Solenoidal and irrotational vector point functions; Scalar potential function; Laplacian operator; Line integral, surface integral and volume integral; Vector integral theorems: Green's theorem in a plane, Stoke's theorem and Gauss divergence theorem without proofs.	
UNIT -V	**SPECIAL FUNCTIONS**
Gamma function, properties of gamma function; Ordinary point and regular singular point of differential equations; Series solutions to differential equations around zero, Frobenius method about zero; Bessel"s differential equation: Bessel functions properties, recurrence relations, orthogonality, generating function, trigonometric expansions involving Bessel functions.	
Text Books:	
1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 9th Edition, 2014. 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2012.	
Reference Books:	
1. T.K.V Iyengar, B.Krishna Gandhi, "Engineering mathematics-I", S. Chand & Co., 6th Edition, 2014. 2. R K Jain, S R K Iyengar, "Advanced Engineering Mathematics", Narosa Publishers, 5th Edition, 2016. 3. S. S. Sastry, "Introduction Methods of Numerical Analysis", Prentice-Hall of India Private Limited, 5th Edition, 2012.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Define Algebraic and Transcendental equations	CLO 1	T1:22.5 R1:2.3
2	Explain Bisection method to find the root of an equation.	CLO 1	T1:22.5 R1:2.4
3	Explain Method of False Position to to find root an equation.	CLO 1	T1:22.6 R1:2.6
4	Explain Newton-Raphson method to find root of an equation.	CLO 3	T1:22.7 R1:4.4
5	Define interpolation of the given data.	CLO 2	T1:22.7 R1:4.10
6	Explain symbolic relations the between the operators.	CLO 2	T1:22.8 R1:4.15
7	Define Newton's forward interpolation formula for evenly spaced intervals..	CLO 2	T1:22.9 R1:5.4
8	Define Newton's backward interpolation formula for evenly spaced intervals.	CLO 2	T1:22.9 R1:5.8
9	Define Gauss forward interpolation formula for evenly spaced intervals..	CLO 2	T1:23.10 R1:6.8
10	Define Gauss backward interpolation formula for evenly spaced intervals.	CLO 2	T1:23.10 R1:6.13
11	Demonstrate Lagrange's formula for unequal intervals.	CLO 5	T1:23.9 R1:7.5
12	Describe the best fit of a straight line by method of least squares.	CLO 6	T1:23.10 R1:7.5
13	Describe the best fit of a second degree parabola by method of least squares	CLO 6	T1:23.10 R1:8.1
14	Describe the best fit of an exponential curve by method of least squares	CLO 6	T1:23.1 R1:9.2
15	Describe the best fit of a power curve by method of least squares	CLO 6	T1:23.1 R1:9.4
16	Solve the ordinary differential equation by Taylors series method.	CLO 6	T1:23.1 R1:9.9
17	Solve the ordinary differential equation by Euler's Method-Euler's modified method.	CLO 8	T1:23.1 R1:9.10
18	Solve the ordinary differential equation by Runge-Kutta Method.	CLO 8	T2:27.5 R1:10.2
19	Evaluate double and triple integrals.	CLO 8	T2:27.7 R1:11.3
20	Use the Change of order of integration cartesian and polar form.	CLO 12	T2:27.8 R1:11.6
21	Explain Transformation of co-ordinate system	CLO 11	T2:27.12 R1:11.7
22	Use double integration for finding the area.	CLO 14	T2:27.12 R1:11.8
23	Use triple integration for finding the volume.	CLO 14	T2:27.12 R1:11.9
24	Define vector calculus and vector fields and their properties	CLO 19	T2:27.12 R1:11.10
25	Determine Gradient, divergent and curl of vector fields.	CLO 19	T2:27.14 R1:12.3
26	Solve line integral along smooth path and find work done.	CLO 17	T2:27.1

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
			R1:12.7
27	Evaluate surface integral.	CLO 17	T2:27.17 R1:12.15
28	Use Green's theorem to evaluate line integrals along simple closed contours on the plane.	CLO 17	T2:27.18 R1:12.19
29	Use Stokes' theorem to give a physical interpretation of the curl of a vector field .	CLO 17	T2:27.19 R2:14.4
30	Use the divergence theorem to give a physical interpretation of the divergence of a vector field.	CLO 17	T2:27.19 R2:14.5
31	Explain gamma function s for improper integrals and gamma properties .	CLO 21	T2:27.19 R2:14.5
32	Define Ordinary and regular point of a differential equation.	CLO 23	T2:27.20 R2:14.5
33	Determine the solution of ordinary differential equations in series form.	CLO 23	T2:27.20 R2:14.5
34	Explain Frobenius Method about zero.	CLO 20	T2:27.19 R2:14.5
35	Define Bessel's Differential equation.	CLO 22	T2:27.19 R2:14.5
36-37	Explain Bessel's differential functions and properties.	CLO 22	T2:27.19 R2:14.5
38-39	Explain Recurrence relations for Bessels function.	CLO 23	T2:27.19 R2:14.5
40-42	Explain Orthogonality of Bessel's function .	CLO 23	T2:27.20 R2:14.5
43-44	Explain Generating function of Bessel's function.	CLO 23	T2:27.20 R2:14.5
45	Explain trigonometric expansions of Bessels function.	CLO 23	T2:27.19 R2:14.5

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Newton Raphson method, Lagranges interpolation, method of least square and Runge-kutta method	Seminars / NPTEL	PO 2	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 4	PSO 1

Prepared by:
Mr. V Subba Laxmi, Assistant Professor

HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MODERN PHYSICS**				
Course Code	AHS008				
Programme	B.Tech				
Semester	II	AE | ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. A Chandra Prakash, Assistant Professor				
Course Faculty	Dr. Rizwana, Professor Ms. S Charvani, Associate Professor Mr. K Saibaba, Assistant Professor				

I. COURSE OVERVIEW:

The course matter is divided into five units covering duly-recognized areas of theory and study. This course develops abstract and critical reasoning by studying mathematical and logical proofs and assumptions as applied in basic physics and to make connections between physics and other branches of sciences and technology. The topics covered include crystallography, X-ray diffraction, defects in crystals, lasers, sensors, fiber optics, interference and diffraction. The course helps students to gain knowledge of basic principles and appreciate the diverse applications in technological fields in respective branches and also in their lives.

II. COURSE PRE-REQUISITES:

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

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Modern Physics	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	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Seminar
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Level	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.	1	Seminar
PSO 2	**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.	-	-
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.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Develop strong fundamentals of crystal structures and properties.
II	Meliorate the knowledge of theoretical and technological aspects of lasers.
III	Correlate principles with applications of the x-ray diffraction and defects in crystals.
IV	Enrich knowledge in modern engineering principles of interference and diffraction.

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
AHS008.01	CLO 1	Recall the basic principles of physics and apply these concepts of physics in solving the real-time problems.	PO 1 , PO 2	3
AHS008.02	CLO 2	Acquire knowledge of basic terms related to crystals, crystal systems, Bravais lattices and Miller Indices.	PO 1 , PO 4	3
AHS008.03	CLO 3	Discuss in detail different crystal structures and calculate their packing factors.	PO 1 , PO 4	3
AHS008.04	CLO 4	Describe different X-ray diffraction in research and development for the study of internal structures of materials.	PO 1 , PO 2	2
AHS008.05	CLO 5	Identify various types of defects in crystals and their effect on structure sensitive properties.	PO 1 , PO 2	2
AHS008.06	CLO 6	Understand the basic principles involved in the production of Laser light and also real-time applications of lasers.	PO 1 , PO 2	2
AHS008.07	CLO 7	Explain the principle involved in working of different types of laser systems.	PO 1 , PO 4	1
AHS008.08	CLO 8	Analyze basic laws of physics to correlate the mechanism of sensors in day to day life. Principle of sensor along with their applications.	PO 2 , PO 4	1
AHS008.09	CLO 9	Understand the importance of various sensors in real-time applications like measurement of pressure in aeronautics, detecting submarines in acoustics.	PO 2 , PO 4	2
AHS008.10	CLO 10	Recollect basic principle, construction, types and attenuation of optical fibers.	PO 1 , PO 2	2
AHS008.11	CLO 11	Apply properties of optical fibers in various real-time applications like measurement of pressure, temperature , displacement etc.,	PO 1 , PO 4	3
AHS008.12	CLO 12	Understand the importance of optical fibers in real-time communication system.	PO 1 , PO 2	3
AHS008.13	CLO 13	Interpret phenomenon of interference in thin films using Newton's rings experiment.	PO 1 , PO 4	3
AHS008.14	CLO 14	Identify difference in diffraction phenomenon due to single slit and N-slits.	PO 2 , PO 4	1
AHS008.15	CLO 15	Apply different laws of radiation to understand the phenomenon behind production of light.	PO 1 , PO 4	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	2											1			
CLO 2	2			2									1			
CLO 3	3			1									1			
CLO 4	1	3														
CLO 5	3	2														
CLO 6	3	2											1			
CLO 7	2			1									1			
CLO 8		2		1												
CLO 9		1		1									1			
CLO 10	3	2											1			
CLO 11	2			1												
CLO 12	3	2											1			
CLO 13	2			1												
CLO 14		1		2									1			
CLO 15	3			2												

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

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

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

UNIT-I	CRYSTALLOGRAPHY AND CRYSTAL STRUCTURES
Crystallography and crystal structures: Space lattice, unit cell, lattice parameters, crystal systems, Bravais lattices, directions and planes in crystals, Miller indices, interplanar spacing of orthogonal crystal systems, atomic radius, coordination number and packing factor of SC, BCC, FCC, NaCl and diamond structures.	
UNIT-II	**X-RAY DIFFRACTION AND DEFECTS IN CRYSTALS**
X-ray diffraction: Bragg's law, Laue method, powder method and applications; Defects in crystals: Concepts of point defects, vacancies, substitutional, interstitial, frenkel, schottky defects, line defects and Burger's vector.	
UNIT-III	**LASERS AND SENSORS**
Lasers: Characteristics of lasers, spontaneous and stimulated emission of radiation, metastable state, population inversion, lasing action, ruby laser, semiconductor diode laser and applications of lasers. Sensors: Introduction, basic principles, sensor materials and applications: principle of pressure, optical, acoustic and thermal sensing.	
UNIT-IV	**FIBER OPTICS**
Fiber optics: Principle and construction of an optical fiber, acceptance angle, numerical aperture, types of optical fibers (Single mode, multimode, step index, graded index), attenuation in optical fibers, application of optical fibers and optical fiber communication system with block diagram.	
UNIT-V	**INTERFERENCE AND DIFFRACTION**
Interference: Phase difference, path difference, coherence, conditions for constructive and destructive interference, interference in thin films due to reflected light, Newton rings experiment. Diffraction: Introduction, differences between interference and diffraction, types of diffraction, Fraunhofer diffraction due to single slit, N-slits, diffraction grating experiment.	
Text Books:	
1. V. Rajendran, "Engineering Physics", Tata Mc Graw Hill Book Publishers, 1st Edition, 2010. 2. Dr. K. Vijaya Kumar, Dr. S. Chandralingam, "Modern Engineering Physics", S. Chand & Co., New Delhi, 1st Edition, 2010.	
Reference Books:	
1. P. K. Palanisamy, "Engineering Physics", Scitech Publishers, 4th Edition, 2014. 2. R. K. Gaur, S. L. Gupta, "Engineering Physics", Dhanpat Rai Publications, 8th Edition, 2001. 3. A. J. Dekker, "Solid State Physics", Macmillan India ltd, 1st Edition, 2000. 4. Hitendra K. Malik, A. K. Singh, "Engineering Physics", Mc Graw Hill Education, 1st Edition, 2009.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Acquire knowledge of basic terms related to crystal structures.	CLO 2	T1:13.5 R1:1.3
2	Discuss different crystal systems.	CLO 2	T1:13.5 R1:1.3
3	Identify and sketch various planes in the crystal using the	CLO 3	T1:13.5 R1:1.3

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
	Miller indices concept.		
4	Derive and calculate the distance between two adjacent parallel planes.	CLO 3	T1:147 R1:3.4
5	Determine co-ordination Number and packing Factor of SC structure.	CLO 3	T1:15.7 R1:4.0
6	Determine co-ordination Number and packing Factor of BCC structure.	CLO 3	T1:16.8 R1:4.5
7	Determine co-ordination Number and packing Factor of FCC structure.	CLO 3	T1:169 R1:5.4
8	Determine co-ordination Number and packing Factor of DC structure.	CLO 3	T1:179 R1:5.8
9	Discuss in detail NaCl structure.	CLO 2	T1:18.10 R1:6.8
10	Analyze the concept of X-ray diffraction in crystals using Bragg's law.	CLO 4	T1:19.0 R1:6.13
11	Apply Bragg's law to Laue method.	CLO 4	T1:19.9 R1:7.5
12	Determine crystal structure using powder method and discuss its applications.	CLO 4	T1:23.1 0 R1:7.5
13	Illustrate point defects like vacancies, substitutional and interstitial defects.	CLO 5	T1:23.1 0 R1:8.1
14	Recall basics of Frenkel and Schottky defects.	CLO 5	T1:23.1 R1:9.2
15	Understand the concept of edge dislocation.	CLO 5	T1:231 R1:9.4
16	Understand the concept of screw dislocation..	CLO 5	T1:23.1 R1:9.9
17	Find the magnitude of Burger's vector.	CLO 5	T1:23.1 R1:9.10
18	Apply Bragg's law for finding parameters related to crystal structures.	CLO 5	T2:27.5 R1:102
19	Review basic phenomena's of laser	CLO 6	T2:27.7 R1:11.3
20	Acquire knowledge of basic terms related to lasers	CLO 6	T2:27.8 R1:11.6
21	Explain the construction of ruby laser	CLO 6	T2:27.12 R1:11.7
22	Explain the working of Ruby laser	CLO 7	T2:27.12 R1:11.8
23	Explain the principle and working of semiconductor diode laser and also Discuss the uses of lasers.	CLO 7	T2:27.2 R1:11.9
24	Understand the basic principle in sensors.	CLO 8	T2:27.12 R1:11.10
25	Analyze different sensing materials.	CLO 8	T2:27.14 R1:12.3
26	Recognize functioning of sensors in different fields.	CLO 8	T2:27.1 R1:12.7
27	Recognize functioning of sensors in different fields.	CLO 9	T2:27.17 R1:12.15
28	Recall the principle of fiber optics.	CLO 10	T2:27.18 R1:12.19
29	Derive relation for acceptance angle.	CLO 10	T2:27.19 R2:14.4
30	Calculate numerical aperture.	CLO 10	T2:27.0 R2:14.5

31	Classify optical fibers based on modes.	CLO 11	T2:30.19 R2:14.5
32	Classify optical fibers based on the refractive index profile.	CLO 11	T2:30.0 R2:15.5
33-34	Identify losses in fibers.	CLO 11	T2:32.19 R2:16.5
35-37	Examine the application of fibers.	CLO 12	T2:32.20 R2:16.5
38	Understand optical fiber communication system.	CLO 12	T2:33.1 R2:16.6
39-41	Solve problems in optical fibers.	CLO 12	T2:34.1 R2:17.1
42-43	Recall the basic principle of interference.	CLO 13	T2:352 R2:172
44-45	Describe interference in thin films.	CLO 13	T2:36.1 R2:18.1
46-48	Demonstrate the formation of Newton rings.	CLO 13	T2:38.19 R2:16.5
49	Demonstrate the formation of Newton rings.	CLO 14	T2:39.19 R2:16.5
50-53	Understand the phenomenon of diffraction.	CLO 14	T2:40.19 R2:16.5
54-55	Examine Fraunhofer diffraction due to single slit	CLO 14	T2:41.9 R2:16.5
56-57	Examine Fraunhofer diffraction due to single slit	CLO 15	T2:42.19 R2:16.5
58-59	Examine Fraunhofer diffraction due to N slits.	CLO 15	T2:42.19 R2:16.5
60	Identify Diffraction grating experiment	CLO 15	T2:42.19 R2:16.5

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	Guest lecture	PO 2	PSO 1

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HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**ENVIRONMENTAL STUDIES**				
Course Code	AHS009				
Programme	B.Tech				
Semester	II	AE | CSE | IT | ECE | EEE | ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Ms. M Lakshmi Prasanna, Assistant Professor				
Course Faculty	Dr. C Mahendar, Professor Ms. V Anitha Rani, Associate Professor Mr. B Raju, Assistant Professor Ms. M Praveen, Assistant Professor Ms. M Malathi, Assistant Professor Mr. G Mahesh Kumar, Assistant Professor Ms. T Mallika, Assistant Professor Ms. M Swathi, Assistant Professor				

I. COURSE OVERVIEW:

Environmental study is interconnected interrelated and interdependent subject. Hence, it is multidisciplinary in nature. The present course is framed by expert committee of UGC under the direction of honorable supreme court to be as a core module syllabus for all branches of higher education and to be implemented in all universities over India. The course is designed to create environmental awareness and consciousness among the present generation to become environmental responsible citizens. The course description is multidisciplinary nature of environmental studies, natural resources Renewable and non-renewable resources Ecosystems Biodiversity and its conservation Environmental pollution Social issues and the environment Human population and the environment Pollution control acts and field work. The course is divided into five chapters for convenience of academic teaching followed by field visits.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic Principles of Environmental Studies

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Environmental Studies	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V. EVALUATION METHODOLOGY:

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

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

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

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

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

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz/AAT	
CIA Marks	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 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

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

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

The AAT chosen for this course is given in section XI.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Seminar
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	Seminar
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
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	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.	1	Seminar
PSO 2	**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.	-	-
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.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Analyze the interrelationship between living organism and environment
II	Understand the importance of environment by assessing its impact on the human world
III	Enrich the knowledge on themes of biodiversity, natural resources, pollution control and waste management
IV	Understand the constitutional protection given for environment

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
AHS009.01	CLO 1	Understand and realize the importance of multi-disciplinary nature of the environment in day to day life	PO 1, PO 3	2
AHS009.02	CLO 2	Describe various types of ecosystems its components and inter-relationship between man and environment	PO 1, PO 3	2
AHS009.03	CLO 3	Examine how pollutants move through various levels in an ecosystem in our daily life	PO 1, PO 3, PO 7	2
AHS009.04	CLO 4	Explain the pathways of relevant chemical elements through the components of the biosphere in real world applications	PO 1, PO 3, PO 7	2
AHS009.05	CLO 5	Understand the relevance and importance of the natural resources in the sustenance of life on earth and living standard.	PO 1, PO 3, PO 5, PO 7	2
AHS009.06	CLO 6	Develop an understanding of the natural resources problems and ethical issues facing humans and the environment	PO 1, PO 3, PO 7	2
AHS009.07	CLO 7	Correlate the exploitation and utilization of conventional and non-conventional resources.	PO 1, PO 3, PO 5,PO 7	2
AHS009.08	CLO 8	Demonstrate the level of chemical usage in agricultural development and its impact in our daily life	PO 1, PO 5, PO 7	2
AHS009.09	CLO 9	Understand the concept of growing energy needs in the world in terms of consumption of energy	PO 1, PO 7	2
AHS009.10	CLO 10	Establish knowledge and existence of endemic, extinct, endangered and threatened species, types and values of biodiversity	PO 1, PO 5, PO 7	2
AHS009.11	CLO 11	Describe our country as mega biodiversity nation in terms of hotspots	PO 1, PO 7	2
AHS009.12	CLO 12	Explain on threats and innovative methods for conservation of biodiversity.	PO 1, PO 3, PO 7	2
AHS009.13	CLO 13	Establish a foundation on different pollutants and pollutions in the environment.	PO 1, PO 3, PO 5, PO 7	2
AHS009.14	CLO 14	Ability to use methods, and strategies to investigate and interpret the pollution problems	PO 3, PO 5, PO 7	2
AHS009.15	CLO 15	Use innovative methods to control the level of water pollution in our day to day life.	PO 3, PO 5, PO 7	2
AHS009.16	CLO 16	Acquire Knowledge on global effects and how to interpret with global environmental problem in our daily life	PO 1, PO 7	2
AHS009.17	CLO 17	Acquire knowledge and skills about health and safety protocols when working with polluted environment in day to day life	PO 1, PO 7	2

AHS009.18	CLO 18	Describe the role of government and legal aspects in environmental protection.	PO 7	1
AHS009.19	CLO 19	Knowledge of proper decontamination techniques for solid waste management.	PO 3, PO 7	2
AHS009.20	CLO 20	Understand the importance of EIA for developmental activities to have minimum negative impacts on people	PO 1, PO 7	2
AHS009.21	CLO 21	Prepare entry level for future generations to meet sustainable development.	PO 7	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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		1													
CLO 2	3		1													
CLO 3	2		2				1									
CLO 4	2		2				1									
CLO 5	3		1		1		1									
CLO 6	2		2				1									
CLO 7	3		1		1		1									
CLO 8	2				1		1									
CLO 9	3						1									
CLO 10	3				1		1									
CLO 11	2						1									
CLO 12	2		2				1									
CLO 13	3		2		2		2									
CLO 14			2		1		1						1			
CLO 15			2		1		1						1			
CLO 16	2						1									
CLO 17	2						1									
CLO 18							1									
CLO 19			1				2									
CLO 20	1						1									
CLO 21							2									

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1,PO3 PO5,PO7	SEE Exams	PO1,PO3 PO5,PO7	Assignments	PO1	Seminars	PO1 PO3
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	ENVIRONMENT AND ECOSYSTEMS
Environment: Definition, scope and importance of environment, need for public awareness; Ecosystem: Definition, scope and importance of ecosystem, classification, structure and function of an ecosystem, food chains, food web and ecological pyramids, flow of energy; Biogeochemical cycles; Biomagnifications	
Unit -II	**NATURAL RESOURCES**
Natural resources: Classification of resources, living and nonliving resources; Water resources: Use and over utilization of surface and ground water, floods and droughts, dams, benefits and problems; Mineral resources: Use and exploitation; Land resources; Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy source, case studies.	
Unit -III	**BIODIVERSITY AND BIOTIC RESOURCES**
Biodiversity and biotic resources: Introduction, definition, genetic, species and ecosystem diversity; Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and optional values; India as a mega diversity nation; Hot spots of biodiversity Threats to biodiversity: Habitat loss, poaching of wildlife, human-wildlife conflicts; Conservation of biodiversity: In situ and ex situ conservation; National biodiversity act.	
Unit -IV	**ENVIRONMENTAL POLLUTION, POLLUTION CONTROL TECHNOLOGIES AND GLOBAL ENVIRONMENTAL PROBLEMS**
Environmental pollution: Definition, causes and effects of air pollution, water pollution, soil pollution, noise pollution; Solid waste: Municipal solid waste management, composition and characteristics of e-waste and its management; Pollution control technologies: Waste water treatment methods, primary, secondary and tertiary; Concepts of bioremediation; Global environmental problems and global efforts: Climate change, ozone depletion, ozone depleting substances, deforestation and desertification; International conventions / protocols: Earth summit, Kyoto protocol and Montreal protocol.	
Unit -V	**ENVIRONMENTAL LEGISLATIONS AND SUSTAINABLE DEVELOPMENT**
Environmental legislations: Environmental protection act, air act1981, water act, forest act, wild life act, municipal solid waste management and handling rules, biomedical waste management and handling rules2016, hazardous waste management and handling rules, Environmental impact assessment(EIA); Towards sustainable future: Concept of sustainable development, population and its explosion, crazy consumerism, environmental education, urban sprawl, concept of green building.	
Text Books:	
1. Benny Joseph (2005)., Environmental Studies, New Delhi, Tata McGraw Hill Publishing co. Ltd 2. Erach Bharucha (2005)., Textbook of Environmental Studies for Undergraduate Courses, Hyderabad, Universities Press.	
Reference Books:	
1. Anji Reddy .M (2007), Textbook of Environmental Sciences and Technology, Hyderabad, BS Publications.	

2. Anjaneyulu.(2004), Introduction to Environmental Sciences, BS Publications
3. Anubha Kaushik(2006).,Perspectives in Environmental Science, 3rd Edition, New Delhi, New age international.
4. Tyler Miller, Scott Spoolman, "Environmental Science", Cengage Learning, 14th Edition, 2012.

XIV. COURSE PLAN:

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

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
1	Summarize about environment and its importance.	CLO 1	T2: 1.1.1, 1.1.2,1.1.3, 1.2.1,1.2.2 R3:1.1-1.3
2	Discuss environment and importance of ecosystems	CLO 1	R1: 1.1,1.2 R3:1.1-1.3
3	Provides the information regarding ecosystem and applicability.	CLO 1	T2:3.2 R1:1.6.1,1.6.2 R3:1.6,1.7
4	Provides the information regarding ecosystem and applicability	CLO 1	T2:3.2 R1:1.6.1,1.6.2 R3:1.6,1.7
5	Acquire knowledge of how all the animals are competing with their food requirements and also understand the various trophic levels in the food chain.	CLO 2	T2:3.6.1-3.6.3 R1:1.7.1,1.7.2, 1.7.3 R3:1.7.1,1.7.2
6	Describe the flow of energy through the various components of ecosystem	CLO 2	T2:3.4 R1:1.8 R3:1.7.5
7	Examine the importance a of nutrients and flow of nutrients in ecosystem	CLO 3	T2:3.4.1-3.4.4 R1:1.9,1.10 R3:1.7.6
8	Examine the importance a of nutrients and flow of nutrients in ecosystem	CLO 3	T2:3.4.1-3.4.4 R2:1.9,1.10 R3:1.7.6
9	Summarize about the toxicity of heavy metals on the biotic and a biotic components.	CLO 4	R1:1.11 R3:1.7.3
10	Distinguish about different types of natural resources and their applicability and illustrate the utility of renewable resources efficiency	CLO 5	R1:2.1 R3:2.1
11	Describe the impact of over utilization of underground and surface water	CLO 5	R1:2.3,2.4.1, 2.4.2,2.4.3 R3:2.2
12	Discuss the disaster manage mental plans	CLO 6	R1:2.4.4 R3:2.2.4,2.2.5
13	Describe the benefits and property dams	CLO 6	R1:2.4.5 R3:2.3
14	Illustrate the uses of mineral resources	CLO 2 CLO 6	R1:2.5 R3:2.4
15	Enumerate the application of the solar energy in modern days	CLO 6	R1:3.1 R3:2.5
16	Enumerate the application of the wind energy in modern days	CLO 6	R1:3.3.1.5 R3:2.5
17	Illustrate the definition and importance of biodiversity	CLO 6	T2:4.1 R1:4.1 R3:3.1

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
18	Acquire the genetic diversity, species and ecosystem diversity	CLO 7	T2:4.1.1,4.1.2, 4.1.3 R1:4.2 R3:3.2
19	Describe the ecological values and consumptive use of ecosystem	CLO 7	T2:4.3 R1:4.3 R3:3.3
20	Recall India is mega diversity nation	CLO 7	T2:4.5 R3:3.4
21	Discuss the hot spot center in and around	CLO 7	T2:4.6 R1:4.6 R3:3.4
22	Analyze the information regarding different causes for loss of biodiversity	CLO 7	T2:4.7 R1:4.4 R3:3.5
23	Analyze various reasons for conflict of species	CLO 7	T2:4.7 R3:3.5.3
24	Illustrate different methods to protect the biodiversity	CLO 7	T2:4.9 R1:4.5 R3:3.7
25	Correlate national biodiversity act	CLO 8	T2:4.9 R1:4.5 R3:3.7
26	Explain the meaning of environmental pollution and classification.	CLO 9	T2:5.1 R1:5.1 R3:4.1
27	Analyze the important pollutants in air pollutants	CLO 9	T2:5.2.1 R1:5.3 R3:4.2
28	Enumerate the sources types and effects of water pollution	CLO 9	T2:5.2.2 R1:5.4 R3:4.6
29	Correlate the sources types and effects of soil pollution	CLO 9	T2:5.2.3 R1:5.5 R3:4.8
30	Analyze the noise quality and permissible levels	CLO 9	T2:5.2.5 R1:5.7 R3:4.13
31	Describe the various methods commonly employed for the disposal of solid waste.	CLO 9	T2:5.3 R1:7.7
32	Identify To understand the recent trends in e- waste management practices.	CLO 10	R1:5.10.6 R3:4.16.3
33	Understand concept of climate change and impacts.	CLO 10	T2:6.6.1 R1:6.5 R3:5.5
34	Summarize the remedial measures of ozone depletion	CLO 10	T2:6.6.4 R1:6.6 R3:5.6,5.7
35	Evolve strategies to environmental issues	CLO 10	R1:6.8 R3:5.10
36	Describe the role of government and legal aspects in environmental protection	CLO 10	T2:6.9-6.14 R1:7.2,7.3,7.4, R3:7.3,7.4,7.5, 7.6,7.7
37	Discuss the silent features of the hazardous waste management	CLO 11	R1:7.9 R3:7.10
38	Understand the importance of EIA for developmental activities	CLO 12	T2:6.14 R3:6.3,6.4

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
39	Understand the importance of EIA for developmental activities	CLO 12	T2:6.14 R1:10.1 R3:6.3,6.4
40	State the aim and objectives of sustainable development	CLO 12	T2:6.1 R1:10.5 R3:8.3
41	State the aim and objectives of sustainable development	CLO 13	T2:6.1 R1:10.5 R3:8.3
42	Enumerate population and its explosion	CLO 15	T2:7.2 R1:10.3 R3:8.2
43	State the aim and objectives of sustainable development	CLO 19	T2:7.2.2.2 R1:10.8 R3:8.6
44	Acquire knowledge of environmental education	CLO 18	T2:7.3 R1:10.6 R3:8.4
45	Summarize the environmental ethics and objectives of green buildings	CLO 21	T2:6.5 R1:10.10,10.12 R3:8.10,8.12

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Types of ecosystem, Energy flow, Biomagnification	Seminars / Field visit	PO 1	-
2	Dams ,Mining Activities, Alternative energy resources	Seminars / NPTEL	PO 3	PSO 1
3	Sources of pollution EIA Methodology, Green building	Guest Lecture	PO 7	-

Prepared by:
Ms. M Lakshmi Prasanna, Assistant Professor

HOD, FRESHMAN ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**ENGINEERING MECHANICS**				
Course Code	AME002				
Programme	B.Tech				
Semester	II	AE|ME|CE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. D. Govardhan, Professor.				
Course Faculty	Mr. T Mahesh Kumar, Assistant Professor.				

I. COURSE OVERVIEW:

The aim of Engineering Mechanics is to introduce students to the fundamental concepts and principles applied by engineers -whether civil, mechanical, aeronautical, etc. This course introduces the concepts of engineering based on forces in equilibrium. Topics include concentrated forces, distributed forces, forces due to friction, inertia, work –energy principle and vibrations as they apply to machines, structures, and systems. It is the branch of science for analyzing force systems that acts upon the bodies either at rest or in motion.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic concepts of physics and mathematics

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Engineering mechanics	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.	2	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	Term paper, Seminars
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Assignments

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	Lecture, Assignments.
PSO 2	**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	-	-
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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Develop the ability to work comfortably with basic engineering mechanics concepts required for analyzing dynamic structures.
II	Identify an appropriate structural system to studying a given problem and isolate it from its environment, model the problem using good free-body diagrams and accurate equilibrium equations.
III	Identify and model various types of loading and support conditions that act on structural systems, apply pertinent mathematical, physical and engineering mechanical principles to the system to solve and analyze the problem.
IV	Understand the meaning of impulse and momentum, virtual work and solve the field problems.
V	Solve the problem of equilibrium by using the principle of work and energy and vibrations for preparing the students for higher level courses such as, Mechanics of Solids, Mechanics of Fluids etc.

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
AME002.01	CLO 1	Understand the concepts of kinematics of the particles and rectilinear motion.	PO1	3
AME002.02	CLO 2	Demonstrate knowledge of ability to identify & apply fundamentals to solve problems like motion curves, rigid body motion and fixed axis rotation.	PO1	2
AME002.03	CLO 3	Explore knowledge & ability to solve various particle motion problems.	PO2	2
AME002.04	CLO 4	Derive the D' Alembert's principle and apply it to various field problems of kinetic motion.	PO2	1
AME002.05	CLO 5	Discuss the nature of relation between force and mass under the influence of time.	PO4	2
AME002.06	CLO 6	Develop the relations for motion of body in lift and on inclined plane.	PO2	2
AME002.07	CLO 7	Determine the impact, impulse and impulsive forces occurring in the system.	PO1	3
AME002.08	CLO 8	Understand the inter relationship between impulse-momentum and virtual work and an ability to use such relationships to solve practical problems.	PO1	2
AME002.09	CLO 9	Knowledge of the lifting machines and simple framed structures equilibrium criteria, and the knowledge of the equilibrium condition systems.	PO2	2
AME002.10	CLO 10	Determine the effect of law of conservation of energy and its consideration in field problems.	PO4	1
AME002.11	CLO 11	Discuss the application of work energy method to particle motion.	PO1	2
AME002.12	CLO 12	Develop the work energy relations and apply to connected systems.	PO2	2
AME002.13	CLO 13	Understand the fixed axis rotation theory and solving the field problems by application of work energy method.	PO1	3
AME002.14	CLO 14	Introduction to concepts of vibration and explain the relation between simple harmonic motion and the equilibrium systems.	PO4	3
AME002.15	CLO 15	Derive the expressions for the concepts of simple, compound and torsional pendulums.	PO2	2
AME002.16	CLO 16	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc.	PO4	1

3 = High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												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												1			
CLO 3		2														
CLO 4		1											2			
CLO 5				2												
CLO 6		2														
CLO 7	3															
CLO 8	2															
CLO 9		2											2			
CLO 10				1												
CLO 11	2															
CLO 12		2														
CLO 13	3															
CLO 14				3									1			
CLO 15		2														
CLO 16				1												

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1 PO2 PO4	SEE Exams	PO1 PO2 PO4	Assignments	PO1 PO4	Seminars	PO2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO2						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

UNIT-I	KINEMATICS OF PARTICLES- RECTILINEAR MOTION
Motion of a particle – Rectilinear motion – motion curves – Rectangular components of curvilinear motion Kinematics of Rigid Body - Types of rigid body motion - Angular motion - Fixed Axis Rotation.	
UNIT-II	**KINETICS OF PARTICLE**
Introduction-Definitions of Matter, body, particle, mass, weight, inertia, momentum. Newton's law of motion. Relation Between force & mass. Motion of a particle in rectangular coordinates. D'Alembert's Principle.Motion of Lift. Motion of body on an inclined plane. Motion of connected Bodies.	
UNIT-III	**IMPULSE AND MOMENTUM, VIRTUAL WORK**
Impulse And Momentum: Introduction- Impact, Momentum, Impulse & Impulsive forces, Units. Law of conservation of Momentum, Newton's law of collision of elastic bodies- coefficient of Restitution. Recoil of Gun. Impulse Momentum Equation. **VIRTUAL WORK:** Introduction – Principle of virtual work – Applications – Beams, Lifting machines, Simple framed structures.	
UNIT-IV	**WORK ENERGY METHOD**
Law of conservation of Energy, Application of Work Energy Method to particle motion and connected system- Work energy applied to Connected Systems - Work energy applied to Fixed Axis Rotation	
UNIT-V	**MECHANICAL VIBRATIONS**
Definitions and Concepts – Simple Harmonic Motion – Free vibrations, simple and Compound Pendulums – Torsion Pendulum – Free vibrations without damping: General cases.	
Text Books:	
1. R.C. Hibbler, "Engineering Mechanics", Prentice Hall, 12th Edition, 2009. 2. Engineering Mechanics - Statics and Dynamics by Ferdinand.L. Singer / Harper International Edition. 3. Engineering Mechanics/ S. Timoshenko and D.H. Young, Mc Graw Hill Book Company.	
REFERENCES:	
1. S. Bhavikatti, "A Text Book of Engineering Mechanics", New Age International, 1st Edition, 2012. 2. A.K Tayal ,"Engineering Mechanics", Uma Publications, 14th Edition, 2013. 3. R.K. Bansal "Engineering Mechanics", Laxmi Publications, 8th Edition, 2013. 4. Engg. Mechanics / KL Kumar / Tata McGraw Hill. 5. Engg. Mechanics / S.S. Bhavikati & K.G. Rajasekharappa. 6. Basudeb Bhattacharya, "Engineering Mechanics", Oxford University Press, 2nd Edition, 2014. 7. K. Vijay Reddy, J. Suresh Kumar, "Singer's Engineering Mechanics, Statics and Dynamics", B S Publishers, 1st Edition, 2013.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Motion of a particle – Rectilinear motion	CLO1	T2:7.3
3-5	motion curves – Rectangular components of curvilinear motion	CLO1	T2:7.5,7.6 R1:2.9.2
6-8	Kinematics of Rigid Body	CLO1	T2:7.7 R1:2.10
9	Types of rigid body motion - Angular motion	CLO2	T2:7.7 R1:2.10
10	Fixed Axis Rotation	CLO2	T2:7.11
11	Introduction-Definitions of Matter, body, particle, mass, weight, inertia, momentum.	CLO3	T2:7.11 R1:2.32
12-13	Newton's law of motion. Relation Between force & mass.	CLO3	T2:15.2 R1:8.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
14-15	Motion of a particle in rectangular coordinates.	CLO3	T2:15.7 R1:8.3.3
16-17	D'Alembert's Principle.	CLO4	T2:15.13 R1:8.7.2
18-20	Motion of Lift. Motion of body on an inclined plane. Motion of connected Bodies	CLO5	T2:15.13 R1:8.7.2
21	Introduction- Impact, Momentum, Impulse & Impulsive forces, Units.	CLO6	T2:15.16 R1:8.7.3
22-24	Law of conservation of Momentum	CLO6	T1:11.9 R2:12.24
25-26	Newton's law of collision of elastic bodies	CLO7	T1:11.9 R3:12.25
27-28	Coefficient of Restitution. Recoil of Gun. Impulse Momentum Equation.	CLO8	T1:3.2 R3:3.2
29	Introduction – Principle of virtual work – Applications.	CLO8	T1:3.3.1 R3:3.2
30	Beams, Lifting machines, Simple framed structures	CLO9	T2:16.5 R1:8.10
31	Law of conservation of Energy.	CLO10	T2:16.9 R1:8.11.1
32-33	Application of Work Energy Method to particle motion and connected system.	CLO11	T2:16.9 R1:8.11.2
34-35	Work energy applied to Connected Systems.	CLO12	T2:16.8 R1:8.12.1
36-39	Work energy applied to Fixed Axis Rotation.	CLO13	T2:16.8 R1:8.12.2
40	Definitions and Concepts**.**	CLO14	T2:16.11 R1:8.14
41-42	Simple Harmonic Motion – Free vibrations	CLO15	T2:16.11 R1:8.20
43-44	Simple and Compound Pendulums – Torsion Pendulum	CLO15	T2:16.12 R1:8.19
45-48	Free vibrations without damping: General cases.	CLO16	T2:16.12 R1:8.77

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

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Banking angle theory for curvilinear motion	Guest lecturers/NPTEL	PO1	PSO1
2	Different types of loads on beams	Seminars	PO2	PSO1
3	Application of vibration theory to field problems	Guest lecturers/Seminars	PO4	PSO1

Prepared by:

Mr. T Mahesh Kumar, Assistant Professor.

HOD, AE

III SEMESTER

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**INTRODUCTION TO AEROSPACE ENGINEERING**				
Course Code	AAE001				
Programme	B.Tech				
Semester	III	AE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. R Sabari Vihar, Assistant professor				
Course Faculty	Ms. K. Sai Priyanka Assistant Professor				

I. COURSE OVERVIEW:

Introduction to Aerospace engineeringcovers the fundamental concepts, and approaches of aerospaceengineering, and are highlighted through lectures on aeronautics, astronautics, and design. Active learning aerospace modules make use of information technology. Student teams are immersed in a hands-on, lighter-than-air (LTA) vehicle design project, where they design, LTA vehicles. The connections between theory and practice are realized in the design exercises. The performance, weight, and principal characteristics of the LTA vehicles are estimated and illustrated using physics, mathematics, and chemistry known to freshmen, the emphasis being on the application of this knowledge to aerospace engineering and design rather than on exposure to new science and mathematics.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS007	I	Applied Physics	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Introduction to aerospace engineering	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, engineeringfundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Assignments
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complexengineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Assignments
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	Videos

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	Tutorials
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.	--	---
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	--	---
PSO4	**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.	1	Seminars

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Get the knowledge of technical areas of aerospace engineering including mechanics and physics of fluids, structures and materials, instrumentation, control and estimation, humans and automation, propulsion and energy conversion, aeronautical and astronautical systems
II	Understand the methodology and experience of analysis, modeling, and synthesis
III	Understand the evolution of human space exploration with a brief introduction to the missions conducted by various countries
IV	Knowledge in satellite engineering and the systems involved in the operation of satellites.

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
AAE001.01	CLO 1	Understand, Identify, Study and comprehend processes that lead to solutions to a particular problem.	PO1	2
AAE001.02	CLO 2	Develop one- self to gain knowledge about current technical term which helps to extend the outputs of research.	PO2	2
AAE001.03	CLO 3	Outline performance of the output of research, development, or design.	PO2	2
AAE001.04	CLO 4	Identify, solve new problems and gain new knowledge.	PO1	2
AAE001.05	CLO 5	Understand about the performance parameters, performance in steady flight, cruise, climb, range, endurance, accelerated flight symmetric maneuvers, turns, sideslips, takeoff and landing.	PO1	2
AAE001.06	CLO 6	Getting knowledge about the theory to produce a safe, effective, economic production of aircraft.	PO3	2
AAE001.07	CLO 7	Understand the theoretical knowledge behind the design and development of aircrafts.	PO1	2
AAE001.08	CLO 8	Gain knowledge about the basic Aerodynamics, Flight mechanics and aircraft structures which are the foundation stones for knowledge based exams.	PO1	2
AAE001.09	CLO 9	Discuss the principle constituents of the transportation system involved in civil and commercial aircrafts and understanding the working of space propulsion systems.	PO7	1
AAE001.10	CLO 10	Extend the outputs of earlier research and discover good ideas for new products or improving current products.	PO3	2
AAE001.11	CLO 11	Memorize procedure and steps to keep the products working effectively.	PO3	2
AAE001.12	CLO 12	Gain knowledge about the anatomy of aircraft, helicopters, satellites and other air vehicles, and about the working importance of each component in an air vehicle.	PO1	2
AAE001.13	CLO 13	Ability to summarize the efficiency of the design in achieving the mission goal and safety of flight.	PO3	2
AAE001.14	CLO 14	Understand the impact of radiations in the outer space on the spacecrafts and satellites and safety precautions to be followed.	PO7	1
AAE001.15	CLO 15	Choose a concept or idea of technical real time problems to form solutions for the same.	PO1	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	2		2										2			1
CLO 2	2	3											2			
CLO 3		1											3			1
CLO 4																1
CLO 5	2		3													1
CLO 6	2		2										2			
CLO 7													2			
CLO 8	2		2										2			1
CLO 9	2															1
CLO 10			1										1			1
CLO 11																1
CLO 12																1
CLO 13	2															1
CLO 14			2										2			
CLO 15			2										2			1

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO2,	SEE Exams	PO 1, PO 2, PO 3	Assignments	PO 1, PO 2	Seminars	PO 3
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	HISTORY OF FLIGHT AND SPACE ENVIRONMENT
Balloons and dirigibles, heavier than air aircraft, commercial air transport; Introduction of jet aircraft, helicopters, missiles; Conquest of space, commercial use of space; Different types of flight vehicles, classifications exploring solar system and beyond, a permanent presence of humans in space; Earth's atmosphere, the standard atmosphere; The temperature extremes of space, laws of gravitation, low earth orbit, microgravity, benefits of microgravity; Environmental impact on spacecraft, space debris; Planetary environments	
UNIT-II	**INTRODUCTION TO AERODYNAMICS**
Anatomy of the airplane, helicopter; Understanding engineering models; Aerodynamic forces on a wing, force coefficients; Generating lift, moment coefficients; Aerodynamic forces on aircraft – classification of NACA airfoils, aspect ratio, wing loading, mach number, centre of pressure and aerodynamic centreaerofoil characteristics-lift, drag curves; Different types of drag..	
UNIT-III	**FLIGHT VEHIVLE PERFORMANCE AND STABILITY**
Performance parameters, performance in steady flight, cruise, climb, range, endurance, accelerated flight symmetric maneuvers, turns, sideslips, takeoff and landing. Flight vehicle Stability, static stability, dynamic stability; Longitudinal and lateral stability; Handling qualities of the airplanes	
UNIT-IV	**INTRODUCTION TO AIRPLANE STRUCTURES AND MATERIALS,POWER PLANT**
General types of construction, monocoque, semi-monocoque; Typical wing and fuselage structure; Metallic & non-metallic materials, use of aluminum alloy, titanium, stainless steel and composite materials; Basic ideas about engines, use of propeller and jets for thrust production; Principles of operation of rocket, types of rockets.	
UNIT-V	**SATELLITE SYSTEMS ENGINEERING HUMAN SPACE EXPLORATION**
Satellite missions, an operational satellite system, elements of satellite, satellite bus subsystems; Satellite structures, mechanisms and materials; Power systems; Communication and telemetry; Propulsion and station keeping; Space missions, mission objectives. Goals of human space flight missions, historical background, the Soviet and US missions; The mercury, Gemini, Apollo (manned flight to the moon), Skylab, apollo-soyuz, space Shuttle; International space station, extravehicular activity; The space suit; The US and Russian designs; Life support systems, flight safety; Indian effort in aviation, missile and space technology.	
Text Books:	
1. Newman D, "Interactive Aerospace Engineering and Design", McGraw-Hill, 1st Edition, 2002. 2. Anderson J. D, "Introduction To Flight", McGraw-Hill Education, 5th Edition,2002	
Reference Books:	
1. Kermode. A. C, "Flight without Formulae", McGraw Hill, 4th Edition, 1997. 2. Barnard R.H and Philpot. D.R, "Aircraft Flight", Pearson, 3rd Edition, 2004. 3. SwattonP.J, "Flight Planning", Blackwell Publisher, 6th Edition, 2002.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Balloons and dirigibles, heavier than air aircraft, commercial air transport.	CL01	T3 - 1.1
2	Introduction of jet aircraft, helicopters, missiles.	CL01	T3 - 1.2
3	Conquest of space, commercial use of pace, exploring solar system and beyond, a permanent presence of humans in space.	CL02	T3- 1.3
4	Earth's atmosphere, standard atmosphere, temperature extremes of space.	CL02	T1-1.6
5	Laws of gravitation, low earth orbit, microgravity, benefits of microgravity.	CL03	T1-1.8.1
6	The near earth radioactive environment. The magnetosphere. Environmental impact on spacecraft.	CL02	T1-1.8.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
7	Meteoroids and micrometeoroids, space debris. Planetary environments.	CL02	T1-1.8.4
8	Anatomy of the airplane, helicopter, launch vehiclesand missiles, space vehicles.	CL012	T3-1.9
9-10	Static forces and moments on the vehicle.	CL07	T2-2.1
11	Understanding engineering models aerodynamic forces on a wing, force coefficients. Generating lift.	CL010	T3-2.2
12	Moment coefficients, center of pressure, aerodynamic of wings. Sources of drag.	CL08	T2-2.4
13-14	Thrust for flight, the propeller and the jet engine, governing equations, rocket engines.	CL07	T2-3.1
15-16	Performance parameters, performance in steady flight.	CL05	T2-3.5
17-19	Cruise, climb, range, endurance, accelerated flight symmetricmaneuvers, turns, sideslips, takeoff and landing.	CL05	T2-3.7.1
20-22	Flight vehicle Stability, static stability, dynamic stability. Longitudinal and lateral stability, handling qualities of theairplanes.	CL08	T2-3.73
23-24	General types of construction, monocoque, semi-monocoque.	CL08	T1-3.8
25	Typical wing and fuselage structure.	CL08	T1-3.8.4
26	Metallic & non-metallic materials.	CL010	T1-3.8.5
27-28	Use of aluminum alloy, titanium, stainless steel.	CL010	T1-4.2
29-30	Use of composite materials.	CL010	T1-4.4
31-32	Basic ideas about engines, use of propeller and jets for thrust production.	CL011	T1-4.5
33	Principles of operation of rocket, types of rockets.	CL09	T1-4.6
34-35	Satellite missions, an operational satellite system, elements of satellite, satellite bus subsystems.	CL013	T1-4.7.1
36	Satellite structures, mechanisms and materials.	CL014	T1-4.9
37-39	Propulsion and station keeping. Space missions. Mission objectives. Case studies.	CL011	T1-5.1.1
40-41	Communication and telemetry. Thermal control. Attitude determination and control.	CL015	T1-5.2
42	Goals of human space flight missions. Historical background. The Soviet and US missions.	CL02	T1-5.3
43-44	The Mercury, Gemini, Apollo (manned flight to the moon), Skylab, Apollo-Soyuz, Space Shuttle. International Space Station, extravehicular activity.	CL02	T1-5.6
45	The space suit. The US and Russian designs. Life support systems. Flight safety.	CL02	T1-5.7

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 lift augmentation devices and control surfaces	Seminars / Guest Lectures / NPTEL	PO 1, PO 3	PSO 4

Prepared by:
Ms.K.Saipriyanka, Assistant Professor

HOD, AE

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**THEORY OF STRUCTURES**				
Course Code	AAE002				
Programme	B.Tech				
Semester	III	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Dr. Sudhir Sastry .Y.B, Professor.				
Course Faculty	Mr. T Mahesh Kumar, Assistant Professor.				

I. COURSE OVERVIEW:

The primary objective of The Theory of Structures is concerned with establishing an understanding of the behavior of structures such as beams, columns, frames, plates and shells, when subjected to applied loads or other actions which have the effect of changing the state of stress and deformation of the structure.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME002	II	Engineering Mechanics	4
UG	AHS007	I	Applied Physics	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Theory of Structures	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.	2	Assignments, term paper
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	Term paper, quiz
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Assignments, Practical's

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	Lecture, Assignments.
PSO 2	**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	-	-
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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the several of Concepts of stress and strain in mechanical components by stressing the fundamentals
II	Calculate bending stresses and shear stresses for in a beam of symmetric and un-symmetric sections
III	Explain the deflections of beams with various load conditions by different approaches
IV	Discuss the buckling behavior of columns with different load and boundary conditions

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
AAE002.01	CLO 1	Calculate the stress strain relations in conjunction with elasticity and material properties	PO1	3
AAE002.02	CLO 2	Describe the resistance and deformation in members which are subjected to axial, flexural and torsion loads.	PO1	2
AAE002.03	CLO 3	Discuss thermal explanations in solid bars and induced thermal stresses	PO2	2
AAE002.04	CLO 4	Solve for bending and shear stresses of symmetric and un-symmetric beams under loading conditions	PO2	1
AAE002.05	CLO 5	Calculate the shear stresses developed in various sections of beams.	PO4	2
AAE002.06	CLO 6	Calculate the flexural developed in various sections of beams of real field problems.	PO2	2
AAE002.07	CLO 7	Differentiate between redundant structures and determinate structures.	PO1	3
AAE002.08	CLO 8	Analyze the redundant complex structural components subjected to different loading and boundary conditions.	PO1	2
AAE002.09	CLO 9	Solve for deflections of beams under loading with various approaches	PO2	2
AAE002.10	CLO 10	Calculate the stability of structural elements and determine buckling loads.	PO4	1
AAE002.11	CLO 11	Discuss critical buckling load for column with various loading and end conditions	PO1	2
AAE002.12	CLO 12	Apply a theories and to predict the performance of bars under axial loading including buckling.	PO2	2
AAE002.13	CLO 13	Describe the behavior of structural components subjected to various loading and support conditions based on principles of equilibrium and constitutional relationships.	PO1	3
AAE002.14	CLO 14	Explain the stress transformation and concept of principle plane and principle stresses	PO4	3
AAE002.15	CLO 15	Evaluate principal stresses, strains and apply the concept of failure theories for design	PO2	2
AAE002.16	CLO 16	Acquire Basic knowledge to solve real time problems in Aircraft structure with different loading conditions	PO4	1
AAE002.17	CLO 17	Apply the fundamental concepts in competitive examinations	PO2	3

3 = High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3															
CLO 2	2												1			
CLO 3		2														
CLO 4		1											2			
CLO 5				2												
CLO 6		2														
CLO 7	3															
CLO 8	2															
CLO 9		2											2			
CLO 10				1												
CLO 11	2															
CLO 12		2														
CLO 13	3															
CLO 14				3									1			
CLO 15		2														
CLO 16				1												
CLO 17		3											2			

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2 PO4	SEE Exams	PO,1PO2 PO4	Assignments	PO1, PO4	Seminars	PO2
Laboratory Practices	PO1	Student Viva	PO4	Mini Project	-	Certification	-
Term Paper	PO1, PO2						

XII. ASSESSMENT METHODOLOGIES – INDIRECT

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

XIII. SYLLABUS

Unit-I	INTRODUCTION
Mechanical properties of materials; Stresses and strains; Hooke‘s law, elastic constant, relation between modulii, working stress, factor of safety, poisons ratio ; bars of varying cross section; Thermal stresses. Torsion of solid and hollow circular shafts and shear stress variations; Power transmission in shafts; Shear force and bending moment diagrams for different types of beams with various loads.	
Unit-II	**STRESSES IN BEAMS**
Bending stresses and Shear stress variation in beams of symmetric and un-symmetric sections; Beams of uniform strength; Flexural stresses: Bending equations, calculation of bending stresses for different sections of beams like I, L, T, C, angle section.	
Unit-III	**BEAMS AND COLUMNS**
Deflection of beams by Double integration method, Macaulay‘s method, moment area method, conjugate beam method; Principle of superposition. Columns, types of columns, Euler‘s formula instability of columns, Rakine‘s and Jonson‘s formula, Eigen values and Eigen modes, concept of beam-column.	
Unit-IV	**REDUNDANT STRUCTURES**
Trusses, perfect frames, analysis of trusses; Determinate and indeterminate structures, order of redundancy; Redundant analysis, analysis of determinate structures, area movement method, Clayperons method, slope deflection method, moment distribution method	
Unit-V	**THEORY OF ELASTISITY**
Equilibrium and compatibility conditions and constitute relations for elastic solid and plane: generalized plane strain cases Airy‘s stress function Stress on inclined planes, stress transformations determination of principal stresses and strains by analytical method and graphical method - Mohr‘s circles and its constructions.	
Text Books:	
1. R. K Bansal, ―Strength of Materials‖, Laxmi publications, 5th Edition, 2012. 2. T. H. G. Megson, ―Aircraft Structures for Engineering Students‖, Butterworth-Heinemann Ltd, 5th Edition, 2012 3. Gere, Timoshenko, ―Mechanics of Materials‖, McGraw Hill, 3rd Edition, 1993.	
REFERENCES:	
1. Dym, C. L, Shames, I. H, ―Solid Mechanics‖, McGraw Hill, Kogakusha, Tokyo, 7th Edition, 2007. 2. Stephen Timoshenko, ―Strength of Materials‖, Vol I & II, CBS Publishers and Distributors, 3rd Edition, 2004. 3. R. K. Rajput, ―Strength of Materials‖, S. Chand and Co., 1st Edition, 1999 4. Timoshenko, S, Young, D. H. ―Elements of Strength of Materials‖, T. Van Nostrand Co. Inc., Princeton N.J, 4th Edition, 1977.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-3	**UNIT 1** **INTRODUCTION** Equilibrium and Compatibility conditions for elastic solids, 2D elasticity equations for plane stress,	CLO1	T2:5.5 R1:1.12.1
4-6	2D elasticity equations plane strain and generalized plane strain cases Airy's stress function	CLO1	T2:5.6 R1:1.12.3
7-8	Simple problems in bars of varying cross sections and thermal stresses	CLO1	T2:5.10 R1:1.15
9-11	2D Elastic equations of torsion of solids an hollow circular shafts	CLO2	T2:5.15 R1:1.16
12-14	Concept of principal planes, principal stress and Strains Power transmission in shafts	CLO3	T2:5.17 R1:1.13.1
15-17	Problems on different beams of Shear force and bending moment diagrams for different types of beams with various loads	CLO4	T2:5.18 R1:1.13.2
18-20	**UNIT 2** **STRESSES IN BEAMS** Bending stresses and Shear stress variation in beams of symmetric and un-symmetric sections;	CLO5	T2:5.19 R1:1.13.3
21-23	Beams of uniform strength; Flexural stresses	CLO5	T2:5.20 R1:1.17.1
24-26	Bending equations, calculation of bending stresses for different sections of beams like I, L, T, C, angle section.	CLO6	T2:5.24 R1:1.17.3
27-30	**UNIT 3** **BEAMS AND COLOUMNS** Deflection of beams by Double integration method, Macaulay's method	CLO7	T2:6.1 R1:2.3
31-33	Deflection of beams using moment area method, conjugate beam method; Principle of superposition.	CLO8	T2:6.3 R1:2.6.1
34-37	Columns, types of columns, Euler's formula instability of columns,	CLO9	T2:6.5 R1:2.6.2
38-39	Rakine's and Jonson's formula, Eigen values and Eigen modes, concept of beam-column.	CLO10	T2:7.3 R1:2.8
39-41	**UNIT 4** **REDUNDANT STRUCTURES** Indeterminate structures and order of redundancy, Introduction to redundant analysis, Statically determinate models, Use of free body diagrams to explain compatibility and redundant analysis principles.	CLO11	T2:7.5,7.6 R1:2.9.2
42-44	Statically determinate models- Area movement method use of free body diagrams to explain compatibility and redundant analysis principles.	CLO12	T2:7.7 R1:2.10
45-47	Statically determinate models- Clayprons method use of free body diagrams to explain compatibility and redundant analysis principles.	CLO13	T2:7.7 R1:2.10
48-50	Singularity method for uniform beams with various boundary	CLO14	T2:7.11

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
	and support conditions (props, hinges and fixities) subjected to distributed / discrete loads (including moments).		R1:2.10.2
51-53	**UNIT 5** **THEORY OF ELASTISITY** Equilibrium and compatibility conditions and constitute relations for elastic solid and plane.	CLO15	T2:7.11 R1:2.32
54-56	generalized plane strain cases Airy‘s stress function).	CLO16	T2:15.2 R1:8.2
57-59	Stress on inclined planes, stress transformations	CLO16	T2:15.7 R1:8.3.3
60-62	determination of principal stresses and strains by analytical method and graphical method - Mohr‘s circles and its constructions..	CLO17	T2:15.13 R1:8.7.2

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

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Broad knowledge of engineering materials and material properties	Seminars / Guest Lectures	PO1	PSO1
2	Practical Exposure about the stress deflections and stability of elements	Seminars / Guest Lectures / NPTEL	PO2	PSO1

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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**FLUID MECHANICS AND HYDRAULICS**				
Course Code	AAE003				
Programme	B.Tech				
Semester	III	AE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. G Satya Dileep, Assistant Professor.				
Course Faculty	Mr. R Sabari Vihar, Assistant Professor.				

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the concept of algorithm as a precise mathematical concept, and study how to design algorithms, establish their correctness, study their efficiency and memory needs. The course consists of a strong mathematical component in addition to the design of various algorithms.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AHS002	I	Linear Algebra and Differential Equations
UG	AME002	II	Engineering Mechanics

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Fluid Mechanics And Hydraulics	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	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Assignments
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 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Videos

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
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	1	Seminar
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	-	-
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.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Illustrate about the basic properties of a fluid, hydrostatic forces on submerged bodies and different manometers.
II	Derive the basic principles of a fluid-continuity, momentum, Euler and Bernoulli‘s equations.
III	Explain the concept of boundary layer theory and importance of Prandtl‘s boundary layer theory.
IV	Understand the flow through pipes and their losses for different geometries.

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
AAE003.01	CLO 1	Define the properties of fluids and its characteristics, which will be used in aerodynamics, gas dynamics, marine engineering etc.	PO 1	3
AAE003.02	CLO 2	Explain the hydrostatic forces on submerged bodies, variation with temperature and height with respect to different types of surfaces.	PO 1	3
AAE003.03	CLO 3	Define different types of manometers and explain buoyancy force, stability of floating bodies by determining its metacentre height.	PO 1	3
AAE003.04	CLO 4	Define fluid kinematics and classification of flows, concepts of stream function and velocity potential function which provides solution for velocity and acceleration of fluid flow in real time applications.	PO 2	2
AAE003.05	CLO 5	Explain one dimensional, two dimensional flows in wind tunnel with classification of both compressible and in compressible flows in continuity equation.	PO 3 PO 4	2
AAE003.06	CLO 6	Recognize the surface and body forces required for obtaining momentum equation and energy equation and explain types of derivatives utilized in various flow field conditions.	PO 2	1
AAE003.07	CLO 7	Develop Bernoulli's equation from Euler's equation and explain phenomenological basis of Navier – stokes equation which are widely used in aerodynamics and gas dynamics for real time problems.	PO 2	2
AAE003.08	CLO 8	Demonstrate Buckingham's π theorem and explain similarity parameters used for scale down models and explain flow measurements with dimensionless parameters.	PO 3 PO 4	2
AAE003.09	CLO 9	Demonstrate for competitive exams, the concepts of boundary layer and qualitative description of boundary layer thickness and velocity profile on a flat plate.	PO 3	2
AAE003.10	CLO 10	Distinguish the pressure drag and skin friction drag and state the relation between the frictions of both the drags.	PO 2	2
AAE003.11	CLO 11	Demonstrate the various types of major and minor losses in pipes and explain flow between parallel plates.	PO 1	3
AAE003.12	CLO 12	Discuss fully developed flow through pipes and variation with friction factor with Reynolds number.	PO 1	3
AAE003.13	CLO 13	Understand Moody's chart for identifying friction factor against Reynold's number for various values of roughness.	PO 3	3
AAE003.14	CLO 14	Describe the concepts of turbo machinery in the field of aerospace engineering and concepts of internal flows through engines.	PO 2	3
AAE003.15	CLO 15	Explain the velocity triangles for turbine blades and centrifugal pumps.	PO 2	3

3 = High; 2 = Medium; 1 = Low

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

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

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 3	SEE Exams	PO 1, PO 2 PO 3	Assignments	PO 1, PO 2	Seminars	PO 2 PO 3
Laboratory Practices	PO 3, PO 4	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	FLUID PROPERTIES AND FLUID STATICS
Density, specific weight, specific gravity, surface tension and capillarity, Newton‘s law of viscosity, incompressible and compressible fluid, numerical problems; Hydrostatic forces on submerged bodies - Pressure at a point, Pascal's law, pressure variation with temperature and height, center of pressure plane, vertical and inclined surfaces; Manometers - simple and differential Manometers, inverted manometers, micro manometers, pressure gauges and numerical problems. Buoyancy - Archimedes principle, metacenter, Meta centric height calculations; Stability.	
UNIT-II	**FLUID KINEMATICS AND BASIC EQUATIONS OF FLUID FLOW ANALYSIS**
Stream line, path line, streak line, stream surface, stream tube, classification of flows, steady, unsteady, uniform, non-uniform, laminar, turbulent flows, one dimensional approximation, examples of real 1-D flows, two dimensional approximation, 2-D flow in wind tunnel; Continuity equations for 1-D and 2-D flows both compressible and incompressible, stream function for two dimensional incompressible flows; Vortices, Irrotational flow, velocity potential function.	
UNIT-III	**FLUID DYNAMICS**
Basic laws for a system in integral form: Reynolds transport theorem, Conservation of mass, Newton‘s 2nd law; Application of the basic laws for a control volume; Kinematics; Motion of a fluid particle; Fluid deformation; Differential analysis of fluid motion: Continuity equation, Differential momentum equation, Surface and body forces, substantive derivative, local derivative and convective derivative, momentum equation, Euler's and Bernoulli's equation, phenomenological basis of Naviers- stokes equation, introduction to vortex flows, flow measurements : pressure, velocity and mass flow rate, viscosity, pitot-static tube, venturi meter and orifice meter, viscometers. Statement of Buckingham‘s π- theorem, similarity parameters - Reynolds number, Froude number, concepts of geometric, kinematic and dynamic similarity, Reynolds number as a very approximate measure of ratio of inertia force and viscous force.	
UNIT-IV	**BOUNDARY LAYER THEORY AND PIPE FLOW**
Boundary layer - introductory concepts of boundary layer, large Reynolds number flows and Prandtl‘s boundary layer hypothesis Pressure drag and skin friction drag; Pipe flow - Reynolds experiment, Darcy‘s equation, major and minor losses in pipes and numerical problems. Flow between parallel plates, flow through long tubes –fully developed flow, Turbulent flow, variation of friction factor with Reynolds‘s Number, Moody's chart.	
UNIT-V	**TURBO MACHINERY**
Introduction and classification of fluid machines: Turbo machinery analysis; The angular momentum principle; Euler turbo machine equation; Velocity triangles; Application to fluid systems - Working principle overview of turbines, fans, pumps and compressors.	
Text Books:	
1. Shames I H, “Mechanics of Fluids: Kogakusha”, Tokyo, 7th Edition, 2007. 2. R. K Bansal, “Fluid mechanics and hydraulic machines”, Laxmi publications ltd, 9th Edition, 2011. 3. Robert W Fox, Alan T McDonald, “Introduction to fluid Mechanics”, John Wiley and Sons, 6th Edition, 1995. 4. Streeter V. L, Wylie, E.B., “Fluid Mechanics”, McGraw-Hill, 9th Edition, 1983.	
Reference Books:	
1. Yuan S W, “Foundations of fluid Mechanics”, Prentice-Hall, 2nd Edition, 1987. 2. Milne Thompson L M, “Theoretical Hydrodynamics”, MacMillan, 5th Edition, 1968. 3. Rathakrishnan. E, “Fundamentals of Fluid Mechanics”, Prentice-Hall, 5th Edition, 2007. 4. Som S. K, Biswas. G, “Introduction to fluid mechanics and fluid machines”, Tata McGraw-Hill, 2ndEdition, 2004.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1- 2	Density, Specific weight, Specific gravity.	CLO 1	T2 : 1.2
3-4	Surface tension and capillarity	CLO 1	T2 : 1.6
5	Newton's law of viscosity	CLO 1	T2 : 1.3
6	Incompressible and compressible fluid, numerical problems.	CLO 1	T2 : 1.3
7	Hydrostatic forces on submerged bodies: Pressure at a point	CLO 2	T2 : 3.1
8	Pascal's law, pressure variation with temperature and height	CLO 2	T2 : 3.1
9-11	Center of pressure plane, vertical and inclined surfaces.	CLO 2	T2 : 3.2
12-13	Manometers: simple and differential Manometers	CLO 3	T2 : 2.5
14	Inverted manometers, micro manometers	CLO 3	T2 : 2.5
15-16	Pressure gauges and numerical problems. Buoyancy : Archimedes principle	CLO 3	T2 : 2.5 T2 : 4.2
17-18	Metacenter, meta centric height calculations.	CLO 3	T2 : 4.4
19	Stream line, path line, streak line, stream surface, stream tube	CLO 4	T2 : 5.2
20-21	Classification of flows, steady, unsteady, uniform, non- uniform, laminar, turbulent flows.	CLO 5	T2 : 5.3
22	One dimensional approximation, examples of real 1-D flows,	CLO 5	T2 : 5.3.6
23	two dimensional approximation, 2- D flow in wind tunnel	CLO 5	T2 : 5.3.6
24	Continuity equations for 1-D and 2-D flows both compressible and incompressible	CLO 5	T2 : 5.6
25	Stream function for two dimensional incompressible flows.	CLO 5	T2 : 5.6
26	Vortices, irrotational flow, velocity potential function.	CLO 4	T2 : 5.8
27-28	Basic laws for a system in integral form: Reynolds transport theorem	CLO 7	T2 : 5.9
29-30	Conservation of mass, Newton's 2nd law; Application of the basic laws for a control volume	CLO 6	T2 : 6.8
31-32	Kinematics; Motion of a fluid particle; Fluid deformation; Differential analysis of fluid motion	CLO 2	T2 : 5.9
33	Continuity equation	CLO 6	T2 : 5.6
34	Differential momentum equation, Surface and body forces	CLO 6	T2 : 6.8
35	Substantive derivative, local derivative and convective derivative,	CLO 6	T2 : 6.8
36	Momentum equation,	CLO 7	T2 : 6.3
37	Euler's and Bernoulli's equation.	CLO 7	T2 : 6.4
38-39	Phenomenological basis of Naviers- stokes equation, introduction to vortex flows.	CLO 7	T2 : 5.10
40	Flow measurements: pressure, velocity and mass flow rate, viscosity, pitot-static tube,	CLO 7	T2 : 6.7
41	Venturimeter and orifice meter, viscometers.	CLO 7	T2 : 6.7
42	Statement of Buckingham's π- theorem, similarity parameters. Reynolds number, Froude number	CLO 8	T2 : 12.4
43	Concepts Of geometric, kinematic and dynamic similarity	CLO 8	T2 : 12.6
44-45	Reynolds number as a very approximate measure of ratio of inertia force and viscous force	CLO 8	T2 : 12.8
46	Introductory concepts of boundary layer	CLO 9	T2 : 13.1
47	large Reynolds number flows and Prandtl's boundary layer hypothesis,	CLO 9	T2 :13.2 R3 : 10.5
48-49	Pressure drag and skin friction drag.	CLO 10	T2 : 13.3 R3 : 10.5

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
50	Reynolds experiment, Darcy's equation	CLO 11	T2 : 10.2 R3 : 7.1
51-52	Major and minor losses in pipes and numerical problems.	CLO 11	T2 : 11.4 R3 : 7.2
53	Exact Solutions of Naviers Stokes Equations.	CLO 6	T2 : 6.9
54	Flow between parallel plates, flow through long tubes –fully developed flow	CLO 11	T2 : 11.9 R3 : 10.2
55-56	Turbulent flow, variation of friction factor with Reynolds's Number	CLO 12	T2 : 10.1 R3 : 10.5
57	Moody's chart	CLO 13	T2 : 11.4.7
58-59	Introduction and classification of fluid machines:	CLO 14	T2 : 18.1
60	Turbo machinery analysis; The angular momentum principle;	CLO 14	T2 : 18.3
61-62	Euler turbo machine equation; Velocity triangles;	CLO 15	T2 : 18.6
63-64	Application to fluid systems - Working principle overview of turbines, fans, pumps and compressors.	CLO 15	T2 : 18.4

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Experimental determination of buoyancy	Seminars	PO 1, PO 2, PO 5	PSO 2
2	Introduction to vortex flows- forced and free vortex flows	Seminars / NPTEL	PO 1, PO 2, PO 5	PSO 3
3	Velocity triangles determination	NPTEL	PO 2, PO 3, PO 4	PSO 3

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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**BASIC ELECTRICAL AND ELECTRONICS ENGINEERING**				
Course Code	AEE018				
Programme	B. Tech				
Semester	III	AE | CE | ME			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. N Shivaprasad, Assistant Professor				
Course Faculty	Mr. N Shivaprasad, Assistant Professor Mr. S Srikanth, Assistant Professor Mr. B Muralidhar Nayak, Assistant Professor Ms. B Manogna, Assistant Professor Ms. B Navothna, Assistant Professor				

I. COURSE OVERVIEW:

Electrical and Electronics Engineering course deals with the concepts of electrical circuits, basic law's of electricity, different methods to solve the electrical networks and the instruments to measure the electrical quantities. It also focuses on the construction, operational features of energy conversion devices such as DC and AC machines, Transformers. It also emphasis on basic electronics semiconductor devices and their characteristics and operational features.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Basic Electrical and Electronics Engineering	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 weight age in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

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

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

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

Table 1: Assessment pattern for CIA

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

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

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

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Seminar
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Five Minutes Video
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.	2	Assignment

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
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	1	Seminar
PSO2	**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	-	-
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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand Kirchhoff laws and their application in series and parallel circuits.
II	Discuss principle and operation of measuring instruments.
III	Analyze the characteristics of alternating quantities, electrical machines.
IV	Illustrate the V-I characteristics of various diodes and bi-polar junction transistor.

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
AEE018.01	CLO 1	Analyze the circuits using Kirchhoff's current and Kirchhoff's voltage law.	PO1	3
AEE018.02	CLO 2	Use star delta transformation for simplifying complex circuits.	PO1	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEE018.03	CLO 3	Generalize operation and principle of measuring instruments.	PO2	3
AEE018.04	CLO 4	Demonstrate the working principle of DC motor, DC generator and transformer.	PO2	3
AEE018.05	CLO 5	Describe the construction of machines and transformer.	PO2	2
AEE018.06	CLO 6	Classify the types of DC machines.	PO2	2
AEE018.07	CLO 7	Derive the EMF equation of DC generator, transformer and Torque equation of DC motor.	PO2	2
AEE018.08	CLO 8	Discuss the principle of operation of induction motor.	PO2	2
AEE018.09	CLO 9	Explain the construction and characteristics of alternator.	PO4	2
AEE018.10	CLO 10	Explain the construction and characteristics of 3-phase induction motor.	PO2	1
AEE018.11	CLO 11	Compare the operation of half wave, full wave and bridge rectifiers.	PO4	2
AEE018.12	CLO 12	Differentiate the operation of Diodes and transistors.	PO2	2
AEE018.13	CLO 13	Apply the concept of diodes in converting AC to DC rectification process.	PO1	2
AEE018.14	CLO 14	Distinguish the different configurations of transistor.	PO4	2
AEE018.15	CLO 15	Examine the voltage, current and frequency of electric network using CRO.	PO1	3
AEE018.16	CLO 16	Apply the knowledge of electromagnetic laws and basic concepts of electronics.	PO2	3
AEE018.17	CLO 17	Process the knowledge and skills for employability and to succeed national and international level competitive examinations.	PO2	3

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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	3														
CLO 2																
CLO 3		3											1			
CLO 4		3											1			
CLO 5		2											1			
CLO 6		2											1			
CLO 7		2											1			
CLO 8		2											1			

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 9				2												
CLO 10		1											1			
CLO 11				2									1			
CLO 12		2											1			
CLO 13	2															
CLO 14				2												
CLO 15	3															
CLO 16		3														
CLO 17		3														

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1,PO2, PO4	SEE Exams	PO1,PO2 PO4	Assignments	PO4	Seminars	PO1
Laboratory Practices	PO1	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	**ELECTRICCIRCUITS,ELECTROMAGNETISM AND INSTRUMENTS**	**Classes: 10**
Electrical Circuits: Basic definitions, types of elements, Ohm's Law, resistive networks, inductive networks, capacitive networks, Kirchhoff's Laws, series, parallel circuits and star delta transformations, simple problems, Faradays law of electromagnetic induction; Instruments: Basic principles of indicating instruments, permanent magnet moving coil and moving iron instruments.		
UNIT -II	**DC MACHINES**	**Classes: 10**
DC Machines: Principle of operation of DC generator, EMF equation, principle of operation of DC motors, torque equation, types of DC machines, applications, three point starter.		
UNIT -III	**ALTERNATING QUANTITIES AND AC MACHINES**	**Classes: 08**
Alternating Quantities: Sinusoidal AC voltage, average and RMS values, form and peak factor, concept of three phase alternating quantity; Transformer: Principle of operation, EMF equation, losses,		

efficiency and regulation. **Three Phase Induction Motor:** Principle of operation, slip, slip torque characteristics, efficiency, applications; Alternator: Principle of operation, EMF Equation, efficiency, regulation by synchronous impedance method.		
UNIT-IV	**SEMICONDUCTOR DIODE AND APPLICATIONS**	**Classes: 09**
Semiconductor Diode: P-N Junction diode, symbol, V-I characteristics, half wave rectifier, full wave rectifier, bridge rectifier and filters, diode as a switch, Zener diode as a voltage regulator.		
UNIT-V	**BIPOLAR JUNCTION TRANSISTOR AND APPLICATIONS**	**Classes: 08**
Bipolar junction: DC characteristics, CE, CB, CC configurations, biasing, load line, transistor as an amplifier.		
Text Books:		
1. A Chakrabarti, "Circuit Theory", Dhanpat Rai Publications, 6th Edition, 2004. 2. K S Suresh Kumar, "Electric Circuit Analysis", Pearson Education, 1st Edition, 2013. 3. Willianm Hayt, Jack E Kemmerly S M Durbin, "Engineering Circuit Analysis", Tata McGraw Hill, 7th Edition, 2010. 4. J P J Millman, C C Halkias, Satyabrata Jit, "Millman"s Electronic Devices and Circuits", Tata McGraw Hill, 2nd Edition, 1998. 5. R L Boylestad, Louis Nashelsky, "Electronic Devices and Circuits", PEI / PHI, 9th Edition, 2006. 6. R L Boylestad, Louis Nashelsky, "Electronic Devices and Circuits", PEI / PHI, 9th Edition, 2006.		
Reference Books:		
1. David A Bell, "Electric Circuits", Oxford University Press, 9th Edition, 2016. 2. U A Bakshi,Atul P Godse "Basic Electrical and Electronics Engineering", Technical Publications, 9th Edition, 2016. 3. A Bruce Carlson, "Circuits", Cengage Learning, 1st Edition, 2008. 4. M Arshad, "Network Analysis and Circuits", Infinity Science Press, 9th Edition, 2016.		

XIV.COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Discuss the basic definitions of voltage, current, power and energy	CLO 1	T2: 1.2-1.8 R2:1.1
2	Understand the concept of Ohm's Law	CLO 1	T2: 1.9 R2:1.5
3	Discuss different elements in power systems and sources	CLO 1	T2:1.10 R2:1.2&1.4
4-5	Describe voltage-current relationship of resistive networks, inductive networks, capacitive networks	CLO 1	T2: 2.3-2.5 R2:1.6
6	Explain Kirchhoff's laws for electrical networks	CLO 1	T2: 1.12 R2:1.14
7-8	Understand series, parallel circuits	CLO 1	T2: 2.6 R2:1.7&1.8
9	Derive the formula for Star delta and delta star transformations techniques.	CLO 2	T2: 2.7 R2:1.12
10	Analyze networks using reduction techniques.	CLO 2	T2: 2.6 R2:1.7&1.8
11	Understand the concept of faradays laws	CLO 3	T2: 1.11 R2:6.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
12	Understand working of different measuring instruments	CLO 3	T2: 10.4 R2:4.0
13-14	Understand working of different measuring instruments	CLO 3	T2: 10.5.1.1 R2:4.0
15-16	Understand working of different measuring instruments	CLO 3	T2: 10.5.1.3 R2:4.0
17	Discuss what is a DC machine	CLO 4	T2: 7.1 R2:5.2
18	Understand the working principle of DC machine	CLO 4	T2: 7.6 R2:5.3
19-20	Demonstrate the cross section view of a DC machine	CLO 5	T2: 7.2 R2:5.4
21-22	Derive the mathematical equation of EMF induced in a DC generator	CLO 7	T2: 7.6.1 R2:5.7
23	Classify the types of DC generator	CLO 6	T2: 7.6.3 R2:5.10,5.11,5.12 ,5.13,5.14
24	Understand the working principle of DC motor	CLO 4	T2: 7.7 R2:5.16
25	Classify the types of DC motor	CLO 6	T2: 7.7.6 R2:5.21,5.22,5.23 ,5.24
26	Derive mathematical equation of torque generated in a DC motor	CLO 7	T2:7.7.5 R2:5.20
27	Understand the applications of DC motor	CLO 4	T2: 7.7.6.1-7.7.6.3 R2:5.31
28	Understand the three point starter	CLO 4	T2: 7.7.7 R2:5.25
29	Understand the concepts of alternating quantities	CLO 4	T2: 4.1 R2:2.1
30	Understand the representation of sinusoidal quantity and analyzing	CLO 4	T2: 4.5-4.6 R2:2.2
31	Understand three phase systems	CLO 4	T2: 5.2.4.1-5.2.4.2 R2:3.2
32	Understand the working principle of Transformer	CLO 4	T2: 6.5 R2:602
33	Derive mathematical equation of EMF induced in a single phase transformer	CLO 7	T2: 6.6.1 R2:6.6
34-35	Understand the percentage efficiency and voltage regulation	CLO 7	T2: 6.9-6.10 R2:6.13&6.15
36	Understand the working principle of induction motor	CLO 8	T2: 9.3 R2:7.2
37	Analyze the speed torque characteristics	CLO 9	T2: 9.3.1 R2:7.8
38	Understand the working principle of Alternator	CLO 9	T2: 8.4 R2:7.11
39-40	Derive the mathematical equation of EMF induced in a Alternator	CLO 9	T2: 8.4 R2:7.13
41-42	Analyze the percentage efficiency of an alternator.	CLO 9	T2: 8.8 R2:7.16
42-43	Analyze the percentage voltage regulation of alternator.	CLO 9	T2: 8.8 R2:7.21

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
44-47	Understand the functioning of P-N Junction diode	CLO 12	T4: 4.11 R2:8.1
48–50	Understand and analyze P -N diode as half wave rectifier, full wave rectifier, bridge rectifier and filters	CLO 11	T4: 4.23 R2:8.8,8.17,8.18, 8.19
51-53	Understand the functioning of Zener diode as a voltage regulator.	CLO 12	T4: 4.19,5.2 R2:8.22.5
54	Analyze simple problems on diodes.	CLO 12	T4: 4.23 R2:8.23
55-56	Understand the concept of bipolar junction: DC characteristics,	CLO 14	T4: 6.4-6.5 R2:9.1
57-59	Examine CE, CB, CC configurations.	CLO 14	T4: 6.6 R2:9.21,9.22,9.23
60	Analyze biasing and load line,	CLO 14	T4: 6.3 R2:9.3
61-63	Model Transistor as an amplifier	CLO 14	T4: 6.7 R2:9.5
64-65	Analyze simple problems on transistors.	CLO 14	T4: 6.6 R2:9.7

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Guest lectures	PO2	PSO1
2	Voltage - Current relationship for passive elements for different input signals - ramp, saw tooth and triangular.	Seminars / NPTEL	PO1	PSO1
3	Resistance color coding	NPTEL	PO1	PSO1

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TITUTE OF AERONAUTICAL ENGINEERING

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Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MATHEMATICAL TRANSFORM TECHNIQUES**				
Course Code	AHS011				
Programme	B.Tech				
Semester	II	EEE			
	III	AE | ECE			
	IV	ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Ms.P Rajani ,Assistant Professor, FE				
Course Faculty	Dr. S Jagadha, Associate Professor, FE Ms. L Indira, Associate Professor, FE Mr.J Suresh Goud, Associate Professor, FE Ms.C Rachana, Assistant Professor, FE				

I. COURSE OVERVIEW:

The course focuses on more advanced engineering mathematics topics which provide with the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes types of matrices, difference calculus methods and differential equations. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

II. COURSE PRE-REQUISITES:

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

III. MARKS DISTRIBUTION:

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

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V. EVALUATION METHODOLOGY:

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

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five 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	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Seminar
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:**Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	1	Seminar
PSO 2	**Problemsolving 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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Epress non periodic function to periodic function using Fourier series and Fourier transforms.
II	Apply Laplace transforms and Z-transforms to solve differential equations.
III	Formulate and solve partial differential equations.

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
AHS011.01	CLO 1	Ability to compute the Fourier series of the function with one variable.	PO 1	3
AHS011.02	CLO 2	Understand the nature of the Fourier series that represent even and odd functions.	PO 1	3
AHS011.03	CLO 3	Determine Half- range Fourier sine and cosine expansions.	PO 1	2
AHS011.04	CLO 4	Understand the concept of Fourier series to the real-world problems of signal processing	PO 2	1
AHS011.05	CLO 5	Understand the nature of the Fourier integral.	PO 2	2
AHS011.06	CLO 6	Ability to compute the Fourier transforms of the function.	PO 2	2
AHS011.07	CLO 7	Evaluate finite and infinite Fourier transforms.	PO 4	1
AHS011.08	CLO 8	Understand the concept of Fourier transforms to the real-world problems of circuit analysis, control system design	PO 2	3
AHS011.09	CLO 9	Solving Laplace transforms using integrals.	PO 2	1
AHS01110	CLO 10	Evaluate inverse of Laplace transforms by the method of convolution.	PO 2	2
AHS011.11	CLO 11	Solving the linear differential equations using Laplace transform.	PO 1	3
AHS011.12	CLO 12	summarize the concept of Laplace transforms to the real-world problems of electrical circuits, harmonic oscillators, optical devices, and mechanical systems	PO 1	3
AHS011.13	CLO 13	Apply Z-transforms for discrete functions.	PO 1	3
AHS011.14	CLO 14	Evaluate inverse of Z-transforms using the methods of partial fractions and convolution method.	PO 1, PO 2	3
AHS011.15	CLO 15	Apply Z-transforms to solve the difference equations.	PO 2	3
AHS011.16	CLO 16	Understand the concept of Z-transforms to the real-world problems of automatic controls in telecommunication.	PO 2	2
AHS011.17	CLO 17	Understand partial differential equation for solving linear equations by Lagrange method.	PO 1, PO 2	3
AHS011.18	CLO 18	Apply the partial differential equation for solving non-linear equations by Charpit's method.	PO 1, PO 2	3
AHS011.19	CLO 19	Solving the heat equation and wave equation in subject to boundary conditions.	PO 1, PO 2	3
AHS011.20	CLO 20	Summarize the concept of partial differential equations to the real-world problems of electromagnetic and fluid dynamics	PO 1, PO 2	3
AHS011.21	CLO 21	Possess the knowledge and skills for employability and to succeed in national and international level competitive examinations.	PO 1	3

3 = High; 2 = Medium; 1 = Low

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

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												1		
CLO 2	3												1		
CLO 3	2												1		
CLO 4		1													
CLO 5		2													
CLO 6		2													
CLO 7				1											
CLO 8				3											
CLO 9		1											1		
CLO 10		2											1		
CLO 11	3														
CLO 12	3														
CLO 13	3														
CLO 14	3	2											1		
CLO 15		3													
CLO 16		2													
CLO 17	3	3											1		
CLO 18	3	3											1		
CLO 19	2	3											1		
CLO 20	3	2											1		
CLO 21	3														

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

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

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

UNIT-I	FOURIER SERIES
Definition of periodic function, determination of Fourier coefficients; Fourier expansion of periodic function in a given interval of length 2π; Fourier series of even and odd functions; Fourier series in an arbitrary interval; Half- range Fourier sine and cosine expansions.	
UNIT-II	**FOURIER TRANSFORMS**
Fourier integral theorem, Fourier sine and cosine integrals; Fourier transforms; Fourier sine and cosine transform, properties, inverse transforms, finite Fourier transforms.	
UNIT-III	**LAPLACE TRANSFORMS**
Definition of Laplace transform, linearity property, piecewise continuous function, existence of Laplace transform, function of exponential order, first and second shifting theorems, change of scale property, Laplace transforms of derivatives and integrals, multiplied by t, divided by t, Laplace transform of periodic functions. Inverse Laplace transform: Definition of Inverse Laplace transform, linearity property, first and second shifting theorems, change of scale property, multiplied by s, divided by s; Convolution theorem and applications.	
UNIT-IV	**Z –TRANSFORMS**
Z-transforms: Elementary properties, inverse Z-transform, convolution theorem, formation and solution of difference equations.	
UNIT-V	**PARTIAL DIFFERENTIAL EQUATIONS AND APPLICATIONS**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equation by Lagrange method; Charpit's method; method of separation of variables; One dimensional heat and wave equations under initial and boundary conditions.	
TEXT BOOKS:	
1. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 10th Edition, 2010. 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.	
REFERENCES:	
1. G. Shanker Rao, "Mathematical Methods", I. K. International Publications, 1st Edition, 2009. 2. G. Shanker Rao, "Engineering Mathematics-1", I. K. International Publications, 1st Edition, 2009.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Define periodic function	CLO 1	T1:22.5 R1:2.3
2	Solve Fourier coefficients	CLO 2	T1:22.5 R1:2.4
3	Apply Fourier series for $(0, 2\pi)$	CLO 2	T1:22.6 R1:2.6
4-5	Determine even and odd function	CLO 4	T1:22.7 R1:4.4
6-7	Determine Fourier series in $(0,2l)$, $(-l,l)$ and also half range series in $(0, l)$	CLO 4	T1:22.7 R1:4.10
8-9	Determine half range series in $(0, \pi)$	CLO 7	T1:22.8 R1:4.15

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
10	Apply Fourier integral theorem to find integrals	CLO 9	T1:22.9 R1:5.4
11	Apply Fourier sine and cosine integrals to find integrals	CLO 9	T1:22.9 R1:5.8
12-13	Define and apply Fourier transforms	CLO 11	T1:23.10 R1:6.8
14	Use properties to solve the given functions	CLO 11	T1:23.10 R1:6.13
15-16	Define and apply Inverse transforms	CLO 13	T1:23.9 R1:7.5
17	Define and apply Finite Fourier transforms	CLO 11	T1:23.10 R1:7.5
18	Define Laplace transform and its property	CLO 9	T1:23.10 R1:8.1
19	Define piecewise continuous function	CLO 14	T1:23.1 R1:9.2
20	Define and apply shifting theorem, change of scale property	CLO 14	T1:23.1 R1:9.4
21	Solve derivatives and integrals, multiplied by t, divided by t	CLO 14	T1:23.1 R1:9.9
22-23	Define periodic functions	CLO 14	T1:23.1 R1:9.10
24-25	Solve Inverse Laplace transform	CLO 14	T2:27.5 R1:10.2
26	Define and apply shifting theorem, change of scale property	CLO 17	T2:27.7 R1:11.3
27	Solve multiplied by s, divided by s	CLO 17	T2:27.8 R1:11.6
28-30	Define and apply Convolution theorem	CLO 19	T2:27.12 R1:11.7
31-32	Define Z-transforms, Elementary properties	CLO 19	T2:27.12 R1:11.8
33-34	Define inverse Z-transform	CLO 20	T2:27.12 R1:11.9
35-36	Define and apply convolution theorem	CLO 20	T2:27.12 R1:11.10
37-38	Formulate partial differential equations	CLO 21	T2:27.14 R1:12.3
39	Solve by lagrange's method	CLO 22	T2:27.1 R1:12.7
40-41	Solve by Charpit's method	CLO 23	T2:27.17 R1:12.15
42	Apply method of separation of variables	CLO 23	T2:18.2 R1:13.1
43-45	Solve heat and wave equations	CLO 23	T2:18.3-18.5 R1:13.2, 13.3

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

S no	Description	Proposed Actions	Relevance with Pos	Relevance with Psos
1	Problem deduction, Initial and Boundary value problems	Seminars	PO 1	PSO 1
2	Fourier Integral Transforms, Convolution theorem in Fourier Transforms, Higher order difference equations	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students to identify the type of transform involved in industry	NPTEL	PO 2	PSO 1

Prepared by:
Ms . P Rajani, Assistant Professor, FE

HOD,AERO

IV SEMESTER

INSTITUTE OF AERONAUTICAL ENGINEERING

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Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**LOWSPEED AERODYNAMICS**				
Course Code	AAE004				
Programme	B.Tech				
Semester	IV	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Dr. Maruthupandiyan K, Associate Professor				
Course Faculty	Dr. Maruthupandiyan K, Associate Professor Dr. P K Mohanata, Associate Professor				

I. COURSE OVERVIEW:

Aerodynamics extends fluid mechanic concepts to the aerodynamic performance of wings and bodies in sub/supersonic regimes. The course has four components: (i) subsonic potential flows, including source/vortex panel methods; (ii) viscous flows, including laminar and turbulent boundary layers; (iii) aerodynamics of airfoils and wings, including thin airfoil theory, lifting line theory, and panel method/interacting boundary layer methods; (iv) introduction to propeller. Aerodynamics is the study of the flow of air about a body. In this case, the body will be an airplane, but much of the aerodynamics in this course is relevant to a wide variety of applications from sail boats to automobiles to birds. The course should help students to: formulate and apply appropriate aerodynamic models to predict the forces on and performance of realistic three-dimensional configurations; assess the applicability of aerodynamic models to predict the forces on and performance of realistic three-dimensional configurations and estimate the errors resulting from their application; perform a computational and experimental aerodynamic analysis and design.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS007	I	Applied physics	4
UG	AAE102	III	Fluid Mechanics and Hydraulics	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Low Speed Aerodynamics	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 fiveunits 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	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Seminar
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.	3	Designing
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Assignments

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	1	Seminar
PSO 2	**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	Tutorials
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	3	Mini project
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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the basics of aerodynamics, aerofoil and wing characteristics
II	Calculate forces and moments acting on aero foils and wings under ideal flow conditions.
III	Design a propeller and determine aerodynamic interaction effects between different components of aircraft.

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
CAAE004.01	CLO 1	Apply knowledge and understand the essential facts, concepts and principles of aerodynamics.	PO 1	3
CAAE004.02	CLO 2	Adapt the basic knowledge of mathematics, science and engineering for problem solving.	PO 1	3
CAAE004.03	CLO 3	Describe principles of physics and aerodynamics to study the wing-body interference junction.	PO 1	3
CAAE004.04	CLO 4	Explain the concept of boundary layer flows to increase the performance of the body.	PO 2	2
CAAE004.05	CLO 5	Understand the concept of source, sink, doublet and vortex.	PO 3	3
CAAE004.06	CLO 6	Demonstrate importance of aerodynamics to develop effective aircraft design and operations.	PO 2	2
CAAE004.07	CLO 7	Apply the concept of lifting line theory to study potential flows over different aerofoils.	PO 4	1
CAAE004.08	CLO 8	Identify the elliptic load distribution for obtaining high lift performance on finite wings.	PO 2, PO 4	2
CAAE004.09	CLO 9	Evaluate the source and vortex panel method for non-lifting and lifting aerofoils.	PO 3	3
CAAE004.10	CLO 10	Illustrate the propeller aerodynamics and the effects of propeller on the wing.	PO 2	2
CAAE004.11	CLO 11	Understand the concept of Prandtl's lifting line theory and eliptical lift distribution.	PO 1, PO 2	2
CAAE004.12	CLO 12	Understand the lift augmentation techniques for high-lift devices and slats.	PO 1	3
CAAE004.13	CLO 13	Understand aerodynamic effect of taper and twist applied to wings.	PO 2	2
CAAE004.14	CLO 14	Apply temperature effects on boundary layer, transition and turbulent flow regimes.	PO 1, PO 3	2
CAAE004.15	CLO 15	Understand the aerodynamic effect of vortex formation around wings.	PO 2	2
CAAE004.16	CLO 16	Evaluate flow past non lifting bodies and method of singularities	PO 2	2
CAAE004.17	CLO 17	Understand the effect of sweep in the context of delta wings.	PO 1, PO 2	2
CAAE004.18	CLO 18	Understand the relation between circulation and lift.	PO 1, PO 3	3
CAAE004.19	CLO 19	Understand the various sources of drag including induced drag and skin friction drag.	PO 1, PO 2	2
CAAE004.20	CLO 20	Evaluate displacement thickness, momentum thickness, energy thickness.	PO 2, PO 4	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
CLO 1	3												1		
CLO 2	3												1		
CLO 3	3												1		3
CLO 4		2													
CLO 5			3												3
CLO 6		2													
CLO 7				1											
CLO 8		2		1										2	
CLO 9			3										1	2	3
CLO 10		2													
CLO 11	3	2													
CLO 12	3														3
CLO 13		2													
CLO 14	3		3										1	2	
CLO 15		2													
CLO 16		2												2	
CLO 17	3	2											1		
CLO 18	3		3												
CLO 19	3	2											1		3
CLO 20		2		2										2	

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2PO 3, PO 4	SEE Exams	PO 1, PO 2PO 3, PO 4	Assignments	PO 1, PO 2	Seminars	PO 2
Laboratory Practices	PO2, PO 3PO 4	Student Viva	-	Mini Project	PO 3	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

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

XIII. SYLLABUS

UNIT-I	**INTRODUCTORY TOPICS FOR AERODYNAMICS**
Potential flow, velocity potential, stream function, Laplace equation, flow singularities-Uniform flow, source, sink, doublet, Vortex, Non lifting and lifting flow over a cylinder Kutta-Joukowski theorem.	
UNIT -II	**THIN AEROFOIL THEORY**
Aerofoil nomenclature, aerodynamic characteristics, centre of pressure and aerodynamic centre; Wing of infinite aspect ratio, CL-α- diagram for a wing of infinite aspect ratio, generation of lift, starting Vortex, Kutta's trailing edge condition; Thin aerofoil theory; Elements of panel method; High lift airfoils, High lift devices.	
UNIT-III	**FINITE WING THEORY**
Vortex motions, vortex line, vortex tube, vortex sheet; Circulation; Kelvin and Helmhotz theorem; BiotSavart's law, applications, Rankine's vortex; Flow past finite wings, vortex model of the wing and bound vortices; Induced drag; Prandtl's lifting line theory; Elliptic wing. Influence of taper and twist applied to wings, effect of sweep back wings; Delta wings, primary and secondary vortex; Elements of lifting surface theory. Source Panel Vortex panel and Vortex lattice methods.	
UNIT-IV	**FLOW PAST NON-LIFTING BODIES AND INTERFERENCE EFFECTS**
Flow past non lifting bodies, method of singularities; Wing-body interference; Effect of propeller on wings and bodies and tail unit; Flow over airplane as awhole.	
UNIT-V	**BOUNDARY LAYER THEORY**
Introduction to boundary layer, laminar and turbulent boundary layer, transition, boundary layer on flat plate, displacement thickness, momentum thickness, energy thickness, effect of curvature, temperature boundary layer.	
Text Books:	
1. J.D.Anderson, "Fundamentals of Aerodynamics", McGraw-Hill publications, 5th Edition, 2011. 2. E. L. Houghton and P.W. Carpenter, "Aerodynamics for Engineering Students", Edward Arnold Publishers Ltd., London, 5th Edition, 1982. 3. John J. Bertin and Russell M. Cummings, "Aerodynamics for Engineering Students", Pearson,5th Edition, 2009.	
Reference Books:	
1. L. J. Clancy, "Aerodynamics", Pitman, 1st Edition, 1986. 2. Louis M. Milne, "Thomson, Theoretical Aerodynamics", 2nd Edition, Dover Publications, 1985. 3. K. Karamcheti, "Principles of Ideal-fluid Aerodynamics", 2nd Edition, Krieger Publication &Co; 2nd Edition, 1980.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Discuss Importance of Aerodynamics	CLO 1	T1:1.1
2	Define potential flow, velocity potential and stream function	CLO 2	T1:2.4-2.15
3	Derive Laplace equation	CLO 2	T1:2.15
4	Discuss flow singularities	CLO 3	T1:3.9-3.15
5	Discuss uniform flow, source, sink	CLO 5	T1:3.11
6	Discuss doublet, Vortex	CLO 5	T1:3.12-3.14
7	Discuss non-lifting flow over a cylinder	CLO 6	T1:3.13
8	Discuss lifting flow over a cylinder	CLO 6	T1:3.15
9	Derive Kutta-Joukowski theorem	CLO 7	T1:3.16
10	Discuss aerofoil nomenclature	CLO 8	T1:4.2
11	Discuss aerodynamic characteristics	CLO 9	T1:4.3
12	Explain centre of pressure, aerodynamic centre and wing of infinite aspect ratio	CLO 11	T1:1.6-4.9
13	Discuss CL-α- diagram for a wing of infinite aspect ratio, generation of lift	CLO 11	T1:4.7
14	Discuss starting Vortex, Kutta‘s trailing edge condition	CLO 11	T1:4.5-4.6
15	Discuss thin aerofoil theory	CLO 12	T1:4.7- 4.10
16-17	Discuss elements of panel method	CLO 9	T1:4.10
18	Discuss high lift airfoils, High lift devices	CLO 12	T1:4.12
19	Discuss vortex motions, vortex line, vortex tube, vortex sheet	CLO 15	T1:5.2
20	Discuss Circulation; Kelvin and Helmhotz theorem vortices; induced drag	CLO 15	T1:4.6
21	Discuss Biot-Savart‘s law, applications, Rankine‘s vortex	CLO 15	T1:5.2
22	Discuss flow past finite wings, vortex model of the wing and bound vortices; induced drag	CLO 15	T1:5.3
23-24	Discuss Prandtl‘s lifting line theory; Elliptic wing	CLO 11	T1:5.3
25	Discuss influence of taper and twist applied to wings, effect of sweep back wings	CLO 13	T1:5.4
26	Discuss delta wings, primary and secondary vortex	CLO 13	T1:5.6
27	Discuss elements of lifting surface theory	CLO 11	T1:5.5

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
28	Discuss Source Panel method	CLO 09	T1:5.4
29	Discuss Vortex Panel method	CLO 09	T1:5.4
30	Discuss Vortex Lattice method	CLO 09	T1:5.5
31	Describe flow past non lifting bodies	CLO 16	T1:5.4
32-33	Discuss method of singularities	CLO 16	T1:5.3
34	Discuss Wing-body interference	CLO 03	T3:5.2
35-37	Discuss effect of propeller on wings and bodies and tail unit	CLO 10	T2:7.1
38	Discuss flow over airplane as a whole	CLO 03	T3:6.2
39-41	Discuss boundary layer	CLO 04	T1:17.1
42-43	Explain laminar and turbulent boundary layer, transition	CLO 04	T1:18.1- 19.1
44-47	Discuss boundary layer on flat plate	CLO 04	T1:18.2
48-52	Discuss displacement thickness, momentum thickness, energy thickness	CLO 20	T1:17.3
53-56	Discuss effect of curvature	CLO 20	T1:17.5
57-60	Explain temperature boundary layer	CLO 20	T1:19.2

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

S NO	Description	Proposed Actions	Relevance with POs	Relevance with PSOs
1	Application of knowledge and skills in the aerodynamic design of a new aircraft	Seminars / Guest Lectures / NPTEL	PO 4,	PSO 3
2	Broad knowledge of aerodynamic studies for various aerofoils and wings currently in use	Seminars / Guest Lectures / NPTEL	PO 4,	PSO 3

Prepared by:
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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**AIRCRAFT MATERIALS AND PRODUCTION**				
Course Code	AAE005				
Programme	B.Tech				
Semester	IV	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Dr. D Govardhan, Professor.				
Course Faculty	Mr. S.Devaraj, Assistant Professor. Mr. T Mahesh Kumar, Assistant Professor. Mr. R Suresh Kumar, Assistant Professor.				

I. COURSE OVERVIEW:

Production engineering is a combination of manufacturing technology with management science. The goal is to accomplish the production process in the smoothest, most-judicious and most-economic way. Production engineering encompasses the application of castings, machining processing, joining processes, metal cutting & tool design, metrology, machine tools, machining systems, automation, jigs and fixtures, and dies and mould design and material science and design of automobile parts and machine designing and manufacturing. Production engineering also overlaps substantially with manufacturing engineering and industrial engineering. In industry, once the design is realized, production engineering concepts regarding work-study, ergonomics, operation research, manufacturing management, materials management, production planning, etc., play important roles in efficient production processes. These deal with integrated design and efficient planning of the entire manufacturing system, which is becoming increasingly complex with the emergence of sophisticated production methods and control systems.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS005	1	Engineering Chemistry	4
UG	AHS007	I	Applied Physics	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Aircraft Materials and Production	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.	2	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	Seminars
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Micro Projects
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.	2	Assignments, Practical's

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	1	Lecture, Assignments.
PSO 2	**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	-	-
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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand about traditional engineering materials like steel and iron material behavior, and to know the enhancement of material properties using heat treatment.
II	Remember the technical areas of aerospace engineering production techniques using casting, different types of casting processes used in aircraft production.
III	Understand methodology and experience of welding techniques and inspection of welding area s using NDT.
IV	Achieve basic engineering production techniques using lathe and various operations such as plane turning, threading, tapering and drilling.
V	Demonstrate knowledge in advancement in material production giving an example of composites and discuss the importance and applications of composites in aircraft industry.

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
AAE005.01	CLO 1	Understand the different phases of iron carbon diagram for manufacturing the different materials with different carbon content.	PO1	3
AAE005.02	CLO 2	Study different material properties and process of heat treatments- annealing, normalizing, hardening and tempering.	PO1	2
AAE005.03	CLO 3	Structure and properties of copper and aluminum and their alloys. Understand the corrosive protective methods for metals	PO2	2
AAE005.04	CLO 4	Discuss different casting procedures- sand casting, metal casting, investment casting, centrifugal casting, etc.	PO3	1
AAE005.05	CLO 5	Understand the procedure of welding processes like arc welding, gas welding, spot welding, Soldering and for different materials.	PO3	2
AAE005.06	CLO 6	Understand the different NDT testing procedures for metals and non-metals by using ultrasonic testing, radiography testing and magnetic particle testing	PO2	2
AAE005.07	CLO 7	Getting knowledge about the sheet metal techniques to produce different objects like punching, blanking, piercing, shearing, etc.	PO3	3
AAE005.08	CLO 8	Understand the concept of spinning, stretch forming and drawing of different materials.	PO1	2
AAE005.09	CLO 9	Understand the different fastening techniques riveting, tooling of aircraft by using jigs and fixtures.	PO2	2
AAE005.10	CLO 10	Gain knowledge about the basic convectional, unconventional riveting and welding for knowledge based exams.	PO3	1
AAE005.11	CLO 11	Getting knowledge to implement the chemical and electro chemical machining techniques.	PO5	2
AAE005.12	CLO 12	Understand the processes parameters of electrical energy based machining processes.	PO2	2
AAE005.13	CLO 13	Demonstrate a good understanding of types and properties of composites used in aircraft.	PO1	3
AAE005.14	CLO 14	Possess knowledge in processing and fabrication of structural composites.	PO5	3
AAE005.15	CLO 15	Understand mechanical behaviors of aircraft composite materials.	PO5	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												1			
CLO 3		2														
CLO 4			1										2			
CLO 5			2													
CLO 6		2														
CLO 7			3													
CLO 8	2															
CLO 9		2											2			
CLO 10			1													
CLO 11					2											
CLO 12		2														
CLO 13	3												1			
CLO 14					3											
CLO 15					2											

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO3, PO5	SEE Exams	PO1, PO2, PO3, PO5	Assignments	PO1,PO5	Seminars	PO2
Laboratory Practices	PO1	Student Viva	-	Mini Project	PO3	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES – INDIRECT

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

XIII. SYLLABUS

Unit-I	AIRCRAFT ENGINEERING MATERIALS
Engineering materials Steels, study of iron, iron carbon phase diagram, heat treatment-annealing, normalizing, hardening and tempering of Aluminum and steel, Non-Ferrous metals and Alloys: Structure and properties of copper and its alloys, Aluminum and its alloys, Titanium and its alloys, Corrosion - Types of Corrosions - Prevention – Protective Treatments.	
Unit-II	**CASTING, WELDING AND INSPECTION TECHNIQUES**
General principles of various casting processes Sand casting, die-casting, centrifugal casting, investment casting, Shell molding types; Principles and equipment used in arc welding, gas welding, resistance welding, solid, laser welding, and electron beam welding, soldering and brazing techniques. Need for NDT, ultrasonic testing, Radiographic testing, Flight testing.	
Unit-III	**SHEET METAL PROCESSES IN AIRCRAFT INDUSTRY**
Sheet metal operations: shearing, punching, super plastic forming; operations in bending like stretch forming spinning drawing. Riveting, types and techniques, equipment, fasteners, integral tanks, final assembly of aircraft, Jigs and Fixtures, stages of assembly, aircraft tooling concepts.	
Unit-IV	**CONVENTIONAL AND UNCONVENTIONAL MACHINING PROCESSES**
General working principles, applications and operations of lathe, shaper, milling machines, grinding, drilling machine, computer numeric control machining. Working principles and applications of abrasive jet machining, ultrasonic machining, Electric discharge machining and electro chemical machining, laser beam, electron beam, plasma arc machining.	
Unit-V	**AIRCRAFT COMPOSITES**
Introduction, Physical metallurgy, Wrought aluminum alloys, Cast aluminum alloys, Production of semi-fabricated forms, Aerospace applications, Plastics and rubber, Introduction to fiber reinforced plastics, glass and carbon composites; Fibers and resins; Characteristics and applications, Classification of aircraft materials; Materials used for aircraft components, Application of composite materials, Super alloys, indigenized alloys, emerging trends in aerospace materials.	
Text Books:	
1. S. Kalpakjian, Steven R. Schmid, "Manufacturing Engineering and Technology", Addison Wesley 5th Edition, 1991. 2. S. C. Keshu, K. K Ganapathy, "Aircraft production technology and management", Interline Publishing House, Bangalore, 3rd Edition, 1993. 3. Douglas F. Horne, "Aircraft production technology", Cambridge University Press, 1st Edition, 1986.	
REFERENCES:	
1. S. C. Keshu, K. K Ganapathy, "Air craft production techniques", Interline Publishing House, Bangalore, 3rd Edition, 1993. 2. R. K. Jain, "Production Technology", McGraw-Hill, 1st Edition, 2002. 3. O. P. Khanna, M. Lal, "Production Technology", Dhanpat Rai Publications, 5th Edition, 1997.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Engineering materials Steels, study of iron	CLO1	T2:5.5 R1:1.12.1
3-5	Iron carbon phase diagram	CLO1	T2:5.6 R1:1.12.3
6-7	Heat treatment-annealing, normalizing, hardening and tempering	CLO1	T2:5.10

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
	of Aluminum and steel, Non-Ferrous metals and Alloys		R1:1.15
8-10	Structure and properties of copper and its alloys, Aluminum and its alloys, Titanium and its alloys,	CLO2	T2:5.15 R1:1.16
11-12	Corrosion - Types of Corrosions - Prevention – Protective Treatments	CLO2	T2:5.17 R1:1.13.1
13-14	General principles of various Casting Processes - Sand casting, die-casting, centrifugal casting, investment casting.	CLO2	T2:5.18 R2:1.13.2
15-16	shell molding types	CLO3	T2:5.19 R1:1.13.3
17-21	Principles and equipment used in arc welding, gas welding	CLO3	T2:5.20 R1:1.17.1
22-23	Laser welding , Electron beam welding	CLO4	T2:5.24 R1:1.17.3
24-25	Soldering and brazing techniques	CLO4	T2:6.1 R1:2.3
26-27	Need for NDT, ultrasonic testing, Radiographic testing	CLO5	T2:6.3 R1:2.6.1
28-30	Sheet metal operations-shearing	CLO5	T2:6.5 R1:2.6.2
31-32	punching, super plastic forming and diffusion bonding	CLO6	T2:7.3 R1:2.8
33-34	Different operations in bending like stretch forming spinning drawing etc.	CLO6	T2:7.5,7.6 R1:2.9.2
35-36	types of equipment for riveted joints	CLO7	T2:7.7 R1:2.10
37-39	Aircraft tooling concepts and Jigs and Fixtures	CLO7	T2:7.7 R1:2.10
40-41	General principles of working and types of lathe	CLO8	T2:7.11 R2:2.10.2
42-44	Shaper, milling machines, grinding, drilling m/c, CNC machining and general principles.	CLO9	T2:7.11 R1:2.32
45-48	Plane turning, threading, tapering, grooving, knurling and chamfering	CLO9	T2:15.2 R1:8.2
49-50	Importance of CNC and Advantages	CLO10	T2:15.7 R2:8.3.3
51-52	Principles (with schematic diagram only) of working and applications of abrasive jet machining,	CLO10	T2:15.13 R1:8.7.2
53-54	USM, EDM, ECM and LBM operations	CLO11	T2:5.20 R1:1.17.1
55-57	Satellite missions, an operational satellite system, elements of satellite, satellite bus subsystems	CLO11	T2:5.24 R1:1.17.3
58-60	Introduction, Physical metallurgy, Wrought aluminum alloys, Cast aluminum alloys, Production of semi-fabricated forms	CLO12	T3:6.1 R1:2.3
61	Introduction to fiber reinforced plastics, glass and carbon composites; Fibers and resins.	CLO12	T2:6.3 R3:2.6.1
62-63	Characteristics and applications, Classification of aircraft materials;	CLO13	T2:6.5 R1:2.6.2
64-65	Materials used for aircraft components, Application of composite material	CLO13	T2:7.3 R1:2.8
67-66	Super alloys, indigenized alloys	CLO14	T3:7.5,7.6 R3:2.9.2
68	emerging trends in aerospace materials	CLO14	T3:7.7 R3:2.10

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

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Gain knowledge in unconventional machining process	Assignments	PO1,PO2	PSO1
2	Encourage students to make case studies on different advanced manufacturing methods	Seminars / Guest Lectures/ NPTEL	PO1,PO5	PSO1

Prepared by:

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HOD, AE

INSTITUTE OF AERONAUTICAL ENGINEERING

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Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**ANALYSIS OF AIRCRAFT STRUCTURES**				
Course Code	AAE006				
Programme	B.Tech				
Semester	IV				
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Dr. Y B Sudhir Sastry, Professor				
Course Faculty	Dr. Y B Sudhir Sastry, Professor				

I. COURSE OVERVIEW:

The primary objective of this course is to understand the different Aircraft structural component loads, and to equip the senior year aerospace engineering students with the relevant infrastructure to carry out the design of aircraft sub-structures like wings, fuselages, landing gears etc.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS007	I	Applied physics	4
UG	AME002	II	Engineering Mechanics	4
UG	AAE002	III	Theory of Structures	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIAExamination	Total Marks
Analysis of Aircraft Structures	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V. EVALUATION METHODOLOGY:

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

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

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

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

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

Table 1: Assessment pattern for CIA

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

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

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

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Presentation on real-world 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.	2	Seminar
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Assignment

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
PSO 2	**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	Assignments
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	2	Laboratory
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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the aircraft structural components and its behavior under different loading conditions
II	Obtain knowledge in plate buckling and structural instability of stiffened panels for airframe structural analysis.
III	Explain the thin walled section and structural idealization of panels and differentiate from the type of loads carried.
IV	Solve for stresses and deflection in aircraft structures like fuselage, wing and landing gear.

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
CAAE006.01	CLO 1	Discuss the Aircraft Structural components, various functions of the components and airframe loads acting on it.	PO 1	3
CAAE006.02	CLO 2	Discuss different types of structural joints and the effect of Aircraft inertia loads, Symmetricmaneuver loads, gust loads on the joints.	PO 1	3
CAAE006.03	CLO 3	Differentiate Monocoque and semi monocoque structures and analyze stresses in thin and thick shells.	PO 1	3
CAAE006.04	CLO 4	Explain energy principles and its application in the analysis of structural components of Aircraft.	PO 2	2
CAAE006.05	CLO 5	Explain the Theory of thin plates and Analyze thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading.	PO 1	3
CAAE006.06	CLO 6	Describe Buckling phenomena of thin plates and derive Elastic, inelastic, experimental determination of critical load for a flat plate.	PO 1, PO 2	2
CAAE006.07	CLO 7	Calculate the local instability, instability of stiffened panels, failure stresses in plates and stiffened panels.	PO 2	1
CAAE006.08	CLO 8	Discuss critical buckling load for flat plate with various loading and end conditions	PO 2	1
CAAE006.09	CLO 9	Solve for bending and shear stresses of symmetric and un-symmetric beams under loading conditions	PO 2	2
CAAE006.10	CLO 10	Solve for deflections of beams under loading with various approaches	PO 2	2
CAAE006.11	CLO 11	Calculate the shear stresses and shear flow distribution of thin walled sections subjected to shear loads.	PO 1	3
CAAE006.12	CLO 12	Explain Torsion phenomenon, Displacements and Warping associated with Bredt-Batho shear flow theory of beams.	PO 1	3
CAAE006.13	CLO 13	Explain the theory of Structural idealization	PO 1	3
CAAE006.14	CLO 14	Principal assumptions in the analysis of thin walled beams under bending, shear, torsion.	PO 1, PO 2	3
CAAE006.15	CLO 15	Solve for stress distribution of idealized thin walled sections subjected to bending.	PO 3	2
CAAE006.16	CLO 16	Solve for stress distribution of idealized thin walled sections subjected to, shear and torsion.	PO 2	2
CAAE006.17	CLO 17	Calculate and analysis of idealized thin walled sections subjected to bending	PO 2	3
CAAE006.18	CLO 18	Calculate and analysis of idealized thin walled sections subjected to shear and torsion.	PO 2	2
CAAE006.19	CLO 19	Analyze fuselage of variable stringer areas subjected to transverse and shear loads.	PO 3	3
CAAE006.20	CLO 20	Analyze Wing spar and box beams of variable stringer areas subjected to transverse and shear loads.	PO 3	3

3 = High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3												2			
CLO 2	3												2			
CLO 3	3															
CLO 4		2														
CLO 5	3													2	2	
CLO 6	3	3													2	
CLO 7		1												2		
CLO 8		1														
CLO 9		2														
CLO 10		2														
CLO 11	3													2		
CLO 12	3															
CLO 13	3															
CLO 14	3	3														
CLO 15			2													
CLO 16		2														
CLO 17		3														
CLO 18		2														
CLO 19			3											2		
CLO 20			3											2		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO2, PO3	SEE Exams	PO 1, PO2, PO3	Assignments	PO 3	Seminars	PO 2
Laboratory Practices	PO 3	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 TO AIRCRAFT STRUCTURAL COMPONENTS AND ENERGY METHODS
Aircraft Structural components and loads, functions of structural components, airframe loads; Types of structural joints, type of loads on structural joints; Aircraft inertia loads; Symmetric manoeuvre loads, gust loads. Monocoque and semi monocoque structures, stress in thin and thick shells; Introductions to energy principles, castiglianos theorems, max wells reciprocal theorem, unit load method, Rayleigh Ritz method, total potential energy method, flexibility method.	
UNIT-II	**THIN PLATE THEORY, STRUCTURAL INSTABILITY**
Analysis of thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading: Thin plates having small initial curvature, energy methods of analysis. Buckling of thin plates: Elastic, inelastic, experimental determination of critical load for a flat plate, local instability, instability of stiffened panels, failure stresses in plates and stiffened panels. Tension field beams- complete diagonal tension, incomplete diagonal tension, post buckling behavior.	
UNIT-III	**BENDING, SHEAR AND TORSION OF THIN WALLED BEAMS**
Unsymmetrical bending: Resolution of bending moments, direct stress distribution, position of neutral axis; Deflections due to bending: Approximations for thin walled sections, temperature effects; Shear loaded thin walled beams: General stress, strain and displacement relationships, direct stress and shear flow system, shear centre, twist and warping. Torsion of beams of closed section: Displacements associated with Bredt-Batho shear flow; Torsion of open section beams; Warping of cross section, conditions for zero warping; Bending, shear, torsion of combined open and closed section beams.	
UNIT-IV	**STRUCTURAL IDEALIZATION**
Structural idealization: Principal assumptions, idealization of panel, effect on the analysis of thin walled beams under bending, shear, torsion loading- application to determining deflection of open and closed section beams. Fuselage frames - bending, shear and torsion.	
UNIT-V	**ANALYSIS OF FUSELAGE, WING AND LANDING GEAR**
Wing spar and box beams, tapered wing spar, open and closed sections beams, beams having variable stringer areas; wings – three boom shell in bending, torsion and shear, tapered wings, deflections, cutouts in wings; Cutouts in fuselages; Fuselage frame and wing rib; principle of stiffener, web constructions. Landing gear and types; Analysis of landing gear.	
TEXT BOOKS:	
1. T. H. G. Megson, “Aircraft Structures”, Butterworth-Heinemann Ltd, 5th Edition, 2012. 2. E. H. Bruhn, “Analysis and Design of Flight vehicles Structures”, Tri-state off set company, USA, 4th Edition, 1965.	
REFERENCES:	
1. B. K. Donaldson, “Analysis of Aircraft Structures - An Introduction”, McGraw Hill, 3rd Edition, 1993. 2. S. Timoshenko, “Strength of Materials”, Volumes I and II, Princeton D. Von Nostrand Co., Reprint, 1977.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-3	Aircraft Structural components and loads.	CLO 1	T1:12.1
4-6	Functions of structural components, airframe loads.	CLO 1	T1:12.2
7-8	Types of structural joints, typeof loads on structural joints; Aircraft inertia loads.	CLO 2	T1:12.3
9-11	Symmetric maneuver loads, gust loads. Monocoque and semi monocoque structures, stress in thin and thick shells.	CLO 2, CLO 3	T1:14.2 R2:IV.25
12-14	Introductions to energy principles, castiglianos theorems, max wells reciprocal theorem, unit load method.	CLO 4	T1:5.5 T1:5.10
15-17	Rayleigh Ritz method, total potential energy method, flexibility method.	CLO 4	T1:5.6 T2:15.2
18-20	Analysis of thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading.	CLO 5	T2:C5.6 R1:22.5
21-23	Thin plates having small initial curvature, energy methods of analysis. Buckling of thin plates: Elastic, inelastic, experimental determination of critical load for a flat plate.	CLO 6	T1:9.1 R1:22.6
24-26	Local instability, instability of stiffened panels, failure stresses in plates and stiffened panels. Tension field beams-complete diagonal tension, incomplete diagonal tension, post buckling behavior.	CLO 7, CLO 8	T2:A18.20 T2:C11.1
27-30	Unsymmetrical bending: Resolution of bending moments, direct stress distribution, position of neutral axis.	CLO 9	T1:16.1
31-33	Deflections due to bending: Approximations for thin walled sections, temperature effects.	CLO 10	T1:16.6
34-37	Shear loaded thin walled beams: General stress, strain and displacement relationships, direct stress and shear flow system, shear centre, twist and warping.	CLO 11	T1:17.1
38-39	Torsion of beams of closed section: Displacements associated with Bredt-Batho shear flow; Torsion of open section beams.	CLO 12	T2:A6.4 R2:X.62
40	Warping of cross section, conditions for zero warping; Bending, shear, torsion of combined open and closed section beams.	CLO 12	T1:18.1.2
41	Structural idealization, Principal assumptions.	CLO 13	T1:20.1
42-44	Idealization of panel, effect on the analysis of thin walled beams under bending, shear, torsion loading.	CLO 14, CLO 15	T1:20.2
45-47	Application to determining deflection of open and closed section beams.	CLO 16	T1:16.3
48-50	Fuselage frames - bending, shear and torsion.	CLO 17, CLO 18	T1:24.2
51-53	Wing spar and box beams.	CLO 20	T2:A22.5
54-56	Open and closed sections beams, beams having variable stringer areas.	CLO 19	T1:27.1
57-59	Wings – three boom shell in bending, torsion and shear, tapered wings, deflections, cutouts in wings.	CLO 20	T1:23.8 T2:A19.14

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
60	Cutouts in fuselages; Fuselage frame and wing rib; principle of stiffener, web constructions. Landing gear and types; Analysis of landing gear.	CLO 20	T1:22.4 T2:A5.18

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Broad knowledge of engineering materials and material properties	Seminars / Guest Lectures/ NPTEL	PO 1	PSO 1
2	Practical Exposure about the stress deflections and stability of elements	Seminars / Guest Lectures / NPTEL	PO 3	PSO 3

Prepared by:
Dr. Y B Sudhir Sastry, Professor **HOD, AE**

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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**COMPLEX ANALYSIS AND PROBABILITY DISTRIBUTION**				
Course Code	AHS004				
Programme	B. Tech				
Semester	II	ECE			
	IV	AE | EEE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Ms. C Rachana, Assistant Professor				
Course Faculty	Mr. Ch Soma shekhar, Assistant Professor Mr. J Suresh Goud, Assistant Professor Ms. P Rajani, Assistant Professor				

I. COURSE OVERVIEW:

The course focuses on more advanced Engineering Mathematics topics which provide with the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes complex functions and differentiation, complex integration power series expansion of complex function and single random variables. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Complex Analysis And Probability Distribution	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	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	3	Seminar
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills**: Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	1	Seminar
PSO 2	**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	-	-
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		

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the basic theory of complex functions to express the power series.
II	Evaluate the contour integration using Cauchy residue theorem.
III	Enrich the knowledge of probability on single random variables and probability distributions.

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
AHS004.01	CLO 1	Define continuity, differentiability, analyticity of a function using limits.	PO 1	3
AHS004.02	CLO 2	Understand the conditions for a complex variable to be analytic and/or entire function.	PO 1	3
AHS004.03	CLO 3	Understand the concepts of Cauchy-Riemann relations and harmonic functions.	PO 2	3
AHS004.04	CLO 4	Understand the concept of complex differentiation to the real-world problems of	PO 4	1

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		signals modulated by electromagnetic waves.		
AHS004.05	CLO 5	Evaluate the area under a curve using the concepts of indefinite integration	PO 2	2
AHS004.06	CLO 6	Understand the concepts of the Cauchy's integral formula and the generalized Cauchy's integral formula.	PO 2	2
AHS004.07	CLO 7	Evaluate complex functions as power series and radius of convergence of power series.	PO 1	3
AHS004.08	CLO 8	Understand the concept of complex integration to the real-world problems of flow with circulation around a cylinder.	PO 4	1
AHS004.09	CLO 9	Solve the Taylor's and Laurent series expansion of complex functions	PO 2	3
AHS004.10	CLO 10	Understand the concept of different types of singularities for analytic function.	PO 1	3
AHS004.11	CLO 11	Evaluate poles, residues and solve integrals using Cauchy's residue theorem.	PO 1	3
AHS004.12	CLO 12	Evaluate bilinear transformation by cross ratio property.	PO 1	2
AHS004.13	CLO 13	Identify the conditions of fixed and critical point of Bilinear Transformation.	PO 4	2
AHS004.14	CLO 14	Understand the concept of Cauchy's residue theorem to the real-world problems of Quantum Mechanical scattering and Quantum theory of atomic collisions.	PO 4	2
AHS004.15	CLO 15	Demonstrate an understanding of the basic concepts of probability and random variables.	PO 4	2
AHS004.16	CLO 16	Classify the types of random variables and calculate mean, variance.	PO 2	3
AHS004.17	CLO 17	Finding moment about origin, central moments, moment generating function of probability distribution.	PO 2	3
AHS004.18	CLO 18	Understand the concept of random variables to the real-world problems like graph theory, machine learning and natural language processing	PO 4	3
AHS004.19	CLO 19	Recognize where the binomial distribution and poisson distribution could be appropriate model and find mean, variance of the distributions.	PO 1, PO 2	3
AHS004.20	CLO 20	Apply the inferential methods relating to the means of normal distributions.	PO 1, PO 2	3
AHS004.21	CLO 21	Understand binomial distribution to the phenomena of real-world problem like sick versus healthy.	PO 4	3
AHS004.22	CLO 22	Understand the mapping of normal distribution in real-world problem to analyze the stock market.	PO 1	3
AHS004.23	CLO 23	Use poission distribution in real-world problem to predict soccer scores.	PO 4	3
AHS010.24	CLO 24	Possess the knowledge and skills for employability and to succeed in national and international level competitive examinations.	PO 4	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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												1			
CLO 2	3												1			
CLO 3		3											1			
CLO 4				1												
CLO 5		2											1			
CLO 6		2											1			
CLO 7	3															
CLO 8				1												
CLO 9		3											1			
CLO 10	3												1			
CLO 11	3															
CLO 12	2															
CLO 13				2												
CLO 14				2									1			
CLO 15				2												
CLO 16		3														
CLO 17		3											1			
CLO 18				3									1			
CLO 19	3	2											1			
CLO 20	3	2											1			
CLO 21				3									1			
CLO 22	3															
CLO 23				3												
CLO 24				2												

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1,PO2, PO4	SEE Exams	PO1,PO2, PO4	Assignments	PO2	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

Unit-I	**COMPLEX FUNCTIONS AND DIFFERENTIATION**
Complex functions differentiation and integration: Complex functions and its representation on argand plane, concepts of limit, continuity, differentiability, analyticity, Cauchy-Riemann conditions and harmonic functions; Milne-Thomson method.	
Unit-II	**COMPLEX INTEGRATION**
Line integral: Evaluation along a path and by indefinite integration; Cauchy's integral theorem; Cauchy's integral formula; Generalized integral formula; Power series expansions of complex functions and contour Integration: Radius of convergence.	
Unit-III	**POWER SERIES EXPANSION OF COMPLEX FUNCTION**
Expansion in Taylor's series, Maclaurin's series and Laurent series. Singular point; Isolated singular point; Pole of order m; Essential singularity; Residue: Cauchy Residue Theorem. Evaluation of Residue by Laurent Series and Residue Theorem. Evaluation of integrals of the type $\int_0^{2\pi} f(\cos\theta,\sin\theta)d\theta$ and $\int_{-\infty}^{\infty} f(x)dx$ Bilinear Transformation	
Unit-IV	**SINGLE RANDOM VARIABLES**
Random variables: Discrete and continuous, probability distributions, mass function-density function of a probability distribution. Mathematical expectation. Moment about origin, central moments, moment generating function of probability distribution.	
Unit-V	**PROBABILITY DISTRIBUTIONS**
Binomial, Poisson and normal distributions and their properties.	
Text Books:	
1. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 10th Edition, 2010 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.	
Reference Books:	
1.T.K.V Iyengar, B.Krishna Gandhi, "Engineering Mathematics - III", S. Chand & Co., 12th Edition, 2015. 2. T.K.V Iyengar, B.Krishna Gandhi, "Probability and Statistics", S. Chand & Co., 7th Edition, 2015. 3. Churchill, R.V. and Brown, J.W, "Complex Variables and Applications", Tata Mc Graw-Hill, 8th Edition, 2012.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Understanding the complex function in Argand plane	CLO 1	T1:12.1 R1:4.2
2	Apply the limit of a complex function	CLO 1	T1:12.3 R1:4.4
3	Apply the continuity of a complex function	CLO 1	T1:12.3 R1:4.6
4	Apply the differentiability and analyticity of a complex function	CLO 1	T1:12.3 R1:4.7
5-6	Identify and Apply the of Cauchy-Riemann conditions in Cartesian and Polar forms	CLO 3	T1:12.4 R1:4.13
7	Evaluate the Harmonic Conjugates	CLO 3	T1:12.4 R1:4.15
8-9	Apply the Milne-Thomson method to find the Analytic function	CLO 3	T1:12.4 R1:4.20
10-11	Demonstrate the Line Integral for a given path	CLO 5	T1:13.1 R1:5.3
12	Analyze the Cauchy's integral theorem in a given plane	CLO 5	T1:13.2 R1:5.5
13-14	Explain the Cauchy's integral formula	CLO 6	T1:13.3 R1:5.9
15-16	Analyze the Cauchy's general integral formula	CLO 6	T1:13.4 R1:5.10
17	Define the Power series expansions of complex functions and contour Integration	CLO 7	T1:14.1 R1:6.1
18	Evaluate the Radius of convergence of power series complex function	CLO 7	T1:14.2 R1:6.1
19-20	Identify the types of power series expansions	CLO 7	T1:14.4 R1:6.2
21	Define the types of Singularities and its nature	CLO 10	T1:15.2 R1:6.6
22	Define the concept of Residues	CLO 11	T1:15.1 R1:7.4
23-24	Evaluate the Residue	CLO 11	T1:15.1 R1:6.5
25	Evaluate of contour integrals	CLO 11	T1:15.3 R1:7.9
26	Analyze the properties of Bilinear transformation	CLO 12	T1:12.5 R1:8.8
27	Understand the basic concepts of Random variables	CLO 15	T2:26.7 R2:2.2
28-29	Understand the types of Probability distributions	CLO 16	T2:26.8 R2:2.6
30-31	Evaluate the Mass function, Density function	CLO 15	T2:26.8 R2:2.7
32	Define the Expectations of Probability Distribution	CLO 16	T2:26.10 R2:2.6
33-34	Evaluate the Moment and Central moments	CLO 17	T2:25.9 R2:3.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
35-36	Evaluate the Moment Generating functions	CLO 17	T2:26.11 R2:3.5
37-39	Understand and Apply the Binomial Distribution parameters	CLO 21	T2:26.14 R2:4.4
40-42	Understand and Apply the Poisson Distribution parameters	CLO 23	T2:26.15 R2:4.10
43-45	Understand and Apply the Normal Distribution parameters	CLO 20	T2:26.16 R2:4.15

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Problem reductions, Conformal mapping	Seminars	PO 1	PSO 1
2	In order to monitor the quality of products to plan effective and efficient designs to improve standards to test and analyze the quality of items	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students based on the taught statements to solve problems	NPTEL	PO 2	PSO 1

Prepared by:
Ms. C Rachana, Assistant Professor

HOD, AERONAUTICAL ENGINEERING

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**THERMODYNAMICS**				
Course Code	AME003				
Programme	B.Tech				
Semester	IV	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. R.Sabari Vihar, Assistant Professor				

I. COURSE OVERVIEW:

Thermodynamics is the science that deals with the relationship between heat and work and those properties of systems that bear relation to heat and work. General laws of energy transformations concerning all types of systems, mechanical, electrical and chemical may fall within the purview of this science. It is a science based on a number of empirical laws formed by experimentation from which all predictions concerning the physical behavior of the system may be deduced by logical reasoning. The findings have been formalized into certain basic laws, which are known as Zeroth, First, Second and third laws of thermodynamics. Power cycles and refrigeration cycle based on thermodynamic system is studied.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic concepts of Mathematics and Physics

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Thermodynamics	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	10	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	3	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	Videos

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.	**-**	**-**
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 laws of thermodynamics and determine thermodynamic properties, gas laws.
II	Apply Knowledge of properties during various phases of pure substances, mixtures, usage of steam tables and Mollier chart, psychometric charts.
III	Understand the direction law and concept of increase in entropy of universe.
IV	Understand the working of ideal air standard, vapor cycles and evaluate their performance in open systems like steam power plants, internal combustion engines, gas turbines and refrigeration systems.

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
AME003.01	CLO 1	Understand various forms of energy, mechanisms of energy transfer, the concept of energy transfer, the concept of temperature, energy balance, energy conservation and conversion efficiency using familiar processes that involver mostly mechanical forms of energy.	PO 1	3
AME003.02	CLO 2	Demonstrate knowledge of ability to identify & apply fundamentals to solve problems like system properties, amount of work transfer and heat during various processes.	PO 1 PO 2	3
AME003.03	CLO 3	Explore knowledge & ability to design the thermal related components in various fields of energy transfer equipment.	PO 1 PO 3	3
AME003.04	CLO 4	Derive the first law of Thermodynamics from the concept of conservation of energy	PO 1	3
AME003.05	CLO 5	Discuss the nature of steady and unsteady processes under the influence of time	PO 1	3
AME003.06	CLO 6	Develop the second law of thermodynamics from the limitations of first law.	PO 1	2
AME003.07	CLO 7	Determine entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations based on Carnot Cycle	PO 1 PO 2	3
AME003.08	CLO 8	Understand the inter relationship between thermodynamic functions and an ability to use such relationships to solve practical problems	PO 3	2
AME003.09	CLO 9	Knowledge of the Gibbs and Helmholtz free energies as equilibrium criteria, and the statement of the equilibrium condition for closed and open systems	PO 1	2
AME003.10	CLO 10	Determine the equilibrium states of a wide range of systems, ranging from mixtures of gases, liquids, solids and pure condensed phases that can each include multiple components.	PO 2	3
AME003.11	CLO 11	Discuss pressure-temperature, volume-temperature, pressure-volume phase diagrams and the steam tables in the analysis of engineering devices and systems.	PO 2	3
AME003.12	CLO 12	Develop the Third Law of Thermodynamics from the concept of absolute thermodynamic scale and describe its significance.	PO 1	3
AME003.13	CLO 13	Understand the process of psychrometry that are used in the analysis of engineering devices like air conditioning systems	PO 3	2
AME003.14	CLO 14	Introduction to concepts of power and refrigeration cycles. Their efficiency and coefficients of performance.	PO 2 PO 3	3
AME003.15	CLO 15	Ability to use modern engineering tools,	PO 3	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		software and equipment to analyze energy transfer in required air-condition application.		
AME003.16	CLO 16	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc.	PO 3	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												2			
CLO 2	3	3											1			
CLO 3	3		2										2			
CLO 4	3												2			
CLO 5	3												2			
CLO 6	3												2			
CLO 7	3	3											2			
CLO 8			2													
CLO 9	3												2			
CLO 10		3														
CLO 11		3														
CLO 12	3												2			
CLO 13		3														
CLO 14		3	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	SEE Exams	PO 1, PO 2, PO 3	Assignments	PO 1, PO 2	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	BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS
Basic Concepts: System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle, Reversibility, Quasi static Process, Irreversible Process, Causes of Irreversibility, Various flow and non-flow processes ,Energy in State and in Transition, Types-Work and Heat, Point and Path function., Zeroth Law of Thermodynamics, Concept of quality of Temperature, Principles of Thermometry, Reference Points, Constant Volume gas Thermometer, Ideal Gas Scale, PMMI - Joule's Experiments, First law of Thermodynamics, Corollaries First law applied to a Process, Applied to a flow system, Steady Flow Energy Equation.	
Unit-II	**SECOND LAW OF THERMODYNAMICS**
Limitations of the first law: Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance, Second Law of Thermodynamics, Kelvin Planck and Clausius Statements and their Equivalence / Corollaries, PMM of Second kind, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase, Availability and Irreversibility, Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations, Elementary Treatment of the Third Law of Thermodynamics.	
Unit-III	**PURE SUBSTANCES**
Phase Transformations, T-S and h-s diagrams, P-V-T- surfaces, Triple point at critical state properties during change of phase, Dryness Fraction, Mollier charts, Various Thermodynamic processes and energy Transfer, Steam Calorimeter. Perfect Gas Laws: Equation of State, Specific and Universal Gas constants, Throttling and Free Expansion Processes, Deviations from perfect Gas Model, Vander Waals Equation of State.	
Unit-IV	**MIXTURE OF PERFECT GASES**
Mole Fraction, Mass friction, Gravimetric and volumetric Analysis, Volume fraction, Dalton's Law of partial pressure, Avogadro's Laws of additive volumes, and partial pressure, Equivalent Gas constant, Internal Energy, Enthalpy, sp. Heats and Entropy of Mixture of perfect Gases . Psychrometric properties-Dry bulb temperature, wet bulb temperature, specific humidity, Relative humidity, saturated air, Degree of saturation-adiabatic saturation, carrier equation, psychrometric chart.	
Unit-V	**POWER CYCLES**
Otto, Diesel, Dual Combustion cycles, Description and representation on P-V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis, comparison of Cycles, Introduction to Brayton cycle and Bell Coleman cycle.	
Text Books:	
1. P. K. Nag, "Engineering Thermodynamics", Tata McGraw Hill Publishers, 5th Edition, 2013. 2. Yunus Cengel, Michael A. Boles, "Thermodynamics-An Engineering Approach", Tata McGraw Hill publishers, 8th Edition, 2014.	
Reference Books:	
1. J. B. Jones, R. E. Dugan, "Engineering Thermodynamics", Prentice Hall of India Learning. 2. Y. V. C. Rao, "An Introduction to Thermodynamics", Universities Press. 3. K. Ramakrishna, "Engineering Thermodynamics", Anuradha Publishers. 4. J.P Holman, "Thermodynamics" Tata McGraw Hill Publishers.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Basics concepts of Thermodynamics: Surrounding, Boundaries, Universe, Types of Systems, properties	CLO 1	T1:1.7 T2:1-3
2	Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium	CLO 2	T1:1.13 T2:1-4
3	State, Property, Process, Cycle, Reversibility, Quasi static Process, Irreversible Process, Causes of Irreversibility	CLO 1	T1:1.11 T2:1-3
4	Various flow and non-flow processes	CLO 1	T1:5.6 T2:2-5
5	Energy in State and in Transition, Types-Work and Heat, Point and Path function	CLO 2	T1:3.2 T2:2-4
6	Zeroth Law of Thermodynamics, Concept of quality of Temperature, Principles of Thermometry, Reference Points	CLO 3	T1:2.1 T2:1-8
7	Constant Volume gas Thermometer, Ideal Gas Scale, PMMI	CLO 1	T1:2.5 T2:1-8
8	Joule's Experiments, First law of Thermodynamics, Corollaries First law applied to a Process	CLO 4	T1:3.6 T2:2-6
9-10	Applied to a flow system, Steady Flow Energy Equation	CLO 5	T1:5.3 T2:2-6
11	Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance	CLO 6	T1:6.3 T2:6-1
12	Second Law of Thermodynamics, Kelvin Planck Statement	CLO 6	T1:6.4 T2:6-4
13-14	Clausius Statements and their Equivalence / Corollaries, PMM of Second kind, Carnot's principle	CLO 7	T1:6.5 T2:6-5
15-16	Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality	CLO 7	T1:6.11 T2:6-6
17-19	Entropy, Principle of Entropy Increase, Availability and Irreversibility, Thermodynamic Potentials, Gibbs and Helmholtz Functions	CLO 9	T1:6.9 T2:7-2
20-22	Maxwell Relations, Elementary Treatment of the third Law of Thermodynamics	CLO 12	T1:11.2 T2:12-2
23-24	Pure Substances: Phase Transformations, T-S and H-S diagrams, P-V-T- Surfaces	CLO 11	T1:9.2 T2:3-4
24-25	T-S And H-S diagrams, P-V-T- Surfaces	CLO 11	T1:9.4 T2:3-4
26	Triple Point At Critical State Properties During Change Of Phase	CLO 10	T1:9.5 T2:1-3
27-28	Dryness Fraction, Mollier Charts, Problems	CLO 10	T1:9.5 T2:1-3
29-30	Various Thermodynamic Processes And Energy Transfer, Steam Calorimeter, Problems	CLO 02	T1:9.6
31-32	Perfect Gas Laws: Equation Of State	CLO 10	T1:10.2 T2:13-1
33	Specific and Universal Gas Constants	CLO 10	T1:10.3 T2:13-1
34-35	Throttling and Free Expansion Processes	CLO 10	T1:10.5 T2:13-2
36	Deviations from Perfect Gas Model	CLO 11	T1:10.6 T2:13-3
37-39	Vander Waals Equation of State	CLO 11	T1:10.4
40-41	Mixtures of Perfect Gases: Mole Fraction, Mass Friction	CLO 10	T1:10.8 T2:13-3

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
42	Gravimetric And Volumetric Analysis, Volume Fraction, Problems	CLO 10	T1:10.8 T2:13-2
43-44	Dalton's Law of Partial Pressure	CLO 10	T1:10.8 T2:13-2
45-46	Avogadro's Laws of Additive Volumes and Partial Pressure	CLO 11	T1:10.7 T2:13-3
47	Equivalent Gas Constant, Internal Energy, Enthalpy	CLO 10	T1:10.9 T2:13-1
48-49	Sp. Heats And Entropy of Mixture of Perfect Gases, Problems	CLO 08	T1:10.9 T2:13-2
50-51	Psychrometric Properties-Dry Bulb Temperature, Wet Bulb Temperature	CLO 13	T1:15.1 T2:14-1
52	Specific Humidity, Relative Humidity	CLO 12	T1:15.2 T2:14-2
53	Saturated Air, Degree of Saturation-Adiabatic Saturation	CLO 12	T1:15.2 T2:14-4
54	Carrier Equation, Psychrometric Chart	CLO 13	T1:15.3 T2:14-5
55-56	Power Cycles: Otto Cycle	CLO 14	T1:13.6 T2:9-5
57	Diesel, Dual Combustion Cycles	CLO 14	T1:13.6 T2:9-6
58	Description and Representation on P-V And T-S Diagram	CLO 14	T1:13.8 T2:9-5
59-60	Thermal Efficiency, Mean Effective Pressures on Air Standard Basis	CLO 14	T1:13.8 T2:9-6
61	Comparison of Cycles	CLO 14	T1:13.9 T2:9-5
62	Introduction to Brayton Cycle And Bell Coleman Cycle	CLO 14	T1:13.12 T2:9-8

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Directional law applied to automobile sector	Guest Lecture/Seminar	PO1,PO2,PO4	PSO 2
2	Gas laws applied to cooling of electronic chips	Seminars	PO 5	PSO 2, PSO 3
3	Cooling of spindle bearings by using chillers	Seminars	PO 3	PSO 1, PSO 3

Prepared by:
Ms. Ch.Ragha Leena, Assistant Professor

HOD, AE

V SEMESTER

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**AIRCRAFT PROPULSION**				
Course Code	AAE007				
Programme	B.Tech				
Semester	V	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	3	2
Chief Coordinator	Dr. Maruthupandiyan K, Associate Professor				
Course Faculty	Dr. Maruthupandiyan K, Associate Professor Mr. Shiva Prasad, Assistant Professor				

I. COURSE OVERVIEW:

This course presents aerospace propulsive devices as systems, with functional requirements and engineering and environmental limitations along with requirements and limitations that constrain design choices. Both air-breathing and rocket engines are covered, at a level which enables rational integration of the propulsive system into an overall vehicle design. Mission analysis, fundamental performance relations, and exemplary design solutions are presented.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME003	IV	Thermodynamics	4
UG	AAE003	III	Fluid Mechanics and Hydraulics	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Aircraft Propulsion	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	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Seminar
PO 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.	3	Designing
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Assignments

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	1	Seminar
PSO 2	**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	Tutorials
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	3	Mini project
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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Analyze parametric cyclic analysis, performance parameters, efficiency, and specific impulse of all air breathing engines.
II	Know the design and performance of subsonic and supersonic inlets, types of combustion chambers and factors affecting the combustors
III	Discuss the types of nozzles, flow conditions in nozzles, interaction of nozzle flow with adjacent surfaces and thrust reversal
IV	Explain different types of compressors and turbines, work done, velocity diagrams and stage efficiency calculations.

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
CAAE007.01	CLO 1	Apply knowledge and understand the essential facts, concepts and principles of thermodynamics.	PO 1	3
CAAE007.02	CLO 2	Understand the basic function of all aircraft engine components and how they work.	PO 1	3
CAAE007.03	CLO 3	Analyze the engine performance parameters and parameters influencing them.	PO 1	3
CAAE007.04	CLO 4	Understand the impact of performance parameters on endurance and range how they affect the aircraft performance.	PO 2	2
CAAE007.05	CLO 5	Demonstrate different type's aircraft engine operating principle.	PO 4	1
CAAE007.06	CLO 6	Understand step by step procedure of engine parametric cycle analysis.	PO 3	3
CAAE007.07	CLO 7	Understand steps involved in performance analysis of all aircraft engine.	PO 3	3
CAAE007.08	CLO 8	Describe operational modes of subsonic inlets and parameters influencing it.	PO 1, PO 3	3
CAAE007.09	CLO 9	Analyze diffuser performance, losses in it and their impact on engine performance.	PO 3	3
CAAE007.10	CLO 10	Describe supersonic inlets, starting problem in it and their operating modes.	PO 1	3
CAAE007.11	CLO 11	Understand different types of combustion chamber and functions of all the components.	PO 1, PO 2	2
CAAE007.12	CLO 12	Analyze combustion chamber performance and parameters influencing them.	PO 1	3
CAAE007.13	CLO 13	Describe theory of flow in isentropic nozzle and physics behind nozzle operation.	PO 1, PO 2	2
CAAE007.14	CLO 14	Understand different nozzle operating conditions for convergent and divergent nozzle.	PO 1, PO 3	2
CAAE007.15	CLO 15	Describe principle of operation of axial and centrifugal compressor.	PO 1, PO 4	2
CAAE007.16	CLO 16	Understand different design of compressor and limitations of each method.	PO 1, PO 3	3
CAAE007.17	CLO 17	Analyze performance characteristics of axial and centrifugal compressor.	PO 2, PO 4	1
CAAE007.18	CLO 18	Describe principle of operation of centrifugal and axial flow turbine.	PO 1, PO 4	3
CAAE007.19	CLO 19	Understand different design of axial and centrifugal turbine.	PO 1, PO 3	3
CAAE007.20	CLO 20	Design of ramjet engine and steps involved in it.	PO 2, PO 4	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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												1			
CLO 2	3												1			
CLO 3	3												1		3	
CLO 4		2														
CLO 5				1											3	
CLO 6			3													
CLO 7			3													
CLO 8	3		3											2		
CLO 9			3										1	2	3	
CLO 10	3															
CLO 11	3	2														
CLO 12	3														3	
CLO 13	3	2														
CLO 14	3		3										1	2		
CLO 15	3			1												
CLO 16	3		3											2		
CLO 17		2		1									1			
CLO 18	3			1												
CLO 19	3		3										1		3	
CLO 20		2		1										2		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 3, PO 4	SEE Exams	PO 1, PO 2 PO 3, PO 4	Assignments	PO 1, PO 2	Seminars	PO 2
Laboratory Practices	PO2, PO 3 PO 4	Student Viva	-	Mini Project	PO 3	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

UNIT-I	**AIR-BREATHING ENGINES**
Classification, operational envelopes; Description and function of gas generator, turbojet, turbofan, turboprop, turbo shaft, ramjet, scramjet, turbojet/ramjet combined cycle engine; Engine thrust, takeoff thrust, installed thrust, thrust equation; Engine performance parameters, specific thrust, specific fuel consumption and specific impulse, thermal efficiency, propulsive efficiency, engine overall efficiency and its impact on aircraft range and endurance; Engine cycle analysis and performance analysis for turbojet, turbojet with afterburner, turbofan engine, turboprop engine.	
UNIT -II	**INLETS AND COMBUSTION CHAMBERS**
Internal flow and stall in subsonic inlets, relation between minimum area ratio and eternal deceleration ratio, diffuser performance, supersonic inlets, starting problem on supersonic inlets, shock swallowing by area variation; Classification of combustion chambers, combustion chamber performance, effect of operating variables on performance, flame stabilization.	
UNIT-III	**NOZZLES**
Theory of flow in isentropic nozzles, nozzles and choking, nozzle throat conditions, nozzle efficiency, losses in nozzles. Over expanded and under expanded nozzles, ejector and variable area nozzles, interaction of nozzle flow with adjacent surfaces, thrust reversal.	
UNIT-IV	**COMPRESSORS**
Principle of operation of centrifugal compressor and axial flow compressor, work done and pressure rise, velocity triangles, degree of reaction, free vortex and constant reaction designs of axial flow compressor, performance characteristics of centrifugal and axial flow compressors, stage efficiency calculations, cascade testing.	
UNIT-V	**TURBINES**
Principle of operation of axial flow turbines, limitations of radial flow turbines, work done and pressure rise, velocity triangles, degree of reaction, free vortex and constant angle designs, performance characteristics, sample ramjet design calculations, flame stability problems in ramjet combustors, integral ram rockets.	
Text Books:	
1. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" ,Addison Wesley Longman INC, 1999. 2. Mattingly J.D., "Elements of Propulsion: Gas Turbines and Rocket", AIAA, 1991.	
Reference Books:	
1. Cohen, H.Rogers, G.F.C. and Saravanamuttoo, H.I.H,"Gas Turbine Theory", Longman, 1989. 2. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Definefunction of gas generator	CLO 1	T2 4.1
3	Define engine thrust, takeoff thrust	CLO 2	T2 4.2
4-5	Explain thrust equation	CLO 2	T1 2.2-2.4
6-8	Explain performance parameters	CLO 3	T2 6.3-6.4
9-10	Discuss engine cycle analysis	CLO 5	T2 5.1-5.8
11-12	Analyze problems on performance analysis	CLO 5	T2 5.1-5.8
13	Define stall in inlets	CLO 6	T1 6.1-6.3
14-15	Explain relation between minimum area ratio and external acceleration	CLO 6	T1 6.1-6.3
16-18	Explain starting problemon supersonic inlets	CLO 7	T1 6.1-6.3
19	Discuss shock swallowing by area variation	CLO 8	T1 6.1-6.3
20	Classify combustion chamber	CLO 9	T1 6.4-6.5 R1 6.1- 6.4
21	Explain combustion chamber performance	CLO 11	R1 6.1- 6.4
23	Discuss effect of operating variables on performance	CLO 11	R1 6.1- 6.4
24	Define flame stabilization	CLO 11	R1 6.5- 6.8
25-26	Explain theory of flow in nozzle	CLO 12	T2 6.6-6.7
27	Define nozzle choaking	CLO 9	T2 6.6-6.7
28	Discuss nozzle throat conditions	CLO 12	T2 6.6-6.7
29-30	Analyze problems in nozzle efficiency	CLO 15	T2 6.6-6.7
31-32	Explain overexpanded and under expanded nozzle	CLO 15	T2 6.6-6.7
33-34	Discuss variable area nozzle	CLO 15	T2 6.6-6.7
36-36	Explain thrust reversal	CLO 15	T2 6.6-6.7
37-39	Explain principle of operation of compressor	CLO 11	R1 5.1- 5.4
40-41	Discuss work done and pressure rise	CLO 13	R1 6.3- 6.4
42	Design velocity triangle	CLO 13	R1 5.1- 5.4
43	Define degree of reaction	CLO 11	R1 6.3- 6.4
44	Discuss free vortex and constant reaction design	CLO 04	R1 .1- 6.4

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
45-46	Discuss performance characteristics of centrifugal compressor	CLO 14	R1 5.1- 5.4
47	Calculate stage efficiency	CLO 15	R1 5.1- 5.4
48	Explain principle of operation of turbine	CLO 16	R1 7.1- 7.4
49	Discuss limitation of radial flow turbines	CLO 16	R1 7.1- 7.4
50-52	Discuss work done and pressure rise	CLO 17	R1 7.1- 7.4
53-54	Design velocity triangle	CLO 17	R1 7.1- 7.4
55-56	Discuss free vortex and constant reaction design	CLO 18	R1 7.1- 7.4
57-58	Solve problems in ramjet design	CLO 19	T1 5.3- 5.4
59	Explainflame stability in ramjet combustors	CLO 19	T1 5.3- 5.4
60	Discuss integral ram rockets	CLO 20	T1 5.3- 5.4

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

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Design of gas turbine for industrial applications	Guest lecture/Industrial visit	PO1,PO2,PO4	PSO2
2	Design and development of compressor for steam turbine application	Seminar/ Guest Lecture	PO3,PO4,	PSO2,
3	Design and development of micro gas turbine	Seminar/ Guest Lecture	PO3,PO4	PSO2,PSO3

Prepared by:
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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:	
1. Tirupathi. R. Chandrapatla, Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Printice Hall India, 3rd Edition, 2003. 2. Rao. S.S., "Finite Element Methods in Engineering," Butterworth and Heinemann, 2001. 3. Reddy J.N., "An Introduction to Finite Element Method", McGraw Hill, 2000.	
Reference Books:	
1. Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw Hill, 2000. 2. K. J. Bathe, E. L. Wilson, "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985. 3. Robert D Cook, David S Malkus, Michael E Plesha, "Concepts and Applications of Finite Element Analysis", 4th edition, John Wiley and Sons, Inc., 2003. 4. Larry J Segerlind, "Applied Finite Element Analysis", 2nd Edition, John Wiley and Sons, Inc. 1984.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	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

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

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

Prepared by:
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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**AIRCRAFT SYSTEMS AND CONTROL**				
Course Code	AAE010				
Programme	B.Tech				
Semester	V	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Ms. G Sravanthi, Assistant Professor				
Course Faculty	Ms. G Sravanthi, Assistant Professor Mr. P.Anudeep, Assistant Professor				

I. COURSE OVERVIEW:

Aircraft Systems is a course of primary important to Aeronautical Engineering students. The aim is to impart the meaning of system in generic .The course covers, the main branching of Aircraft System Systems sub systems based on functionalities .These describes the working principles and their importance to aircraft. The course also gives basic knowledge of design procedures, failure severities Safety measures of system.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AAE003	III	Fluid Mechanics And Hydraulics	3

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Aircraft Systems And Control	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.	2	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	Seminars
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	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** 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	Seminars
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	1	Assignments
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	Explain the concept and meaning of system and classify the various systems required for aircraft and their contribution in order to fulfill the aircraft tasks.
II	Describe the various types of Electrical power generations and distribution in aircraft and impart the knowledge of pneumatic, hydraulic and environmental control system.
III	Demonstrate the different flight control actuators and flight control system and fly-by-wire control laws and give knowledge about the landing gears systems and brake management system.
IV	Explain the concept of different aircraft gas turbine engines and their control systems and describe the fuel system characteristics and their operating modes and knowledge about the fuel safety management.

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
AAE0010.01	CLO1	Define the meaning of the system and its characteristics and identify different types of aircraft systems.	PO1	2
AAE0010.02	CLO2	Describe the various electrical power generations in the aircraft and discover more electric aircraft.	PO1	2
AAE0010.03	CLO3	Estimate the electrical power requirements and can optimize the load distribution.	PO1	2
AAE0010.04	CLO4	Describe the importance of hydraulic systems and its components and develop hydraulic systems.	PO1	2
AAE0010.05	CLO5	Illustrate the importance and criticality of landing gears.	PO3	2
AAE0010.06	CLO6	Recognize the applications of pneumatic systems and the application of the bleed air.	PO2	2
AAE0010.07	CLO7	Classify the various types of engine control system including advanced digital controls.	PO3	2
AAE0010.08	CLO8	Identify important flight control operations and selects suitable flight control actuations.	PO2	1
AAE0010.09	CLO9	Demonstrate the various types of air conditioning systems and vapour cycle systems.	PO3	1
AAE0010.10	CLO10	Identify the environmental control systems relating to aircraft systems.	PO3	3
AAE0010.11	CLO11	Classify the types of hydraulic fluids applied in aircraft industry and advancement in it.	PO2	2
AAE0010.12	CLO12	Estimate the various fuel inerting systems and indications for aircraft systems.	PO3	3
AAE0010.13	CLO13	Illustrate the importance of fly-by-wire technology in aircraft systems.	PO2	1
AAE0010.14	CLO14	Describe the pneumatics systems and its components.	PO3	1
AAE0010.15	CLO15	Estimate the various engine performances and their application in aircraft systems.	PO3	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	2												1			
CLO 2	1															

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 3	2													2		
CLO 4	2													1		
CLO 5			2											3		
CLO 6		2													1	
CLO 7			2												1	
CLO 8		1												3		
CLO 9			1										3			
CLO 10			3												1	
CLO 11		2											1			
CLO 12			3										2			
CLO 13		1													2	
CLO 14			1										1			
CLO 15			2											2		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1, PO2, PO3	SEE Exams	PO1, PO2, PO3	Assignments	PO1	Seminars	PO2, PO3
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 TO AIRCRAFT SYSTEMS
System concepts, everyday examples of systems, sub-systems; Generic system definition, inputs, outputs, feedback, external influence. Aircraft systems- airframe systems, vehicle systems, avionics systems, mission systems and their sub-systems; Specification of requirements, mission requirements, performance requirements; Operating environment conditions.	

UNIT-II	ELECTRICAL SYSTEMS AND AIR CONDITIONING, PRESSURIZING SYSTEMS
Electrical loads in aircraft. Electrical power generation and control- DC, AC- types. Power distribution primary, secondary. Power conversion and energy storage; Load protection; Electrical load management systems, variable speed constant frequency (VSCS) cycloconverter, 270 V DC systems; Basic air cycle systems; Vapour cycle systems, boost-strap air cycle system; Evaporative vapour cycle systems; Evaporative air cycle systems; Oxygen systems; Fire protection systems, deicing and anti icing systems.	
UNIT-III	**HYDRAULIC SYSTEMS AND PNEUMATIC SYSTEMS**
Hydraulic systems: Study of typical workable system, function, merits, application, system loads, design requirements; Principal components; Hydraulic fluid: required properties, operating fluid pressures, temperatures, and flow rates; Hydraulic piping, pumps, reservoir, accumulator; Landing gear and brake management systems. Pneumatic systems ; Advantages;- Working principles ; Typical air pressure system ; Brake system; Typical pneumatic power system ; Components, landing gear systems ; Classification.	
UNIT-IV	**ENGINE CONTROL AND FUEL SYSTEMS**
Principle of operation of aircraft gas turbine engines; Engine - airframe interfaces; Control of fuel flow, air flow, exhaust gas flow- need, means, system parameters, basic inputs and outputs; Limited authority control systems, full authority control systems- examples; Engine monitoring- sensors, indicators; Power off takes- need, types, effect on engine performance; Fuel systems- characteristics, components, operating modes; Fuel tank safety- fuel inserting system.	
UNIT-V	**AIRPLANE CONTROL SYSTEMS**
Flight control systems- primary and secondary flight control conventional systems; Power assisted and fully powered flight controls ; Power actuated systems; Engine control systems; Push pull rod system; Components; Modern control systems; Digital fly by wire systems , control laws, implementation; Auto pilot system active control technology, communication and navigation systems instrument landing systems; Control linkages, actuation- types, description and redundancy.	
Text Books:	
1. Moir, I. and Sea bridge, A, ―Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration‖, John Wiley, 3rd Edition 2008. 2. Moir, I. and Sea bridge, A, ―Design and Development of Aircraft Systems- An Introduction‖, AIAA Education Series‖, AIAA, 2004.	
Reference Books:	
1. Pallett, E.H.J., ―Aircraft Instruments and Integrated Systems‖, Longman Scientific &Technical 10th edition, 1992. 2. Harris, D, ―Flight Instruments and Automatic Flight Control Systems‖, 6th edition, 2004. 3. Bolton, W., "Pneumatic and Hydraulic Systems", Butterworth-Heinemann.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-3	Aircraft systems- airframe systems.	CLO 1	T2:2.4
4-7	vehicle systems, avionics systems, mission systems and their sub-Systems.	CLO 2	T2:2.4.3
8-10	Specification of requirements- mission requirements, performance requirements	CLO 2	T2:2.5
11-13	Operating environment conditions.	CLO 3	T2:7.4
14-15	Electrical loads in aircraft.	CLO 5	T1:3.1
16-18	Electrical power generation and control- DC, AC- types.	CLO 5	T1:3.1.1
19-20	Power distribution- primary, secondary	CLO 7	T1:3.2
21-22	Power conversion and energy storage. Load protection.	CLO 7	T1:3.4

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
23-25	Advanced systems- electrical load management systems, variable speed constant frequency (VSCS), Cycloconverter, 270 V DC systems.	CLO 7	T1:3.5
26-28	Basic air cycle systems, Vapour cycle systems, boost-strap air cycle system.	CLO 7	T1:4.2
29-31	Evaporative vapour cycle systems, Evaporative air cycle systems, Oxygen systems.	CLO 8	T1:4.3
32	Fire protection systems, deicing and anti icing systems.	CLO 8	T1:4.5
33	Aircraft hydraulic systems- function, merits, application, system loads, design requirements.	CLO 8	T1:5.1
34	Principal components, description, applications.	CLO 8	T1:5.2
35	Hydraulic fluid- required properties, operating fluid pressures, temperatures, and flow rates Hydraulic piping, pumps, reservoir, accumulator	CLO 8	T1:5.3
36	Landing gear and brake management systems, Brake management systems.	CLO 8	T1:5.9
37	Pneumatic systems, advantages, working principles.	CLO 9	T1:6.1
38	Typical air pressure system, Brake system, Typical pneumatic power system, Components.	CLO 9	T1:6.2
39	Landing gear systems, Classification.	CLO 9	T1:5.9
40	Principle of operation of aircraft gas turbine engines.	CLO 10	T1:9.1
41	Engine - airframe interfaces; Control of fuel flow, air flow, exhaust gas flow- need, means, system parameters, basic inputs and outputs	CLO 11	T1:9.2
42	Limited authority control systems, full authority control systems- examples. Engine monitoring- sensors, indicators.	CLO 11	T1:9.3
43	Power off takes- need, types, effect on engine performance. Fuel systems- characteristics, components, operating modes.	CLO 12	T1:9.4
44	Flight control systems- primary and secondary flight control conventional systems.	CLO 13	T1:9.5
45	Systems control linkages, actuation- types, and description.	CLO 14	T1:3.6
46	Redundancy. Fly-by-wire control- control laws, Fly- by-wire control-control laws, implementation	CLO 15	T1:3.7
47	Auto pilot system active control technology, communication and navigation systems instrument landing systems	CLO 15	T1:3.8,3.9

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 autopilot system active control technology.	Seminars	PO3	PSO 2
2	Encourage students to make case studies on different types of engine instruments, flight instruments and navigation instruments.	Guest Lecture	PO2	PSO1,PSO3

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Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**AIRCRAFT PERFORMANCE**				
Course Code	AAE011				
Programme	B.Tech				
Semester	V	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Ms. G Swathi, Assistant Professor				
Course Faculty	Ms. G Swathi, Assistant Professor Mr. A Rathan Babu, Assistant Professor				

I. COURSE OVERVIEW:

Flight mechanics is the science that investigates the control of aircraft and other flying vehicles. From the time of the Wright brothers it was recognized that flight without control is impossible. Since then, several different concepts for controlling aircraft flight have been devised including control surfaces, deformable surfaces, rockets and others. This course introduces some of these concepts and describes their operation, as well as the degree of stability that they can provide. Both aircraft and helicopters are addressed. Modern aircraft control is ensured through automatic control systems. Their role is to increase safety, facilitate the pilot's task and improve flight qualities. The course will introduce modern aircraft control and discuss some of its objectives and applications.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AAE001	III	Introduction to aerospace engineering	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Aircraft Performance	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.	2	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	3	Assignments, 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.	3	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	1	Seminars, 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.	3	Tutorials
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	Learn the different Regimes of aircraft and performance requirements at different atmospheric conditions.
II	Understand the different type of velocities and gives differences between stall velocity and maximum and minimum velocities.
III	Estimate the time to climb and descent and gives the relation between rate of climb and descent and time to climb and descent at different altitudes.
IV	Illustrate the velocity and radius required for different type of maneuvers like pull-up, pull down and steady turn.

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
AAE011.01	CLO 1	Apply Remember and understand the atmospheric conditions that are suitable for better performance of an aircraft.	PO 1	3
AAE011.02	CLO 2	Adapt the basic Remember of mathematics, science and engineering for problem solving.	PO 1 PO 2	3
AAE011.03	CLO 3	Describe different atmospheric models that an aircraft encounters in its real-time practice.	PO 1	3
AAE011.04	CLO 4	Demonstrate different methods for the measurement of air data and their respective systems working principle.	PO 2	3
AAE011.05	CLO 5	Describe mission profiles that an aircraft adapts depending upon its category and requirements.	PO 1	2
AAE011.06	CLO 6	Understand different phases of design process from performance standpoint.	PO 3	3
AAE011.07	CLO 7	Identify definition of aircraft performance for different categories of aircraft.	PO 1	2
AAE011.08	CLO 8	Explain the force system of the aircraft and the development of equations of motion.	PO 2	3
AAE011.09	CLO 9	Evaluate the performance of aircraft in cruising phase and appropriate conclusions are drawn.	PO 2	3
AAE011.10	CLO 10	Illustrate the climb and descent performance of the aircraft and its performance parameters are measured.	PO 2	3
AAE011.11	CLO 11	Understand the concept behind various methods that are employed during takeoff and landing phases depending upon its mission.	PO 2	3
AAE011.12	CLO 12	Evaluate the factors that enhance the performance of aircraft during takeoff and landing.	PO 1	2
AAE011.013	CLO 13	Understand the maneuver performance of typical transport and military aircrafts.	PO 1	2
AAE011.14	CLO 14	Understand the parametric performance data analysis for different phases of aircraft and various methods of measurement.	PO 2	3
AAE011.15	CLO 15	Understand the concept of flight planning, fuel planning and how it affects the performance of aircraft.	PO 3	3
AAE011.16	CLO 16	Understand the propulsive force characteristics like thrust that affects the aircraft performance.	PO 1	2
AAE011.17	CLO 17	Describes the flight measurement of performance, with detailed sections on airworthiness certification and the performance manual.	PO 2	3
AAE011.18	CLO 18	Evaluate the full law calibration equations that are employed to the aircraft instruments to derive air data.	PO 2	3
AAE011.19	CLO 19	Understand the aerodynamic force characteristics like lift and drag that affects the aircraft performance.	PO 1	3
AAE011.20	CLO 20	Evaluate the full equation of motion, which are developed and used in the expressions for maneuver performance.	PO 2	3

3 = High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3												2			
CLO 2	3	3												3		
CLO 3	3												2			
CLO 4		3												3		
CLO 5	2												1			
CLO 6			3										3			
CLO 7	2												1			
CLO 8		3												3		
CLO 9		3												3		
CLO 10		3												3		
CLO 11		3												3		
CLO 12	2												1			
CLO 13	2												1			
CLO 14		3												3		
CLO 15			3										3			
CLO 16	2												1			
CLO 17		3												3		
CLO 18		3												3		
CLO 19	3												2			
CLO 20		3												3		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2, PO 3	SEE Exams	PO 1, PO 2, PO 3	Assignments	PO 1, PO 2	Seminars	PO 3
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 TO AIRCRAFT PERFORMANCE
The role and design mission of an aircraft; Performance requirements and mission profile; Aircraft design performance, the standard atmosphere; Off-standard and design atmosphere; Measurement of air data; Air data computers; Equations of motion for performance - the aircraft force system; Total airplane drag-estimation, drag reduction methods; The propulsive forces, the thrust production engines, power producing engines, variation of thrust, propulsive power and specific fuel consumption with altitude and flight speed; The minimum drag speed, minimum power speed; Aerodynamic relationships for a parabolic drag polar.	
UNIT-II	**CRUISE PERFORMANCE**
Maximum and minimum speeds in level flight; Range and endurance with thrust production, and power producing engines; Cruise techniques: constant angle of attack, constant mach number; constant altitude, methods- comparison of performance. The effect of weight, altitude and temperature on cruise performance; Cruise performance with mixed power-Plants.	
UNIT-III	**CLIMB AND DESCENT PERFORMANCE**
Importance of Climb and descent performance, Climb and descent technique generalized performance analysis for thrust producing, power producing and mixed power plants, maximum climb gradient, and climb rate. Energy height and specific excess power, energy methods for optimal climbs - minimum time, minimum fuel climbs. Measurement of best climb performance. Descent performance in Aircraft operations. Effect of wind on climb and decent performance.	
UNIT-IV	**AIRCRAFT MANEUVER PERFORMANCE**
Lateral maneuvers- turn performance- turn rates, turn radius- limiting factors for turning performance. Instantaneous turn and sustained turns, specific excess power, energy turns. Longitudinal aircraft maneuvers, the pull-up, maneuvers. The maneuver envelope, Significance. Maneuver boundaries, Maneuver performance of military Aircraft, transport Aircraft.	
UNIT-V	**SAFETY REQIREMENTS – TAKEOFF AND LANDING PERFORMANCE AND FLIGHT PLANNING**
Estimation of takeoff distances. The effect on the takeoff distance of weight wind, runway conditions, ground effect. Takeoff performance safety factors. Estimation of landing distances. The discontinued landing, Baulk landing, air safety procedures and requirements on performance. Fuel planning fuel requirement, trip fuel, Environment effects, reserve, and tankering.	
Text Books:	
1. Anderson, J.D. Jr., "Aircraft Performance and Design", International Edition McGraw Hill, 1st Edition, 1999, ISBN: 0 2. Eshelby, M.E., "Aircraft Performance theory and Practice", AIAA Education Series, AIAA, 2nd Edition, 2000, ISBN: 1	
Reference Books:	
1. McCormick, B.W, "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, 2ndEdition, 1995, ISBN: 0 2. Yechout, T.R. et al., "Introduction to Aircraft Flight Mechanics", AIAA Education Series, AIAA, 1st Edition, 2003, ISBN: 1 3. Shevel, R.S., "Fundamentals of Flight‖, Pearson Education", 2nd Edition, 1989, ISBN: 81	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	The role and design mission of an aircraft; Performance requirements and mission profile	CLO 05, CLO 07	T2:1.1-12
2	Aircraft design performance	CLO 06	T2:1.3-1.5
3	The standard atmosphere; Off-standard and design atmosphere; Measurement of air data; Air data computers	CLO 01, CLO 03, CLO 04	T2:2.2-2.4
4	Equations of motion for performance - the aircraft force system	CLO 02, CLO 08	T2:.3.1-3.2
5	Total airplane drag- estimation, drag reduction methods	CLO 19	T2:3.3
6	The thrust production engines, power producing engines	CLO 16	T2:3.4
7	Variation of thrust, propulsive power and specific fuel consumption with altitude and flight speed	CLO 16	T2:3.4
8	The minimum drag speed, minimum power speed; Aerodynamic relationships for a parabolic drag polar	CLO 02, CLO 19	T2:3.3
9-10	Maximum and minimum speeds in level flight	CLO 09	T2:4.2
11-13	Cruise techniques: constant angle of attack, constant mach number; constant altitude, methods	CLO 09	T2:4.3
14	Comparison of performance	CLO 09	T2:4.3
15-16	The effect of weight, altitude and temperature on cruise performance	CLO 02, CLO 09	T2:4.3
17	Cruise performance with mixed power-Plants	CLO 09	T2:4.5
18-19	Importance of Climb and descent performance	CLO 10	T2:5.1
20-22	Climb and descent technique generalized performance analysis for thrust producing	CLO 02, CLO 10	T2:5.2,5.5
23-24	Power producing and mixed power plants	CLO 10	T2:5.2
24-25	maximum climb gradient, and climb rate	CLO 02, CLO 10	T2:5.2
26	Energy height and specific excess power	CLO 10	T2:5.2
27-28	Energy methods for optimal climbs - minimum time, minimum fuel climbs	CLO 10	T2:5.3
29-30	Measurement of best climb performance and descent performance in Aircraft operations	CLO 10	T2:5.4
31	Lateral maneuvers- turn performance- turn rates, turn radius	CLO 20	T2:7.1
32	Limiting factors for turning performance	CLO 20	T2:7.1
33	Instantaneous turn and sustained turns, specific excess power, energy turns	CLO 20	T2:7.1
34	Longitudinal aircraft maneuvers, the pull-up, maneuvers	CLO 20	T2:7.3
35	The maneuver envelope, Significance	CLO 20	T2:7.2
36	Maneuver boundaries	CLO 20	T2:7.2.1-7.2.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
37	Maneuver performance of military Aircraft, transport Aircraft	CLO 13	T2:7.4-7.5
38	Estimation of takeoff distances	CLO 11	T2:6.2
39	The effect on the takeoff distance of weight wind, runway conditions, ground effect	CLO 12	T2:6.2.2
40	Takeoff performance safety factors	CLO 12	T2:9.3.3
41	Estimation of landing distances	CLO 11	T2:6.3
42	The discontinued landing, Baulk landing	CLO 12	T2:9.6.3
43	Air safety procedures and requirements on performance	CLO 14	T2:9.3.3
44	Fuel planning fuel requirement, trip fuel	CLO 15	T2:9.8
45	Environment effects, reserve, and tankering	CLO 15	T2:9.8

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Application of knowledge and skills in the estimation of aircraft performance parameters	Seminars / Guest Lectures / NPTEL	PO 2, PO 4	PSO 2
2	Broad knowledge of aircraft performance measurement and data handling	Seminars / Guest Lectures / NPTEL	PO 2, PO 4	PSO 2

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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**HEAT TRANSFER**				
Course Code	**AAE515**				
Programme	B. Tech				
Semester	V	AE			
Course Type	Elective				
Regulation	IARE-R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Dr. P. Srinivas Rao, Professor, Department of Aeronautical Engineering				
Course Faculty	Dr. P. Srinivas Rao, Professor, Department of Aeronautical Engineering				

I. COURSE OVERVIEW:

Heat transfer is the flow of thermal energy driven by thermal non-equilibrium, commonly measured as a heat flux, i.e. the heat flow per unit time at a control surface. This course focuses on the problems and complexities of heat transfer and emphasizes on analysis using correlations. The course assumes basic understanding of thermodynamic and fluid mechanics and exposure to differential equations and methods of solutions. Topics include modes of heat transfer and their laws, boundary conditions, conduction heat transfer – three dimensional, one dimensional steady and unsteady without heat generation, variable thermal conductivity, fin analysis, lumped heat capacity systems, free and forced convection with dimensional analysis, laminar boundary layer theory, heat exchangers, heat transfer with phase change and radiation heat transfer.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME003	IV	Fluid Mechanics	4
UG	AHS002	III	Thermodynamics	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
HEAT TRANSFER	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	Seminars
PO 12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2	Videos

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 product	1	Lectures, Assignments
PSO 2	**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	1	Lectures, Assignments
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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the basic modes of heat transfer like conduction, convection radiation with and without phase change in solid liquids and gases
II	Design and analyze thermal fluidic components in engineering systems to energy mechanisms (in the form of heat transfer) for steady and unsteady state.
III	Conduct experiments in laboratories and analyze the results with theoretical ones to evolve research oriented projects in the field of heat transfer as well as propulsion.

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
AAE515.01	CLO 1	Understand basic concepts of modes of heat transfer and Fourier Law and First thermodynamic law.	PO 1	3
AAE515.02	CLO 2	Remember the basic laws of energy involve heat transfer mechanisms..	PO 1	3
AAE515.03	CLO 3	Understand the physical system to convert into mathematical model depending upon the mode of Heat Transfer..	PO 1	3
AAE515.04	CLO 4	Understand the thermal response of engineering systems for application of Heat Transfer mechanism in both steady and unsteady state problems.	PO 2	2
AAE515.05	CLO 5	Understand heat transfer process and systems by applying conservation of mass and energy into a system.	PO 1	3
AAE515.06	CLO 6	Understand heat transfer process and systems by applying conservation of mass and energy into a system..	PO1	3
AAE515.07	CLO 7	Understand the physical mechanisms involved in conduction heat transfer. Each student can Fourier law in conjunction with conservation of energy to develop the heat diffusion equation.	PO 2	1
AAE515.08	CLO 8	Understand phase change heat transfer involves boiling and condensation.	PO 2, PO 12	2
AAE515.09	CLO 9	Utilize solution methods for the heat diffusion equation to analyze 1D, 2D, steady and transient problems, including the use of thermal circuits and analytical and numerical methods.	PO 2	2
AAE515.10	CLO 10	Understand the concepts of black and gray body radiation heat transfer..	PO 2	2
AAE515.11	CLO 11	Understand the basic applications of heat exchangers and its analysis.	PO 1	3
AAE515.12	CLO 12	Conduct experiments and analyze data involving all the modes of heat transfer.	PO 1, PO 12	3
AAE515.13	CLO 13	Remember the concepts to work out real time problems in industry which involves the concepts of Heat Transfer mechanisms.	PO 1	3
AAE515.14	CLO 14	Understand the physical phenomena associated with convection and use non-dimensional parameters to analyze convection heat transfer.	PO 1, PO 2	3
AAE515.15	CLO 15	Calculate local and global convective heat fluxes using Newton's law of cooling	PO 2, PO 12	2
AAE515.16	CLO 16	Understand empirical correlations to analyze external and internal, forced and free convection problems.	PO 2, PO 12	2

3 = High; 2 = Medium; 1 = Low

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

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

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1,PO2, PO 12	SEE Exams	PO1,PO2, PO 12	Assignments	PO 1	Seminars	PO 2
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 TO HEAT TRANSFER, CONDUCTION
Modes and mechanisms of heat transfer, Basic laws of heat transfer. Conduction heat transfer: Fourier rate equation, Steady and unsteady and periodic heat transfer -Initial and boundary conditions, Overall heat transfer coefficient, Electrical analogy, Critical radius of insulation, Extended surfaces (Fins) Long, Short and insulated tips. Application to error measurement of temperature. Significance of Biot and Fourier numbers, Chart solutions of transient conduction systems –concept of Functional Body..	
UNIT-II	**CONVECTION, FORCED CONVECTION**
Buckingham Pi Theorem, application for developing semi-empirical non-dimensional correlation for convection heat transfer-significance of non-dimensional numbers-Concepts of Continuity, Momentum and Energy Equations. Concepts of hydrodynamic and thermal boundary layer -Flat plates and Cylinders. Concepts about Hydrodynamic and Thermal Entry Lengths-division of internal flows based on this- use of empirical correlations for Horizontal Pipe Flow and annulus flow	
UNIT-III	**FREE CONVECTION, CONDENSATION**
Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes. Film boiling. Film wise and drop wise condensation, Nusselt,,s theory of condensation on a vertical plate. Film condensation on vertical and horizontal cylinders using empirical correlations. Application in Aero engines, Gas turbine combustion chamber –Working principle, correlation with convection and condensation	
UNIT-IV	**HEAT EXCHANGERS**
Classification of heat exchangers, overall heat transfer Coefficient and fouling factor, Concepts of LMTD and NTU methods, Problems using LMTD and NTU Methods, Application in Aero engines.	
UNIT-V	**RADIATION HEAT TRANSFER**
Emission characteristics, Laws of black-body radiation, Irradiation, Total and Monochromatic quantities, Laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann, Heat exchange between two black bodies, concepts of shape factor, Emissivity, heat exchange between grey bodies, radiation shields, electrical analogy for radiation networks. Application in Space Engineering	
Text Books:	
1.Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw hill Education (P)Ltd, New Delhi, India. 4th Edition, 2012 2. R. C. Sachdeva, "Fundamentals of Engineering, Heat and Mass Transfer", New Age, New Delhi, India, 3rd Edition, 2012..	
Reference Books:	
1.Holman, "Heat Transfer", Tata McGraw Hill education (P) Ltd, New Delhi, India. 10th Edition, 2012. 2. Ghoshdastidar, P. S, "Heat Transfer", Oxford University Press, New Delhi, India. 2nd Edition, 2012	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Modes and mechanisms of heat transfer, Basic laws of heat transfer	CLO 1	T1:1-1
3	Applications of heat transfer	CLO 2	R2:5.2
4-6	Fourier Equation , General heat conduction equations in Cartesian Cylindrical and Spherical coordinates.	CLO 2	T1:2-2
7-8	Ultrasonic machining – elements of the process	CLO 4	R2:5.7
9-10	Simplification and forms of the field equation Steady state and Transient heat transfer, Initial and boundary conditions	CLO 4	T1:5.7
11	One dimensional steady state heat conduction heat transfer	CLO 7	T1:5.9

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
	Homogeneous slabs, hollow cylinders and spheres		
12-13	Overall heat transfer coefficient, Electrical analogy	CLO 9	T1:10.2
14	One dimensional steady state heat conduction heat transfer: systems with variable thermal conductivity and Systems with internal heat generation.	CLO 9	R1:2.5
15	Extended surfaces (Fins) , Long, Short and insulated tips.	CLO 11	T1:2-2
16	Tutorials	CLO 11	R2:5.8
17-18	Problems	CLO 13	T2:3.5
21-22	One Dimensional Transient Conduction heat Transfer Systems with negligible internal resistance, of different geometries.	CLO 11	T1:5.4-5.8
23-24	Significance of Biot and Fourier umbers,	CLO 9	T1:3.1
25-26	Chart solutions of transient conduction systems.	CLO 10	T1 3.5
27	Classification of systems based on causation flow ,condition of flow, configuration of flow and medium flow	CLO 10	T1:5.3
28-29	Dimensional analysis as a tool for experimental investigation-Buckingham pi theorem Dimensional analysis-Application for developing non-dimensional correlation for convective heat transfer	CLO 11	T1:3.6
30	Concepts of Continuity, Momentum and Energy Equations	CLO 11	T1 8.2
31-32	Forced Convection External Flows Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for Flat plates and Cylinders	CLO 11	T1 8.2
33	Problems	CLO 12	T1:7.1
34	Development of Hydrodynamic and thermal boundary layer along a vertical	CLO 11	T1:7.1,7.2
35	Use of empirical relations for Vertical plates and pipes	CLO 12	T1:9.1
36	Regimes of Pool boiling and Flow boiling, Critical heat flux, Calculations on Nucleate Boiling	CLO 13	T1: 9.4
37	critical heat flux and film boiling	CLO 14	T1:10.1-10.2
38	Condensation, Film wise and drop wise condensation, Nusselt's theory of condensation on a vertical plate.	CLO 13	T1:10.3 R1:6.6
37-38	concepts of shape factor	CLO 13	T1:10.4
39-40	Film condensation on vertical and horizontal cylinders using empirical correlations	CLO 12	T1:10.5-10.6
41	Radiation Emission characteristics	CLO 12	T1:11.2,11.3
42	Black-body radiation, Irradiation, Total and monochromatic quantities , Laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann.	CLO 13	T1: 11.4
43	Heat exchange between grey bodies.	CLO 12	T1: 12.2
44	concepts of shape factor,	CLO 11	T1:12.3
45	Comparison of thermal and non -thermal processes	CLO 13	T1:12.5
46	Radiation shields, electrical analogy for radiation networks.	CLO 14	T1: 13.1-13.2
47-48	Classification of heat exchangers	CLO 14	T:13.3
49-50	Overall heat transfer Coefficient and fouling factor	CLO 15	T1:13.4,13.5
51-53	Concepts of LMTD and NTU methods	CLO 16	T1:3.6,R1:6.5
54-56	Problems using LMTD and NTU methods	CLO 16	T1:8.2

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To understand the industrial and practical applications	Guest Lecturer/Seminar	PO1	PSO2

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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MECHANISM AND MACHINE DESIGN**				
Course Code	AAE523				
Programme	B.Tech				
Semester	V				
Course Type	Elective				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Dr. Y B Sudhir Sastry, Professor				
Course Faculty	Dr. Y B Sudhir Sastry, Professor				

I. COURSE OVERVIEW:

The primary objective of this course is to understand the different Aircraft structural component loads, and to equip the senior year aerospace engineering students with the relevant infrastructure to carry out the design of aircraft sub-structures like wings, fuselages, landing gears etc.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME001	I	Engineering Drawing	4
UG	AME002	II	Engineering Mechanics	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIAExamination	Total Marks
Mechanism and Machine Design	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V. EVALUATION METHODOLOGY:

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

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

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

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

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

Table 1: Assessment pattern for CIA

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

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

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

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Presentation on real-world 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.	2	Seminar
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Assignment

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
PSO 2	**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	Assignments
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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the basic principles of kinematics and the related terminology of machines
II	Discriminate mobility; enumerate links and joints in the mechanisms.
III	Formulate the concept of analysis of different mechanisms
IV	Understand the working of various straight line mechanisms, gears, gear trains, steering gear mechanisms, cams and a Hooke's joint
V	Analyze a mechanism for displacement, velocity and acceleration of links in a machine

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
CAAE523.01	CLO 1	Understand the kinematic links, kinematic pairs and formation of the kinematic chain.	PO 1	3
CAAE523.02	CLO 2	Distinguish between mechanism and machine.	PO 1	3
CAAE523.03	CLO 3	Design and develop inversions of quadratic cycle chain, slider crank mechanism, double slider crank mechanism and cross slider mechanism.	PO 1	3
CAAE523.04	CLO 4	Demonstrate type synthesis, number synthesis and dimensional synthesis.	PO 2	2
CAAE523.05	CLO 5	Construct Graphical methods of velocity polygon and acceleration polygons for a given configuration diagram.	PO 1, PO 2	3
CAAE523.06	CLO 6	Understand other methods of acceleration diagrams like Klien's construction.	PO 1, PO 2	2
CAAE523.07	CLO 7	Develop secondary acceleration component i.eCorreli's component involving quick return mechanisms	PO 2	1
CAAE523.08	CLO 8	Alternative approach for determining velocity by using I centers and centroids methods.	PO 2	1
CAAE523.09	CLO 9	Significance of relative motion between two bodies, three centres in line theorem	PO 2	2
CAAE523.10	CLO 10	Application of instantaneous centre, simple mechanisms and determination of angular velocity of points and links	PO 2	2
CAAE523.11	CLO 11	Applications of gyroscope, free and restrained, working principle, the free gyro, rate gyro, integrating gyro as motion measuring instruments	PO 1	3
CAAE523.12	CLO 12	The effect of precession on the stability of vehicles, Applications of motorbikes, automobiles, airplanes and ships	PO 1, PO 3	3
CAAE523.13	CLO 13	Develop the Cam profiles and followers design	PO 1	3
CAAE523.14	CLO 14	Understand the uniform velocity, simple harmonic motion and uniform acceleration, maximum velocity and acceleration during outward and return strokes	PO 1, PO 2	3
CAAE523.15	CLO 15	Understand the Davis steering gear, Ackerman's steering gear, velocity ratio	PO 3	2
CAAE523.16	CLO 16	Understand the hook's joint, single and double hooks joint, universal coupling, applications.	PO 1, PO 2	2
CAAE523.17	CLO 17	Derive the expression for minimum number of teeth to avoid interference in case of pinion and gear as well as rack and pinion.	PO 2	3
CAAE523.18	CLO 18	Application of different gear trains including epi-cyclic and deduce the train value using tabular and relative velocity method.	PO 2	2
CAAE523.19	CLO 19	Significance of differential gear box in an automobile while taking turn on the road.	PO 3	3
CAAE523.20	CLO 20	Enable the students to understand the importance of Freudenstein equation, Precession point synthesis, Chebyshev's method, structural error	PO 3	3

3 = High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3												2			
CLO 2	3												2			
CLO 3	3															
CLO 4		2														
CLO 5	3	3												2		
CLO 6	2	2														
CLO 7		1												2		
CLO 8		1														
CLO 9		2														
CLO 10		2														
CLO 11	3													2		
CLO 12	3		3													
CLO 13	3															
CLO 14	3	3														
CLO 15			2													
CLO 16	2	2														
CLO 17		3														
CLO 18		2														
CLO 19			3											2		
CLO 20			3											2		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO2, PO3	SEE Exams	PO 1, PO2, PO3	Assignments	PO 3	Seminars	PO 2
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	MECHANISMS & MACHINES
Elements of links, classification, rigid link, flexible and fluid link, types of kinematic pairs, sliding, turning, rolling, screw and spherical pairs, lower and higher pairs, closed and open pairs, constrained motion, completely, partially or successfully constrained, and incompletely constrained, mechanism and machines, classification, kinematic chain, inversion of mechanism, inversion of quadratic cycle, chain, single and double slider crank chains; Exact and approximate straight line mechanisms: Paucellier, hart t, Chibichef, pantograph.	
UNIT-II	**KINEMATIC ANALYSIS OF MECHANISMS**
Velocity and acceleration, motion of link in machine, determination of velocity and acceleration diagrams, graphical method, application of relative velocity method for four bar chain, analysis of slider crank chain for displacement, velocity and acceleration of sliding, acceleration diagram for a given mechanism, Kleins construction, Coriolis acceleration, determination of Coriolis component of acceleration.	
UNIT-III	**PLANE MOTION OF BODY & GYROSCOPIC MOTION PRECESSION**
Instantaneous centre of rotation, centroids and axodes, relative motion between two bodies, three centres in line theorem, graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links. The gyroscope, free and restrained, working principle, the free gyro, rate gyro, integrating gyro as motion measuring instruments, effect of precession on the stability of vehicles, motorbikes, automobiles, airplanes and ships, static and dynamic forces generated due to in precession in rotating mechanisms.	
UNIT-IV	**CAMS AND FOLLOWERS, STEERING GEARS**
Cams and followers, definition uses, types, terminology, types of follower motion, uniform velocity, simple harmonic motion and uniform acceleration, maximum velocity and acceleration during outward and return strokes, roller follower, circular cam with straight, concave and convex flanks, condition for correct steering, Davis steering gear, Ackerman‘s steering gear, velocity ratio, hook‘s joint, single and double hooks joint, universal coupling, applications.	
UNIT-V	**GEARS AND GEAR TRAINS, DESIGN OF FOUR BAR MECHANISMS**
Introduction to gears: Types, law of gearing; Tooth profiles: Specifications, classification, helical, bevel and worm gears, simple and reverted gear train, epicyclic gear trains, velocity ratio or train value, four bar mechanism, Freudenstein equation, Precession point synthesis, Chebyshev‘s method, structural error.	
TEXT BOOKS:	
1. Amithab Ghosh, Asok Kumar Malik, ―Theory of Mechanisms and machines, East West Press Pvt Ltd, 2001. 2. J. S. Rao, R.V. Dukkipati ―Mechanism and Machine Theory / New Age Publications‖, 1996.	
REFERENCES:	
1. Jagadish Lal, “Theory of Mechanisms and Machines”, Metropolitan Book Company, 1st Edition,1978. 2. P. L. Ballaney, ―Theory of Machines‖, Khanna Publishers, 3rd Edition, 2003.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Elements of links, classification, rigid link, flexible and fluid link	CLO1	T1:1.2, R1:5.2
2	Types of kinematic pairs, sliding, turning, rolling, screw and spherical pairs	CLO1	T1:1.3

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
3	Lower and higher pairs, closed and open pairs	CLO1	T1:1.4
4	Constrained motion, completely, Partially or successfully constrained	CLO2	T1:1.6, R1:5.6
5-6	Incompletely constrained, mechanism and machines, Classification, kinematic chain, inversion of mechanism	CLO2	T1:2.2
7-9	Inversion of quadratic cycle ,Single slider crank chains, Double slider crank chains	CLO3	T1:2.4, R1:6.2
10-12	Exact and approximate straight line mechanisms: Paucellier,	CLO4	T1:2.25, R2:4.2
13	Exact and approximate straight line mechanisms: pantograph.	CLO5	T1:2.6
14-15	Velocity and acceleration, motion of link in machine	CLO5	T1:2.8
16	Determination of velocity and acceleration diagrams	CLO6	T1:2.9, R1:6.8
17	Graphical method	CLO6	T1:2.11
18	Application of relative velocity method for four bar chain	CLO6	T1:3.2, R2:4.8
19	Analysis of slider crank chain for displacement,	CLO7	T1:3.4
20	Velocity and acceleration of sliding, acceleration diagram for a given mechanism	CLO7	T1:3.5, R1:5.7
21	Kleins construction	CLO6	T1:3.6
22	Coriolis acceleration	CLO7	T1:3.6
23	Determination of Coriolis component of acceleration.	CLO7	T1:3.8
24	Instantaneous centre of rotation, centroids and axodes, relative motion between two bodies,	CLO8	T1:3.9
25	Three centres in line theorem graphical determination of instantaneous centre,	CLO8	T1:3.9, R2:4.12
26	Diagrams for simple mechanisms and determination of angular velocity of points and links	CLO9	T1:3.12, R2:4.8
27	The gyroscope, free and restrained, working principle,	CLO10	T2:5.1
28	The free gyro, rate gyro, Integrating gyro as motion measuring instruments	CLO10	T2:5.3, R1:5.9
29	Effect of precession on the stability of vehicles,	CLO11	T2:5.4
30	Effect of precession on the stability of motorbikes, automobiles,	CLO12	T2:5.4, R2:4.9
31	Effect of precession on the stability of airplanes and ships,	CLO12	T2:5.7
32	Static and dynamic forces generated due to in precession in rotating mechanisms.	CLO12	T2:5.9, R2:7.2
33	Cams and followers	CLO 13	T1:8.1
34	Definition uses, types, terminology, types of follower motion	CLO 13	T1:8.3, R1:5.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
35	Uniform velocity, simple harmonic motion	CLO 14	T1:8.4, R1:6.3
36	Uniform acceleration	CLO 14	T1:8.8
37	Maximum velocity and acceleration during outward and return strokes,	CLO 14	T1:8.9, R1:7.5
38	Roller follower, circular cam with straight, concave and convex flanks	CLO 14	T1:8.12
39	Condition for correct steering, Davis steering gear, Ackerman's steering gear	CLO 15	T1:7.3, R2:7.6
40	Velocity ratio, hook's joint, single and double hooks, joint Universal coupling, applications	CLO 16	T1:7.8
41	Introduction to gears: Types, law of gearing; Tooth profiles: Specifications, classification	CLO 17	T1:9.1, R1:7.6
42	Helical, bevel, Worm gears	CLO 17	T1:9.2, R2:7.8
43	Simple and reverted gear train	CLO 17	T1:9.3
44	Epicyclic gear trains	CLO 18	T1:9.5, R1:9.5
45	Velocity ratio or train value, four bar mechanism, Freudenstein equation	CLO 19	T1:9.6
46	Precession point synthesis	CLO 20	T1:9.7
47	Chebyshev's method, structural error.	CLO 20	T1:9.9, R2:9.5

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Broad knowledge of engineering materials and material properties	Seminars / Guest Lectures/ NPTEL	PO 1	PSO 1
2	Practical Exposure about the stress deflections and stability of elements	Seminars / Guest Lectures / NPTEL	PO 3	PSO 3

Prepared by:
Dr. Y B Sudhir Sastry, Professor **HOD, AE**

VI SEMESTER

INSTITUTE OF AERONAUTICAL ENGINEERING

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Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**SPACE PROPULSION**				
Course Code	AAE012				
Programme	B.Tech				
Semester	VI	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. Shiva Prasad U, Assistant Professor				
Course Faculty	Mr. Shiva Prasad U, Assistant Professor Mrs. G. Sravanthi, Assistant Professor				

I. COURSE OVERVIEW:

This course flinches with a basic principles of rocket propulsion and presents an overview of the space missions followed by the system requirements. It includes an overview of different types of propulsion like solid, liquid and hybrid propulsion. Solid propulsion grain design and estimates for the mission will be evaluated by gaining the knowledge. In addition to solid, liquid and hybrid propulsion techniques will be detailed in the current course and this also tries to forecast the future development of propulsion technologies, identifying some futuristic propulsion systems, which will need to use new space propulsion technologies. It includes an overview of the relevant propulsion technologies (e.g., cold gas, chemical, electric), propulsion technology selection, system design, and component evaluation.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AAE007	V	Aircraft Propulsion	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Space propulsion	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	Seminars
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	Mini Project

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	Seminars
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	1	Mini Project
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	Appraise various space missions, parameters to be considered for designing trajectories and rocket mission profiles.
II	Classify the different chemical rocket propulsion systems, types of igniters and performance considerations of rockets.
III	Discuss the working principle of solid and liquid propellant rockets and gain basic knowledge of hybrid rocket propulsion.
IV	Illustrate electric propulsion techniques, ion and nuclear rocket and the performances of different advanced propulsion systems.

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
AAE012.01	CLO1	Demonstrate the basic principles of space propulsion and its applications in different types of orbits.	PO1	3
AAE0012.02	CLO2	Describe the concept of orbital elements and basic orbital equations.	PO1	3
AAE0012.03	CLO3	Adapt the concepts of vertical takeoff and landing for space applications and launch trajectories.	PO1	3
AAE0012.04	CLO4	Explain the concept of single staging to rockets and two staging to rockets	PO1	3
AAE0012.05	CLO5	Explain the operating principle of rocket engine and demonstrate the tsiolkovsky rocket equation.	PO2	2
AAE0012.06	CLO6	Discuss the different Newton's laws of motion and the relation of thrust generation to different laws of motion	PO1	3
AAE0012.07	CLO7	Describe the different types of propulsion systems and preliminary concepts in nozzle less propulsion and air augmented rockets.	PO2	2
AAE0012.08	CLO8	Demonstrate the salient features of solid propellants rockets and estimate the grain configuration designs suitable for different missions.	PO2	2
AAE0012.09	CLO9	Discuss the various feed systems and injectors for liquid propellants rockets and associated heat transfer problems.	PO3	2
AAE0012.10	CLO10	Understand the peculiar problems associated with operation of cryogenic engines in different missions.	PO3	2
AAE0012.11	CLO11	Identify the applications of standard and reverse hybrid systems with an overview of its limitations.	PO3	2
AAE0012.12	CLO12	Appreciate the different propellant feed system options for both chemical and electric propulsion systems, and their similarities/differences.	PO3	2
AAE0012.13	CLO13	Evaluate the factors that limit the performance of these different propellant feed systems.	PO2, PO3	2
AAE0012.14	CLO14	Classify different types of electric propulsion systems, and evaluate their advantages and disadvantages.	PO2,PO3	2
AAE0012.15	CLO15	Design an electric propulsion system for a particular scenario, and evaluate the design experimentally.	PO2,PO3	2
AAE012.16	CLO16	Emphasize the practical application of theoretical analysis and encourage a deeper appreciation of propulsion systems design.	PO3	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AAE012.17	CLO17	Appreciate the suitability of a given propulsion system for a particular space application.	PO3	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												3			
CLO 2	3												1			
CLO 3	1															
CLO 4	3													2		
CLO 5		2											1			
CLO 6	3												3			
CLO 7		2												3		
CLO 8		2												2		
CLO 9			1													
CLO 10			3											3		
CLO 11			2										1			
CLO 12			3													
CLO 13		2	3													
CLO 14		2	1											2		
CLO 15		2	3												1	
CLO 16			1												1	
CLO 17			3													

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1, PO2	SEE Exams	PO2, PO3	Assignments	PO1	Seminars	PO2
Laboratory Practices	PO1	Student Viva	-	Mini Project	PO3	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

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

XIII. SYLLABUS

UNIT-I	PRINCIPLES OF ROCKET PROPULSION
History of rockets, Newton's third law, orbits and space flight, types of orbits, basic orbital equations, elliptical transfer orbits, launch trajectories, the velocity increment needed for launch, the thermal rocket engine, concepts of vertical takeoff and landing, SSTO and TSTO, launch assists.	
UNIT-II	**FUNDAMENTALS OF ROCKET PROPULSION**
Operating principle, Rocket equation, Specific impulse of a rocket, internal ballistics, Rocket nozzle classification, Rocket performance considerations of rockets, types of igniters, preliminary concepts in nozzle less propulsion, air augmented rockets, pulse rocket motors, static testing of rockets and instrumentation, safety considerations.	
UNIT-III	**SOLID ROCKET PROPULSION**
Salient features of solid propellant rockets, selection criteria of solid propellants, estimation of solid propellant adiabatic flame temperature, propellant grain design considerations. Erosive burning in solid propellant rockets, combustion instability, strand burner and T-burner, applications and advantages of solid propellant rockets.	
UNIT-IV	**LIQUID AND HYBRID ROCKET PROPULSION**
Salient features of liquid propellant rockets, selection of liquid propellants, various feed systems and injectors for liquid propellant rockets, thrust control cooling in liquid propellant rockets and the associated heat transfer problems, combustion instability in liquid propellant rockets, peculiar problems associated with operation of cryogenic engines, introduction to hybrid rocket propulsion, standard and reverse hybrid systems, combustion mechanism in hybrid propellant rockets, applications and limitations.	
UNIT-V	**ADVANCED PROPULSION TECHNIQUES**
Electric rocket propulsion, types of electric propulsion techniques, Ion propulsion, Nuclear rocket, comparison of performance of these propulsion systems with chemical rocket propulsion systems, future applications of electric propulsion systems, Solar sail.	
Text Books:	
1. Hill, P.G. and Peterson, C.R., Mechanics and Thermodynamics of Propulsion, 2nd Edition, Addison Wesley, 1992. 2. Turner, M.J.L., Rocket and Spacecraft Propulsion, 2nd Edition, MIT Press, 1922. 3. Hieter and Pratt, Hypersonic Air breathing propulsion th Edition, 1993.	
Reference Books:	
1. Sutton, G.P., "Rocket Propulsion Elements" John Wiley & Sons Inc., New York, 5th Edition, 1993. 2. Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers and Distributors, Delhi, 1988. 3. Tajmar, M., Advanced Space Propulsion Systems, Springer 2003.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	History of rockets, Newton's third law	CLO 1	T2:1.1-1.1.4
3-5	Orbits and space flight, Types of Orbits, Basic Orbital Equations	CLO 2	T2:1.3-1.4.3
6-7	Elliptical transfer orbits, Launch trajectories, Velocity increment needed for launch, Thermal rocket engine,	CLO 2	T2:1.3-1.3.1 ,2.1
8-9	Concepts of vertical takeoff and landing, SSTO and TSTO, launch assists.	CLO 3	T2:8.3
10-11	Operating principle	CLO 5	T2:1.2-1.2.1
12	Rocket equation, Specific impulse of a rocket,	CLO 5	T2:1.2-1.2.1,2.5.1
13	Internal ballistics, Rocket nozzle classification, Rocket performance considerations of rockets	CLO 7	R1 : 3.4
14	Types of igniters	CLO 7	R1 : 8.1
15	Preliminary concepts in nozzle less propulsion	CLO 7	T2: 6.6
16-17	Air augmented rockets, pulse rocket motors,	CLO 7	T2: 6.6
18-19	Static testing of rockets and instrumentation, safety considerations.	CLO 8	T2:7.22
20-21	Salient features of solid propellant rockets,	CLO 8	T2:4.2
22-23	Selection criteria of solid propellants,	CLO 8	R1:12.2
24-27	Estimation of solid propellant adiabatic flame temperature, propellant grain design considerations.	CLO 8	R1:11.3
28	Erosive burning in solid propellant rockets, combustion instability,	CLO 8	R1:11.3
29-31	Strand burner and T-burner, applications and advantages of solid propellant rockets.	CLO 8	R1:11.1
32-33	Salient features of liquid propellant rockets,	CLO 9	R1:6.1
34-36	Selection of liquid propellants, various feed systems and injectors for liquid propellant rockets	CLO 9	R1:7.1
37	Thrust control cooling in liquid propellant rockets and the associated heat transfer problems	CLO 9	R1:8.2
38-40	Combustion instability in liquid propellant rockets, peculiar problems associated with operation of cryogenic engines,	CLO 10	R1:15.4
41-42	Introduction to hybrid rocket propulsion,	CLO 11	R1:15.0
43-46	Standard and reverse hybrid systems	CLO 11	R1:15.2
47	Combustion mechanism in hybrid propellant rockets, applications and limitations.	CLO 15	R1:15.1
48	Electric rocket propulsion,	CLO 12	T2:6.3
49	Types of electric propulsion techniques	CLO 13	T2:6.4
50-51	Ion propulsion, Nuclear rocket, comparison of performance of these propulsion systems with chemical rocket propulsion systems	CLO 14	T2:6.5
52-53	Future applications of electric propulsion systems	CLO 16	T2:6.9

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
54	Solar sail.	CLO 17	R3:5.1

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Testing of rocket propulsion systems at various operating conditions	Mini Projects	PO3, PO 4	PSO 3
2	Advances in propulsion techniques for Nozzle less propulsion	Guest Lecture	PO 2	PSO 2

Prepared by:
Mr. Shiva Prasad U, Assistant Professor
Mrs. Sravanthi G, Assistant Professor

HOD, AE

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**COMPUTATIONAL AERODYNAMICS**				
Course Code	AAE013				
Programme	B.Tech				
Semester	VI	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr G Satya Dileep, Assistant Professor				
Course Faculty	Mr G Satya Dileep, Assistant Professor, Ms. D. Anitha, Assistant Professor				

I. COURSE OVERVIEW:

The subject provides students with necessary skills and knowledge in basics and should be able to assess a problem for analysis using computational aerodynamics, formulate a problem, select a method and obtain a solution. Each unit provides systematic development of computational aerodynamics. The role of CA elaborates applications, including projects for students and professionals to use CFD in much more realistic situations.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AAE003	III	Fluid Mechanics and Hydraulics	4
UG	AAE004	IV	Low Speed Aerodynamics	4
UG	AAE008	V	High Speed Aerodynamics	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Computational Aerodynamics	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	Presentation on real-world problems and videos
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	3	Assignments
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	Seminars
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Videos on real time problems
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	Videos on real time problems

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	1	Seminar
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.	1	Videos on real time problems
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	Discuss the fundamental aspects of numerical discretization and the major theories, approaches and methodologies used in computational aerodynamics.

II	Analyze to build up the skills in the actual implementation of computational aerodynamics methods boundary conditions, turbulence modeling etc by using commercial CFD codes.
III	Demonstrate the applications of CFD for classic fluid dynamics problems and basic thoughts and philosophy associated with CFD.
IV	Understand the various grids used in practice, including some recommendations related to grid quality and choose appropriate data structure to solve problems in real world.

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
AAE013.01	CLO 1	Understand the necessity of CFD tool as both research and design areas in modern computational world	PO 1 PO 2	3
AAE013.02	CLO 2	Explain the applications of computational fluid dynamics tool in various engineering branches other than aerospace engineering.	PO 1	3
AAE013.03	CLO 3	Recognize the selection of type of flow from the finite control volume and infinitesimal small fluid element depending upon the requirements.	PO 2	3
AAE013.04	CLO 4	Develop the governing equations required for computational aerodynamics in both conservation and non-conservation forms.	PO 2 PO 3	3
AAE013.05	CLO 5	Explain the need of classification of quasi linear partial differential equations by Cramer's rule and Eigen Value Method.	PO 2	2
AAE013.06	CLO 6	Understand the concepts of range of influence and domain of dependence for a flow field.	PO 1	2
AAE013.07	CLO 7	Explain the general behaviour of the partial differential equations which falls in hyperbolic, parabolic and elliptic equations.	PO 2 PO 3	2
AAE013.08	CLO 8	Demonstrate the CFD aspects of the hyperbolic, parabolic and elliptic equations in aerodynamic problems and physical problems.	PO 3	2
AAE013.09	CLO 9	Discuss the concepts of finite differences approximation for first order, second order and mixed order derivatives.	PO 2 PO 3	3
AAE013.10	CLO 10	Distinguish between explicit and implicit approaches that are needed for solving different finite differential equations.	PO 2 PO 3	3
AAE013.11	CLO 11	Explain the Consistency analysis and von Neumann stability analysis of finite difference methods and physical significance of CFL condition.	PO 2 PO 3	3
AAE013.12	CLO 12	Discuss the different types of grids available for different flow fields available in computational fluid dynamics.	PO 3	2
AAE013.13	CLO 13	Understand the need for generating grids for solving the finite differential equations in analyzing a flow field.	PO 3	2
AAE013.14	CLO 14	Describe the various CFD techniques available for solving the finite differential equations for a flow field.	PO 4	2
AAE013.15	CLO 15	Discuss the aspects of numerical dissipation and numerical dispersion and explain the applications of each in CFD techniques.	PO 4 PO 5	2
AAE013.16	CLO 16	Explain the technique of pressure correction method with the need of staggered grid and its philosophy.	PO 2 PO 4	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AAE013.17	CLO 17	Explain the numerical procedures for analysis like SIMPLE, SIMPLER SIMPLEC and PISO algorithms and differentiate with regular CFD techniques.	PO 4 PO 5	3
AAE013.18	CLO 18	Discuss the concepts of finite volume method and explain the difference from finite difference method for solving different flow field.	PO 3 PO 4	2
AAE013.19	CLO 19	Demonstrate the need of finite volume discretization and its general formulation of a numerical scheme in finite volume method.	PO 3	3
AAE013.20	CLO 20	Understand the principle of two dimensional finite volume methods in solving flow fields with finite control volume.	PO 4	3

3 = High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3	3														
CLO 2	3															
CLO 3		3											1			
CLO 4		3	2													
CLO 5		2														
CLO 6	2															
CLO 7		3	2										1			
CLO 8			2										1			
CLO 9		3	3										2			
CLO 10		3	3										2			
CLO 11		3	3										2			
CLO 12			2										1			
CLO 13			2										1			
CLO 14				2										1		
CLO 15				3	1									2		
CLO 16		2		2										1		
CLO 17				3	2									2		

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 18			3	1										1		
CLO 19			3										2			
CLO 20			3											1		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2, PO 3, PO 4, PO 5	SEE Exams	PO 1, PO 2, PO 3, PO 4, PO 5	Assignments	PO 1, PO 2	Seminars	PO 1, PO 3, PO 4
Laboratory Practices	PO 4, PO 5	Student Viva	-	Mini Project	PO4, PO 5	Certification	PO 5
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

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

XIII. SYLLABUS

UNIT-I	INTRODUCTION TO COMPUTATIONAL AERODYNAMICS
Need of computational fluid dynamics, philosophy of CFD, CFD as a research tool as a design tool, applications in various branches of engineering, models of fluid flow finite control volume, infinitesimal fluid element, substantial derivative physical meaning of divergence of velocity, derivation of continuity, momentum and energy equations, physical boundary conditions significance of conservation and non-conservation forms and their implication on CFD applications strong and weak conservation forms shock capturing and shock fitting approaches.	
UNIT-II	**MATHEMATICAL BEHAVIOR OF PARTIAL DIFFERENTIAL EQUATIONS AND THEIR IMPACT ON COMPUTATIONAL AERODYNAMICS**
Classification of quasi-linear partial differential equations by Cramer‘s rule and Eigen value method, general behavior of different classes of partial differential equations and their importance in understanding physical and CFD aspects of aerodynamic problems at different Mach numbers involving hyperbolic, parabolic and elliptic equations: domain of dependence and range of influence for hyperbolic equations, well-posed problems.	
UNIT-III	**BASIC ASPECTS OF DISCRETIZATION**
Introduction to finite difference: finite difference approximation for first order, second order and mixed derivatives, explicit and implicit approaches, truncation and round-off errors, consistency, stability, accuracy, convergence, efficiency of numerical solutions. Von Neumann stability analysis, physical significance of CFL stability condition. Need for grid generation, structured grids artesian grids, stretched (compressed) grids, body fitted structured grids, H-mesh, C-mesh, O-mesh, I-mesh, multi-block grids, C-H mesh, H-O-H mesh, overset grids, adaptive grids, unstructured grids: triangular, tetrahedral cells, hybrid grids, quadrilateral, hexahedral cells	

UNIT-IV	CFD TECHNIQUES
Lax-Wendroff technique, MacCormack's technique, Crank Nicholson technique, Relaxation technique, aspects of numerical dissipation and dispersion. Alternating-Direction-Implicit (ADI) Technique, pressure correction technique: application to incompressible viscous flow, need for staggered grid. Philosophy of pressure correction method, pressure correction formula. Numerical procedures: SIMPLE, SIMPLER, SIMPLEC and PISO algorithms, boundary conditions for the pressure correction method.	
UNIT-V	**FINITE VOLUME METHODS**
Basis of finite volume method, conditions on the finite volume selections, cell-centered and cell vertex approaches. Definition of finite volume discretization, general formulation of a numerical scheme, two dimensional finite volume methods with example.	

Text Books:

1. J. D. Anderson, Jr., "Computational Fluid Dynamics- The Basics with Applications", McGrawHill Inc, 2012.
2. D A Anderson, J C Tannehill, R H Pletcher, "Computational Fluid Mechanics and Heat Transfer", 1st edition, 1997.

Reference Books:

1. Hirsch, C., "Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics", Vol. I, Butter worth-Heinemann, 2nd edition, 2007.
2. Hoffmann, K. A. and Chiang, S. T., "Computational Fluid Dynamics for Engineers", Engineering Education Systems, 4th edition, 2000.
3. Patankar, S.V., "Numerical Heat Transfer and Fluid Flow", Hemisphere Pub. Corporation, 1st edition, 1980.
4. H K Varsteeg, W Malalasekera, " An Introduction to Computational Fluid Dynamics – The Finite Volume MEthod", Longman Scientific and Technical, 1st edition, 1995.

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Computational Fluid Dynamics introduction	CLO 1	T1 : 1.1
2-3	CFD is a Research tool, as a design tool and Applications in various branches of engineering	CLO 2	T1 : 1.2,1.3,1.4
4-5	Models of fluid flow, Finite Control Volume Infinitesimal Fluid Element Substantial derivative	CLO 3	T1 : 2.2, 2.3
6	Physical meaning of Divergence of velocity	CLO 3	T1 : 2.4
7-8	Continuity, Momentum Equations	CLO 4	T1 : 2.5, 2.6
9-10	Energy Equations	CLO 4	T1 : 2.7
11-12	Physical Boundary Conditions	CLO 4	T1 : 2.9
13-14	Significance of conservation and non-conservation forms and their implication on CFD applications	CLO 4	T1 : 2.10
15	Strong and weak conservation forms	CLO 4	T1 : 2.10

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
16	Shock capturing and shock fitting approaches.	CLO 4	T1 : 2.10
17-18	Classification of quasi-linear partial differential equations by Cramer's rule and Eigen value method	CLO 5	T1 : 3.2,3.3
19	General behavior of different classes of partial differential equations	CLO 7	T1 : 3.4
20	Partial different equations importance in understanding physical and CFD aspects of aerodynamic problems.	CLO 8	T1 : 3.4
21	Different Mach numbers involving hyperbolic, parabolic and elliptic equations	CLO 7	T1 : 3.4
22	Dependence and range of influence for hyperbolic equations, Well-posed problems	CLO 6	T1 : 3.4
23-24	Introduction to Finite Differences finite difference approximation for first order, second order and mixed derivatives	CLO 9	T1 : 4.1, 4.2, 4.3
25	Pros and cons of higher order difference schemes	CLO 9	T1 : 4.3
26-27	Difference equations- explicit and implicit approaches	CLO 10	T1 : 4.4
28	Truncation and round-off errors, consistency, stability, accuracy, convergence	CLO 11	T1 : 4.5
29-30	Von Neumann stability analysis Physical significance of CFL stability condition	CLO 11	T1 : 4.5
31	Need for grid generation Structured grids	CLO 12	R1 : 6.1
32-33	Cartesian grids stretched (compressed) grids body fitted structured grids	CLO 12	R1 : 6.1.1, 6.1.3
34-36	H-mesh, C-mesh, O-mesh, I-mesh & Multi-block grids, C-H mesh, H-O-H mesh, overset grids,	CLO 12	R1 : 6.1.3, 6.1.4
37-38	Adaptive grids, Unstructured grids Triangular/ tetrahedral cells, hybrid grids Quadrilateral/ hexahedra cells	CLO 13	R1 : 6.2
39-40	Lax-Wendroff technique, Mac Cormack's technique Crank Nicholson technique	CLO 14	T1 : 6.2, 6.3, 4.4
41-42	Relaxation technique, aspects of numerical dissipation and dispersion, Alternating Direction Implicit Technique	CLO 15	T1 : 6.5, 6.6, 6.7
43	Pressure correction technique- application to incompressible viscous flow	CLO 16	T1 : 6.8
44-45	Need for staggered grid. Philosophy of pressure correction method	CLO 16	T1 : 6.8.2, 6.8.3
46-47	Pressure correction formula and Numerical procedures	CLO 16	T1 : 6.8.4
48-50	SIMPLE, SIMPLER, SIMPLEC and PISO algorithms	CLO 17	R4 : 6.4, 6.6, 6.7, 6.8
51	Boundary conditions for the pressure correction method	CLO 16	T1 : 6.8.6
52	Basis of finite volume method conditions on the finite volume selections	CLO 18	R1 : 5.1
53	Cell-centered and cell-vertex approaches	CLO 18	R1 : 5.2
54-55	Definition of finite volume discretization General formulation of a numerical scheme	CLO 19	R1 : 5.2.2, 5.2.3
56-57	2-dimensional finite volume method with example	CLO 20	R1 : 5.3.1

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Transformation of space coordinates into computational coordinates	Assignments / Seminars/ NPTEL/ Guest Lectures	PO 1, PO 2, PO 5	PSO 2
2	Numerical calculations for solving PDEs	Seminars / Laboratory Practices / Video Lectures	PO 1, PO 2, PO 3, PO 4	PSO 2, PSO 3

Prepared by:
Mr. G Satya Dileep, Assistant Professor

HOD, AE

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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**AIRCRAFT STABILITY AND CONTROL**				
Course Code	AAE014				
Programme	B.Tech				
Semester	VI	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. Yagya Dutta Dwivedi, Professor				
Course Faculty	Dr. Yagya Dutta Dwivedi, Professor Ms. G. Swathi, Assistant Professor				

I. COURSE OVERVIEW:

Aircraft Stability and Control is the science that investigates the stability and control of aircraft and all other flying vehicles. From the first flight by the Wright brothers, it was observed that flight without knowledge of stability and control was unfeasible. Since then, several different concepts for controlling aircraft flight have been devised including control surfaces, deformable surfaces, morphing of wings etc. This course introduces some of these concepts and describes their operation, as well as the degree of stability that they can provide. Both fixed wing and rotary wings are addressed in this course. Modern aircraft control is ensured through automatic control systems known as autopilot. Their role is to increase safety, facilitate the pilot's task and improve flight qualities. The course will introduce modern aircraft stability and control and discuss some of its objectives and applications.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AAE011	V	Aircraft Performance	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Aircraft Stability and Control	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	Assessing real-world problems by case study
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Seminar/ Research papers
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Assignments

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	Lectures, Assignments, Seminars
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	Tutorials, Software Practice
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	1	Industry Exposure
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	Demonstrate concept of stability and application to dynamic systems like Aircraft, and the role of primary controls and secondary controls in longitudinal stability.
II	Learn about the mathematical modeling of an aircraft in longitudinal, lateral and directional cases.
III	Estimate the longitudinal and directional parameters with the help of the linearized equations of aircraft motion.
IV	Analyze the different type of modes in longitudinal, lateral and directional motion of aircraft, and recovery from those modes.

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
AAE014.01	CLO 1	Apply concept of stability, controllability and maneuverability in an aircraft.	PO 1	3
AAE014.02	CLO 2	Use and interpret the basic mathematics, science and engineering for solving problems of longitudinal, lateral and directional static stability.	PO 1	3
AAE014.03	CLO 3	Describe stick fixed and stick free conditions for neutral point.	PO 2	2
AAE014.04	CLO 4	Demonstrate different methods for finding static margin, control force and CG limitation.	PO 2	2
AAE014.05	CLO 5	Organize total stability parameters in order of merit of flight conditions.	PO 4	1
AAE014.06	CLO 6	Locate the cause of instability in an aircraft and solve the issue.	PO 4	1
AAE014.07	CLO 7	Identify aircraft different types of stability for different categories of aircraft.	PO 1	3
AAE014.08	CLO 8	Demonstrate the aircraft component contribution for different stability.	PO 1	3
AAE014.09	CLO 9	Discuss and identify the stability problems of aircraft in different phases.	PO 2	2
AAE014.10	CLO 10	Relate different stability criteria and do the comparative study.	PO 1	3
AAE014.11	CLO 11	Interpret the concept behind equations of motions in different frame of references.	PO 2	3
AAE014.12	CLO 12	Appraise the factors that enhance the stability of aircraft during different flight regime.	PO 4	1
AAE014.13	CLO 13	Create new concept of the stability in new configuration and type of aircrafts.	PO 4	1
AAE014.14	CLO 14	Describe the effects of forces and moments in disturbed or perturbed conditions on the stability.	PO 1	3
AAE014.15	CLO 15	Discuss the concept of linearization of equation of motion and aerodynamic forces and moments.	PO 2	3

3 = High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3												2			
CLO 2	3													3		
CLO 3		2											2			
CLO 4		2													1	
CLO 5				1										2		

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

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2	SEE Exams	PO 1, PO 2	Assignments	PO 4	Seminars	PO 2
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 AND LONGITUDINAL STABILITY-I
Aircraft axes system, definition: equilibrium, stability, controllability & maneuverability. Examples from simple mechanical systems for stability. Longitudinal static stability and dynamic stability for un accelerated flight. Criteria for longitudinal static stability and trim condition. Contribution of Principle components. Equations of equilibrium- stick fixed neutral point, elevator angle required to trim. Definition-static margin. Equations of motion in steady, symmetric pull-up maneuver, elevator effectiveness, elevator hinge moment, neutral point, maneuver point, static margin for stick fixed and stick free conditions, control force and control gradient. Trim tabs and types of trim tabs, aerodynamic and mass balancing of control surfaces, forward and aft most limits of CG.	
UNIT-II	**LATERAL-DIRECTIONAL STATIC STABILITY**
Introduction to lateral-direction stability- aerodynamic forces and moments, aircraft side force due to side slip, aircraft rolling moment due to side slip and aircraft yawing moment due to side slip. Aircraft component	

contribution on directional static stability, Aircraft component contribution for lateral-directional stability, rudder requirements.	
UNIT-III	**AIRCRAFT EQUATION OF MOTION**
Description of motion of flight vehicle - systems of reference frames - Earth, body, wind, stability axes - relative merits. Euler angles, angles of attack and sideslip– definitions- Earth to body axis transformation, stability axis to body axis transformation. Rotating axis system- expressions for linear and angular moment of rigid body, time derivatives-inertia tensor, components of linear and angular velocities, accelerations. Components of aerodynamic, gravity forces, moments applied on flight vehicle. Equations of motion-longitudinal and lateral-directional. Relation between angular velocity components and Euler angle rates. Determination of velocities of airplane in Earth axis system.	
UNIT-IV	**LINEARIZATION OF EQUATIONS OF MOTION AND AERODYNAMIC FORCES AND MOMENTS DERIVATIVES**
Description of state of motion of vehicle, forces and moments as perturbations over prescribed reference flight condition. Equation of motion in perturbation variables. Assumption of small perturbations, first order approximations-linearization equations of motion. Linearised of force and moment equation, of motion Linearised longitudinal and lateral-directional equations of perturbed motion. Significance of aerodynamic derivatives. Derivatives of axial, normal force components and pitching moment with respect to the velocity, angle of attack, angle of attack rate, pitch rate, elevator angle.	
UNIT-V	**AIRCRAFT DYNAMIC STABILITY**
Principle modes of motion characteristics, mode shapes and significance, time constant, undamped natural frequency and damping ratio- mode shapes- significance. One degree of freedom, two degree of freedom approximations- constant speed (short period), constant angle of attack (long period) approximations-solutions. Determination of longitudinal and lateral stability from coefficients of characteristic equation-stability and lateral stability from coefficients of characteristics equation- stability criteria, Aircraft spin-entry, balance of forces in steady spin, recovery, pilot techniques.	
Text Books:	
1. Yechout, T.R. et al., "Introduction to Aircraft Flight Mechanics", AIAA education Series, 2003, ISBN 1-56347-577-4. 2. Nelson, R.C., "Flight Stability and Automatic Control", 2nd Edn., Tata McGraw Hill, 2007, ISBN 0-07-066110-3. 3. Etkin, B and Reid, L.D., "Dynamics of Flight", 3rd Edn., John Wiley, 1998, ISBN0-47103418-5.	
Reference Books:	
1. Schmidt, L.V., "Introduction to Aircraft Flight Dynamics", AIAA Education Series, 1st Edition, 1998, ISBN A-56347-226-0.G. 2. McCormick, B.W., "Aerodynamics, Aeronautics, and Flight Mechanics", Wiley India, 2nd Edition, 1995, ISBN 97.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Describe the basic aerodynamics, atmosphere, characteristics of airfoils, forces and moments, aircraft axis system, equilibrium.	CLO 1	T2: 1.1-1.5, T1: 4.1
3-4	Recall the stability, controllability and maneuverability. Practical example of stability, longitudinal static stability and dynamic static stability.	CLO 1	T2: 2.1-2.2, R1: 3.1
5-6	Identify the accelerated flight, Criteria for longitudinal static stability and trim condition. Contribution of the components of static stability, Equations of equilibrium.	CLO 2	T2: 2.3-2.4

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
7-8	Recall the Stick fixed neutral point, Elevator angle required to trim, Static margin, Equation of motion in steady pull maneuver.	CLO 2	T2: 2.5-2.6, R1: 3.3
9-10	Recognize the elevator effectiveness and elevator hinge moment.	CLO 3	T2: 3.3
11	Explain about control force and control gradient, neutral point, maneuver point.	CLO 4	T2: 3.4, R1: 4.1
12	Explain about trim tabs and types of trim tabs, static margin for stick fixed and stick free conditions.	CLO 5	T2: 3.4
13-14	Apply aerodynamic and mass balancing of control surfaces, forward and aft most limits of CG.	CLO 5	T2: 3.3
15-16	Recognize. Introduction to lateral-direction stability-aerodynamic forces and moments.	CLO 6	T2: 4.2
17-18	Explain about the aircraft side force due to side slip, aircraft rolling moment due to side slip.	CLO 6	T2: 5.1
19-20	Define about the aircraft yawing moment due to side slip, aircraft component contribution, directional static stability.	CLO 7	T2: 5.2
21-22	Estimate the aircraft component contribution for lateral-directional stability, rudder requirements.	CLO 7	T2: 5.3
23-24	Recognize description of motion of Flight vehicle - systems of reference frames - Earth, body, wind.	CLO 8	T2: 4.5
25	Recall Stability axes - relative merits. Euler angles, angles of attack and sideslip.	CLO 8	T1: 4.1
26	Define- Earth to body axis transformation, stability axis to body axis transformation.	CLO 9	T1: 4.2
27-28	Recognize rotating axis system- expressions for linear and angular moment of rigid body, time derivatives-inertia tensor	CLO 9	T1: 4.3
29-30	Recall Components of linear and angular velocities, accelerations. Components of aerodynamic, gravity forces, moments applied on flight vehicle.	CLO 10	T2: 5.2
31-32	Interpret Equations of motion- longitudinal and lateral-directional. Relation between angular velocity components and Euler angle rates. Determination of velocities of airplane in earth axis system	CLO 10	T2: 5.2
33-34	Interpret description of state of motion of vehicle, forces and moments as perturbations over prescribed reference flight condition.	CLO 11	T2: 5.3
35-36	Explain Equation of motion in perturbation variables, Assumption of small perturbations, first order approximations-linearization equations of motion.	CLO 11	T1: 6.1-6.2
37-38	Identify linearized of force and moment equation of motion Linearised longitudinal and lateral-directional equations of perturbed motion. Significance of aerodynamic derivatives	CLO 12	T1: 6.3, R2:6.1
39-40	Inferre derivatives of axial, normal force components and pitching moment with respect to the velocity, angle of attack, angle of attack rate, pitch rate, elevator angle.	CLO 12	T1: 6.4
41-42	Identify Principle modes of motion characteristics, mode shapes and significance, time constants.	CLO 13	T1: 6.5
43-44	Interpret undamped natural frequency and damping ratio, mode shapes, significance.	CLO 13	T1: 7.1
45-46	Recall One degree of freedom, two degree of freedom approximations- constant speed (short period).	CLO 14	T1: 7.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
47	State and apply Constant angle of attack (long period) approximations- solutions.	CLO 14	T1: 7.3
48-49	Calculate longitudinal and lateral stability from coefficients of characteristic equation.	CLO 14	T1: 7.4, R2: 4.1-4.4
50-51	Explain Stability and lateral stability from coefficients of characteristics equation- stability criteria.	CLO 15	T1: 7.5, R2: 7.3
52-53	Apply the concept of aircraft spin- entry, balance of forces in steady spin.	CLO 15	T1: 7.6
54-55	Apply the concept of recovery methods, pilot techniques for recovery.	CLO 15	T1: 7.7

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Application of knowledge and skills in the estimation of aircraft stability and control system	Seminars / Expert Lectures / Flight testing	PO 2, PO 4	PSO 2
2	Experimental knowledge of aircraft Stability measurement and data handling	Experimental work need to be done	PO 2, PO 4	PSO 3

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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**AIR TRANSPORTATION SYSTEM**				
Course Code	AAE 526				
Programme	B. Tech				
Semester	VI	AERO			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. Anudeep, Assistant Professor				
Course Faculty	Mr. Anudeep, Assistant Professor				

I. COURSE OVERVIEW:

A system of air transportation in which local airports offer air transportation to a central airport where long distance flights are available called air transportation system. This course provides an overview of the air transportation system that illustrates the interdependence among its components i.e. airlines, airports, civil aviation authorities and air navigation services. This will include understanding the role, function and operation of aircraft, in addition to airports, airspace and commercial airlines

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AAE001	III	Introduction to Aerospace Engineering	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Air Transportation System	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V. EVALUATION METHODOLOGY:

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

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

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

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

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

Table 1: Assessment pattern for CIA

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

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

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

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Presentation on real-world 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	2	Seminars
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	1	Assignments
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.	2	seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	1	Lectures, Assignments, Seminars
PSO 2	**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	-	-
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	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Apply knowledge and skills in the aviation industry and make more effective decisions for organisation.
II	Provide insight into current trends and issues in civil aviation, such as aviation safety and security, law and new technology.
III	Understand complexity of air transport operation and to find best solution for the issues.
IV	Understand many transport issues involved in handling passengers, freight of aircraft.

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
AAE526.01	CLO 1	Communicate at technical level with aviation service providers and aerospace professionals and organizations about aircraft and their systems.	PO 2	2
AAE526.02	CLO 2	Describe the effects the atmosphere has on aircraft operations and the implications for the air transport industry.	PO 2	3
AAE526.03	CLO 3	Analyze the aerodynamic and associated performance characteristics for aircraft and infer the corresponding economic implications.	PO 2 PO 3	3
AAE526.04	CLO 4	Assess the impact of contemporary challenges and practical aspects in air transportation.	PO 2	2
AAE526.05	CLO 5	Evaluate pros and cons of emerging technological aspect and responses.	PO 1	2
AAE526.06	CLO 6	Develop an applied knowledge to the global aviation industry and key issues.	PO 1	2
AAE526.07	CLO 7	Understand international law and policies related to air transportation activities.	PO 1	1
AAE526.08	CLO 8	Assess the impact of airline activities and operations on economics and finances.	PO 1	1
AAE526.09	CLO 9	Evaluate the various factors influencing aviation industry and effects of these factors on air transportation	PO 2	2
AAE526.10	CLO 10	Developing capability to asses' functions of airports, the basic principles of aviation policy.	PO 2 PO 3	2
AAE526.11	CLO 11	Execution of aviation policies related to airline economics and flight planning.	PO 1	3
AAE526.12	CLO 12	Implementing standard procedure for air cargo handling and its management.	PO 1	3
AAE526.13	CLO 13	Exposit legal, social, economic, ethical and environment interest while undertaking air transportation system.	PO 7	2
AAE526.14	CLO 14	Acquire the competencies to handle airspace, aircrafts and air traffic control system.	PO 1 PO 2	2
AAE526.15	CLO 15	Develop knowledge to coordinate with different organization in the air transportation system.	PO 1	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	PSO 4
CLO 1		2														
CLO 2		2														
CLO 3		3	1										1			
CLO 4		3														
CLO 5	2															
CLO 6	2															
CLO 7	2															
CLO 8	2															
CLO 9		3														
CLO 10		2	1										1			
CLO 11	2															
CLO 12	2															
CLO 13							2									
CLO 14	3	2														
CLO 15	2															

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2, PO 3, PO 7	SEE Exams	PO 1, PO 2, PO 3, PO 7	Assignments	PO 3	Seminars	PO 2, PO7
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	AVIATION INDUSTRY
Introduction, history of aviation, evolution, development, growth, challenges; Aerospace industry, air transportation industry- economic impact, types and causes; Airline industry, structure and economic characteristics; Airlines as oligopolists, other unique economic characteristics; Significance of airline passenger load factors.	
UNIT-II	**NATURAL ENVIRONMENT, REGULATORY ENVIRONMENT AND OPERATIONAL ENVIRONMENT**
The earth as a habitat, The Earth: physical issues affecting demand- surface, core, continents; Shape of demand; Demand forecasting- based on historical data, comparative analysis, theoretical demand models; Reliability of forecasts; The breadth of regulation- ICAO, IATA, national authorities (DGCA, FAA); Service properties: service volumes, international air service agreements, deregulation, privatization; Evolution: Communication, navigation and surveillance systems (CNSS); Radio communications: VHF, HF, ACARS, SSR, ADS; Navigation: NDB, VOR, DME, area-navigation systems(R-Nav), ILS, MLS, GPS, INS, laser-INS; Surveillance: SSR, ADS; Airborne elements: AFCS, PMS, electronic control and monitoring/engine instrumentation and central automated systems, EFIS, FMS, GPWS, TCAS- future trends.	
UNIT-III	**AIRCRAFT**
Costs- project cash-flow, aircraft price; Compatibility with the operational infrastructure; Direct and indirect operating costs; Balancing efficiency and effectiveness-payload-range, fuel efficiency. Technical contribution to performance, operating speed and altitude, aircraft field length performance; Typical operating costs; Effectiveness- wake-vortices, cabin dimensions, flight deck.	
UNIT-IV	**AIRPORTS AND AIRLINES**
Setting up an airport: airport demand, airport sitting, runway characteristics, length, declared distances, aerodrome areas, obstacle safeguarding; Runway capacity, evaluating runway capacity, sustainable runway capacity; Setting up an airline, modern airline objectives; Route selection and development, airline fleet planning, annual utilization and aircraft size, seating arrangements; Indirect operating costs; Aircraft-buy or lease; Revenue generation, computerized reservation systems, yield management; Integrating service quality into the revenue-generation process; Marketing the seats; Airline scheduling; Evaluating success, financial viability, regulatory compliance, efficient use of resources, effective service	
UNIT-V	**AIRSPACE**
Categories of airspace, separation minima, airspace sectors, capacity, demand and delay; Evolution of air traffic control system, procedural ATC system, procedural ATC with radar assistance, first generation 'automated system, current generation radar and computer-based ATC systems; Aerodrome air traffic control equipment and operation - ICAO future air-navigation systems (FANS); Air-navigation service providers as businesses	
Text Books:	
1.Hirst, M., The Air Transport System, Woodhead Publishing Ltd, Cambridge, England, 2008.	
Reference Books:	
1. Wensven, J.G., Air Transportation: A Management Perspective, Ashgate,2nd Edition 2007. 2. Belobaba, P. Odoni, A. and Barnhart, C., Global Airline Industry, 2nd Edition Wiley, 2009. 3. M. Bazargan, M., Airline Operations and Scheduling, Ashgate, 1st Edition 2004.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Introduction, history of aviation.	CLO 1	R1:1.1
3-4	Evolution, development, growth, challenges.	CLO 2	R1:1.1
5-7	Aerospace industry, air transportation industry.	CLO 1	R1:1.2,1.3
8-9	Economic impact, types and causes; Airline industry.	CLO 3	R2:1.1
10	Structure and economic characteristics; Airlines as oligopolists.	CLO 3	R1:6.2
11-14	Other unique economic characteristics; Significance of airline passenger load factors.	CLO 3	R1:6.3,6.4
15-17	The earth as a habitat, The Earth: physical issues affecting demand	CLO 8	T1:2.2,2.3
18-19	Surface, core, continents; Shape of demand; Demand forecasting-based on historical data, comparative analysis.	CLO 9	T1:2.4,2.5
20-21	Theoretical demand models; Reliability of forecasts; The breadth of regulation- ICAO, IATA, national authorities (DGCA, FAA).	CLO 7	T1:2.5.3,2.6,3.2
22-23	Service properties: service volumes, international air service agreements, deregulation, privatization; trends	CLO 13	T1:3.4,3.4.2, 3.4.3,3.4.4
24	Evolution: Communication, navigation and surveillance systems (CNSS)	CLO 14	T1:4.2,4.3, 4.3.2,4.3.3
25	Radio communications: VHF, HF, ACARS, SSR, ADS; Navigation: NDB, VOR, DME,	CLO 14	T1:4.3.1,4.3.2
26-28	Area-navigation systems (R-Nav), ILS, MLS, GPS, INS, laser-INS; Surveillance: SSR, ADS; Airborne elements: AFCS, PMS, electronic control and monitoring/engine instrumentation and central automated systems, EFIS, FMS, GPWS, TCAS- future trends.	CLO 14	T1:4.3.2,4.4.1
29	Costs- project cash-flow, aircraft price.	CLO 3	T1:5.2
30-31	Compatibility with the operational infrastructure; Direct and indirect operating costs	CLO 2	T1:5.3,5.4
32	Balancing efficiency and effectiveness-payload-range, fuel efficiency.	CLO 5	T1:5.5
33-34	Technical contribution to performance, operating speed and altitude, aircraft field length performance.	CLO 1	T1:5.5.3
35	Typical operating costs; Effectiveness- wake vortices, cabin dimensions, flight deck.	CLO 3	T1:5.5.4,5.6,5.6.2
36-37	Setting up an airport: airport demand, airport sitting, runway characteristics, length, declared distances	CLO 6	T1:7.2,7.3, 7.4,7.5
38-40	Aerodrome areas, obstacle safeguarding; Runway capacity, evaluating runway capacity, sustainable runway capacity.	CLO 15	T1:7.5.3,7.6,7.6.2 R1:11.6
41	Setting up an airline, modern airline objectives; Route selection and development.	CLO 15	T1:6.2,6.3, 6.4 R2:6.2
42	Airline fleet planning, annual utilization and aircraft size, seating arrangements; Indirect operating costs.	CLO 12	T1:6.5,6.6, 6.7,6.8
43	Aircraft- buy or lease; Revenue generation, computerized reservation systems, yield management; Integrating service quality into the revenue-generation process; Marketing the seats.	CLO 8	T1:6.11,6.12,6.13,6.14
44	Airline scheduling; Evaluating success, financial viability, regulatory compliance.	CLO 6	T1:6.15,6.16,6.16.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
45	Efficient use of resources, effective service.	CLO 4	T1:6.16.4

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Application of knowledge and skills in the estimation of Air Transportation System.	Seminars / Expert Lectures / Flight testing	PO 2, PO 4	PSO 1
2	On job training on air traffic control, airspace, aircraft operation is needed	Practical exposure is needed.	PO 2, PO 4	PSO 1

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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**AEROSPACE PROPULSION AND COMBUSTION**				
Course Code	AAE551				
Programme	B. Tech				
Semester	VI	AE|ME			
Course Type	Open Elective - I				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. M Vijay Kumar , Assistant Professor				
Course Faculty	Mr. M Vijay Kumar , Assistant Professor				

I. COURSE OVERVIEW:

The aim of Aerospace propulsion and combustion is to introduce students to the analyze parametric cyclic analysis, performance parameters, efficiency, and specific impulse of air breathing and non air breathing engines and know the design and performance of subsonic and supersonic inlets, types of combustion chambers and factors affecting the combustors. To be able to describe the principal figures of merit for aircraft engine and rocket motor performance and explain how they are related to vehicle performance. To be able to describe the principal design parameters and constraints that set the performance of gas turbine engines and to apply ideal-cycle analysis to a gas turbine engine to relate thrust and fuel burn to component-level performance parameters and flight conditions. It is the branch of rocket science for analyzing the performance of an engine.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME003	IV	Thermodynamics	4
UG	AME007	V	Aircraft propulsion	3

III. MARKS DISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Aerospace propulsion and combustion	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	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Seminar
PO 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.	1	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	2	Presentation on current challenges
PSO 2	**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.	-	-
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.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Analyze parametric cyclic analysis, performance parameters, efficiency, and specific impulse of all air breathing engines.
II	Know the design and performance of subsonic and supersonic inlets, types of combustion chambers and factors affecting the combustors
III	Discuss the types of nozzles, flow conditions in nozzles, interaction of nozzle flow with adjacent surfaces and thrust reversal
IV	Explain different types of compressors and turbines, work done, efficiency calculations.

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
AAE551.01	CLO 1	Apply knowledge and understand the essential facts, concepts and principles of thermodynamics.	PO 1	3
AAE551.02	CLO 2	Understand the basic function of all aircraft engine components and how they work.	PO 1	3
AAE551.03	CLO 3	Analyze the engine performance parameters and parameters influencing them.	PO 2	2
AAE551.04	CLO 4	Understand the impact of performance parameters on endurance and range how they affect the aircraft performance.	PO 1	2
AAE551.05	CLO 5	Demonstrate different types of aircraft engine operating principle.	PO 1	1
AAE551.06	CLO 6	Understand step by step procedure of engine parametric cycle analysis.	PO 2	2
AAE551.07	CLO 7	Understand steps involved in performance analysis of all aircraft engine.	PO 2	2
AAE551.08	CLO 8	Describe operational modes of subsonic inlets and parameters influencing it.	PO 1	2
AAE551.09	CLO 9	Analyze diffuser performance, losses in it and their impact on engine performance.	PO 2	2
AAE551.10	CLO 10	Describe supersonic inlets, starting problem in it and their operating modes.	PO 1	1
AAE551. 11	CLO 11	Understand different types of combustion chamber and functions of all the components.	PO 1	2
AAE551. 12	CLO 12	Analyze combustion chamber performance and parameters influencing them.	PO 3	1
AAE551. 13	CLO 13	Describe principle of operation of axial and centrifugal compressor.	PO 1	2
AAE551. 14	CLO 14	Understand the different nozzle operating conditions for C-D nozzle	PO 1	2
AAE551. 15	CLO 15	Describe principle of operation of axial and centrifugal compressor.	PO 1	1
AAE551. 16	CLO 16	Understand different design of compressor and limitations of each method.	PO 3	2
AAE551. 17	CLO 17	Analyze performance characteristics of axial and centrifugal compressor.	PO 2	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	3												2			
CLO 3		2														
CLO 4	2															
CLO 5	1												2			
CLO 6		2														
CLO 7		2														
CLO 8	2															
CLO 9		2											2			
CLO 10	1															
CLO 11	2															
CLO 12			1													
CLO 13	2															
CLO 14	2												1			
CLO 15	1															
CLO 16			2													
CLO 17		2														

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

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

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

UNIT-I	ELEMENTS OF AIRCRAFT PROPULSION	Classes: 10
Classification of power plants, methods of aircraft propulsion, propulsive efficiency, specific fuel consumption, thrust and power, factors affecting thrust and power, illustration of working of gas turbine engine, characteristics of turboprop, turbofan and turbojet engines and performance.		
UNIT-II	**COMPONENTS OF JET ENGINES**	**Classes: 08**
Ram jet, scram jet engines construction and nomenclature, theory and performance, methods of thrust augmentation, atmospheric properties, introduction to compressors, turbines, combustors and after burners for aircraft engines.		
UNIT-III	**INLETS, NOZZLES AND PROPERLLER THEROY**	**Classes: 10**
Propeller performance parameters, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts. Subsonic and supersonic inlets, relation between minimum area ratio and external deceleration ratio. Starting problem in supersonic inlets, modes of inlet operation, jet nozzle, efficiencies, over expanded, under and optimum expansion in nozzles, thrust reversal.		
UNIT-IV	**THERMODYNAMICS OF REACTING SYSTEMS**	**Classes: 09**
Classification of combustion chambers, combustion chamber performance, flame tube cooling, flame stabilization, effect of operating variables on performance.		
UNIT-V	**PREMIXED FLAMES**	**Classes: 08**
Rankine hugoniot relations, theories of laminar premixed flame propagation, quenching and flammability limits; Diffusion flames: Burke-Schumann theory, laminar jet diffusion flame, droplet combustion, turbulent combustion, closure problem, premixed and non-premixed turbulent combustion, introduction to DNS and LES.		
Text Books:		
1. Stephen R. Turns, "An Introduction to Combustion", McGraw-Hill, 3rd Edition, 2012. 2. Thomas A. Ward, "Aerospace Propulsion Systems", John Wiley and Sons, 1st Edition, 2010.		
Reference Books:		
1. M. H. Sadd, "Elasticity: Theory, Applications, and Numerics", Academic Press, 2nd Edition, 2009. 2. R. G. Budynas "Advanced Strength and Applied Stress Analysis", McGraw-Hill, 2nd Edition, 1999. 3. A.P. Boresi, R.J. Schmidt, "Advanced Mechanics of Materials", John Willey & Sons, 5th Edition, 2003.		

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Introduction to aerospace engineering	CLO 1	T2:5.5 R1:1.12.1
2	Define function of gas generator, Classify gas turbine engines	CLO 1	T2:5.6 R1:1.12.3
3	Operational envelops	CLO 1	T2:5.10 R1:1.15
4	Turbojet performance	CLO 1	T2:5.15 R1:1.16
5	Turbo fan performance	CLO 1	T2:5.17 R1:1.13.1
6	Turbo prop performance characteristics	CLO 1	T2:5.18 R1:1.13.2
7	Define engine thrust, takeoff thrust	CLO 2	T2:5.19 R1:1.13.3
8	Thrust equation, installed thrust	CLO 2	T2:5.20 R1:1.17.1
9	Methods of aircraft propulsion	CLO 2	T2:5.24 R1:1.17.3
10	Propulsive efficiency, efficiency of a turbo prop	CLO 3	T2:6.1 R1:2.3
11	Efficiency of a turbo fan and turbo jet	CLO 3	T2:6.3 R1:2.6.1
12	Explanation of performance parameters	CLO 4	T2:6.5 R1:2.6.2
13	Specific fuel consumption, specific impulse	CLO 4	T2:7.3 R1:2.8
14	Components of jet engines	CLO 5	T2:15.13 R1:8.7.2
15	Working principle of ramjet and Scram jet operating principle	CLO 5	T2:15.13 R1:8.7.2
16	Methods of thrust augmentation in aircrafts engines	CLO 5	T2:15.16 R1:8.7.3
17	Atmospheric properties influence on when aircrafts are flying	CLO 6	T1:11.9 R2:12.24
18	Use of after burner in an engine	CLO 6	T1:11.9 R3:12.25
19	Explanation of principle of operation of turbine	CLO 6	T1:3.2 R3:3.2
20	Operation of axial flow turbines	CLO 6	T1:3.3.1 R3:3.2
21	Design of a turbine blade and nomenclature	CLO 7	T2:16.5 R1:8.10
22	Explain principle of operation of compressor	CLO 7	T2:16.9 R1:8.11.1
23	Operation of centrifugal compressor and axial flow compressor	CLO 7	T2:16.9 R1:8.11.2
24	Stage efficiency calculations, cascade testing	CLO 7	T2:16.8 R1:8.12.1
25	Design of velocity triangles of a turbine blade	CLO 5	T2:16.8 R1:8.12.2
26	Define degree of reaction of a compressor	CLO 8	T2:16.11 R1:8.14
27	Internal flow and stall in subsonic inlets	CLO 8	T2:16.11 R1:8.20

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
28	Relation between minimum area ratio and eternal deceleration ratio	CLO 8	T2:16.12 R1:8.19
29	Working phenomenon of subsonic and supersonic inlets	CLO 8	T2:16.12 R1:8.77
30	Diffuser performance	CLO 9	T2:1.2 R1:7.2
31	Starting problem of subsonic inlets	CLO 9	T2:1.16 R1:7.7
32	Shock swallowing by area variation	CLO 9	T2:1.20 R1:7.8
33	Starting problem of supersonic inlets	CLO 9	T2:1.20 R1:7.8
34	Definition of propeller and working principle	CLO 10	T2:2.1 R1:7.9.2
35	Performance of propeller in an engine	CLO 10	T2:16.11 R1:8.14
36	Types of propellers – ducted, prop fans etc	CLO 10	T2:16.8 R1:8.12.1
37	Calculated efficiency of a sub sonic and supersonic inlets of an engine	CLO 10	T2:5.17 R1:1.13.1
38	Definition of nozzle and its importance	CLO 11	T2:5.18 R1:1.13.2
39	Over expanded, under and optimum expansion in nozzles	CLO 11	T2:5.19 R1:1.13.3
40	Concept of thrust reversal in a nozzle	CLO 12	T2:5.20 R1:1.17.1
41	Classification of combustion chambers	CLO 12	T2:5.24 R1:1.17.3
42	Combustion chamber performance	CLO 12	T2:6.1 R1:2.3
43	Effect of operating variables on performance	CLO 12	T2:6.3 R1:2.6.1
44	Flame stabilization	CLO 13	T2:6.5 R1:2.6.2
45	Effect of operating variables on performance and cooling	CLO 13	T2:5.24 R1:1.17.3
46	Combustion chamber types – annular and circular	CLO 13	T2:6.1 R1:2.3
47	Combustion types , combustion inlet temperature and pressure variations	CLO 14	T2:6.3 R1:2.6.1
48	Definition of pre mixed flames	CLO 14	T2:15.13 R1:8.7.2
49	Rankine hugoniot relations for pre mixed flows	CLO 14	T2:15.13 R1:8.7.2
50	Theories of laminar premixed flame propagation	CLO 15	T2:15.16 R1:8.7.3
51	Quenching and flammability limits	CLO 15	T2:15.16 R1:8.7.3
52	Diffusion flames: Burke-Schumann theory	CLO 15	T1:11.9 R3:12.25
53	Laminar jet diffusion flame, droplet combustion	CLO 16	T1:3.2 R3:3.2
54	Turbulent combustion, closure problem	CLO 16	T1:3.3.1 R3:3.2
55	Premixed for turbulent combustion	CLO 16	T2:16.5 R1:8.10

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
56	Non-premixed turbulent combustion	CLO 16	T2:16.9 R1:8.11.1
57	Introduction to DNS	CLO 16	T2:16.9 R1:8.11.2
58	Introduction to LES	CLO 17	T2:15.13 R1:8.7.2
59	Discussion of laminar jet diffusion flame	CLO 17	T2:15.13 R1:8.7.2
60	Application of numerical techniques in visualizing mixed flows	CLO 17	T2:15.16 R1:8.7.3

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

S. No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 2	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	Guest lectures	PO 2	PSO 1

Prepared By:
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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**INTRODUCTION TO AUTOMOBILE ENGINEERING**				
Course Code	AME552				
Programme	B.Tech				
Semester	VI	AE			
Course Type	Elective				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. M Prashanth Reddy, Assistant Professor				
Course Faculty	Mr. M Prashanth Reddy, Assistant Professor				

I. COURSE OVERVIEW:

This course is intended to introduce structural and operational details of automobile and its systems. Major systems are fuel supply, cooling, ignition, electrical, transmission, suspension, braking and steering. Transport of personnel and goods play an important role in the economy of country and standard of living. Lakhs of vehicles running crores of kilometers. So the man power is required to manufacture and maintain all these vehicles. After completion of this course the students gains adequate knowledge either to work in manufacturing or maintenance sector of automobiles.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AAE002	III	Theory of Structures	4
UG	AME003	IV	Thermodynamics	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Introduction to Automobile Engineering	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& Projects
PO 3	**Design/ development of solutions**: Competence to design a system, component or process to meet societal needs within realistic constraints.	1	Assignments
PO 5	**Modern tool usage:** An ability to formulate solve complex engineering problem using modern engineering and information Technology tools.	1	Assignments& Projects
PO 6	**The engineer and society:** To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.	2	Assignments& Seminars
PO 8	**Ethics:** An understanding and implementation of professional and ethical responsibilities.	1	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	3	Projects& Seminars
PSO 2	**Problem solving skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	1	Projects
PSO 3	**Successful career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	3	Projects

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the concept on working principles of various systems of auto mobiles and fuel supply systems.
II	Understand the working principles and operational details of cooling, ignition and electrical systems
III	Analyze the working principles and operations details of transmission and suspension systems.
IV	Evaluate the operational details and design principles of breaking and steering systems
V	Compare the effects of emissions from automobiles. And to know the ways and means of reducing emissions.

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
AME552.01	CLO 1	Understand the basic working of Auto mobile and different automobile components	PO 1 PO 3	2 2
AME552.02	CLO 2	Analyse the working of the basic components in the IC engines	PO 1 PO 3	3 3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME552.03	CLO 3	Understand the importance of lubrication system in automobile	PO 1	1
AME552.04	CLO 4	Compare different fuel injection system and advantages of each individual and Concept electronic controlled fuel injection	PO 1 PO 3 PO 5	1 2 3
AME552.05	CLO 5	Compare the different cooling processes in I.C engines, working of radiator and cooling accessories	PO 1	2
AME552.06	CLO 6	Analyse the different spark ignition system	PO 1	2
AME552.07	CLO 7	Understand the working of different automobile components like lighting system, horn, wiper, fuel gauge, temperature indicator	PO 1 PO 8	3 1
AME552.08	CLO 8	Understand the different working principles of clutches, and fly wheel	PO 3 PO 5	1 3
AME552.09	CLO 9	Analyse the transmission systems like gear boxes, propeller shafts, universal joints, differential gear boxes	PO 1 PO 3	3 3
AME552.10	CLO 10	Explain the shock absorbers, suspension system	PO 1 PO 6	2 3
AME552.11	CLO 11	Compare the types of braking system, working principles	PO 1 PO 3	3 2
AME552.12	CLO 12	Explain the steering system and components of steering system	PO 1	3
AME552.13	CLO 13	Explain the steering mechanisms	PO 1	3
AME552.14	CLO 14	Understand the importance of pollution controls, pollution control techniques	PO 6 PO 8	3 3
AME552.15	CLO 15	Understand the importance of alternative fuels	PO 6 PO 8	3 3
AME552.16	CLO 16	Analyse the different alternative energy sources	PO 6 PO 8	3 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
CLO 1	2		2										1	1	3
CLO 2	3		3										3	1	
CLO 3	1												1		
CLO 4	1		2		3								2		
CLO 5	2												1	3	
CLO 6	2													1	
CLO 7	3							1					3		
CLO 8			1		3								1		
CLO 9	3		3										2	1	

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

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1 PO 3 PO 5 PO 6	SEE Exams	PO 1 PO 3 PO 5 PO 6	Assignments	PO 1 PO 3 PO 5 PO 6	Seminars	PO 6 PO 8
Laboratory Practices	-	Student Viva	PO 1	Mini Project	PO 1 PO 5	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 automobile engineering, chassis and automobile components, automobile engines, Otto cycle, diesel cycle, dual cycle, engine lubrication, lubricating oil, lubrication oil filter, engine servicing; Fuel supply system; Fuel tank, strainer, feed pump, fuel filter, injection pump, injector, filters, electronic controlled fuel injection, common rail direct injection systems	
Unit-II	**COOLING SYSTEM**
Cooling requirements, air cooling, liquid cooling, water forced circulation system, radiators, cooling fan, water pump, thermostat, pressure sealed cooling, antifreeze solutions, intelligent cooling; Ignition system: Function of an ignition system, battery ignition system, storage battery, condenser and spark plug, magneto coil ignition system, electronic ignition system, electronic ignition, spark advance mechanisms; Electrical system: Charging circuit, generator, current-voltage regulator, starting system, bendix drive mechanism solenoid switch, lighting systems, automatic high beam control, horn, wiper, fuel gauge, oil pressure gauge, engine temperature indicator.	
Unit-III	**TRANSMISSION AND SUSPENSIONS SYSTEMS**
Transmission system: Clutches, principle, types, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel.	

Gear boxes, types, constant mesh, synchro mesh gear boxes, epicyclic gear box, auto transmission, continuous variable transmission, propeller shaft, Hotch-Kiss drive, Torque tube drive, universal joint, differential, rear axles types, wheels and tyres; Suspension system: Objects of suspension systems, rigid axle suspension system, torsion bar, shock absorber, independent suspension system.	
Unit-IV	**BRAKING AND STEERING SYSTEMS**
Braking system: Mechanical brake system, Hydraulic brakes system, Master cylinder, wheel cylinder, Requirements of brake fluid, pneumatic and vacuum brake, ABS; Steering system: Steering geometry, camber, castor, king pin, rake, combined angle toe-in, toe-out, types of steering mechanism, Ackerman steering mechanism, Davis steering mechanism, steering gears types, steering linkages.	
Unit-V	**EMISSIONS FROM AUTOMOBILES**
Emissions from automobiles, pollution standards national and international, pollution control techniques, petrol injection, common rail diesel injection, variable valve timing; Energy alternatives, solar, photovoltaic, hydrogen, biomass, alcohols, LPG, CNG, liquid fuels and gaseous fuels, hydrogen as a fuel for internal combustion engines, their merits and demerits.	
Text Books:	
1. Willam H crouse, Donald L. Anglin, ―Automobile Engineering‖, McGraw Hill, 10th Edition, 2006. 2. Manzoor, Nawazish Mehdi, Yosuf Ali, ―A Text Book Automobile Engineering‖, Frontline Publications, 1 st Edition, 2011.	
Reference Books:	
1. Joseph Heinter, ―Automotive Mechanics‖, CBS, 2nd Edition, 2006. 2. K. Netwon, W. Steeds, T. K.Garrett, ―Automotive Engineering‖, Butterworth-Heinamann, 13th Edition, 2016. 3. S. Srinivasan, ―Automotive Engines‖, Tata McGraw-Hill, 2nd Edition, 2003. 4. Khalil. U. Siddiqui, ―A Text Book of Automobile Engineering‖, New Age International, 1st Edition, 2012.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Introduction: Resistance to vehicle motion Layout of automobile Chassis and body components	CLO 1	T1.4
3	Types of automobile engines	CLO 2	T1.1
4	Engine lubrication, Engine Servicing	CLO 3	T2.1
5	Fuel System in S.I Engines mechanical and electrical, Fuel filters	CLO 4	T2.4
6	Carburetor, Air filters	CLO 2	T2.8
7	Petrol injection, MPFI and GDI Systems	CLO 2	T2.8
8	C.I Engines: Diesel injection systems	CLO 2	T2.9
9	Types of injection systems, DI systems IDI systems, Fuel pump, Nozzle, spray formation	CLO 4	T2.9
10-11	Injection timing, testing of fuel pumps, CRDI and TDI systems	CLO 4	T2.9
12-13	Cooling system: Cooling requirements, Air cooling, Liquid cooling, Thermo, Water and Forced circulation system	CLO 5	T2.5
14	Radiators, cooling fan, water pump	CLO 5	T2.5
15	Thermostat, evaporative cooling-pressure sealed cooling-antifreeze solutions	CLO 5	T2.5

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
15	Ignition System: Function of an ignition system, battery ignition system	CLO 6	T2.12
17	Storage batteries, auto transformer, contact breaker points.	CLO 6	T2.14
18	Condenser and spark plug-Magneto coil ignition system.	CLO 6	T2.12
19	Electronic ignition system using contact breaker	CLO 6	T2.13
20	Electronic ignition using contact triggers	CLO 6	T2.13
21	Spark advance and retard mechanism.	CLO 6	T2.13
22	Electrical System: Charging circuit, Generator	CLO 7	T2.15
23	Current voltage regulator	CLO 7	T2.15
24	Starting system, bendix drive mechanism	CLO 7	T2.16
25	Solenoid switch, lighting systems, Horn, wiper, fuel gauge	CLO 7	T2.16
26	Oil pressure guage, engine temperature indicator	CLO 7	T2.6
27	Transmission system:Clutches, principle, types, cone clutch	CLO 8	T1.3
28	Single plate clutch, Multi plate clutch, Magnetic and centrifugal clutches	CLO 8	T1.3
29	Fluid fly wheel-gear boxes, types	CLO 8	T1.3
30	Sliding mesh, constant mesh, synchromesh gear boxes	CLO 9	T1.4
31-32	Epicyclic gear box, over drive torque converter	CLO 9	T1.5
33	Propeller shaft-Hotch kiss drive, Torque tube drive	CLO 9	T1.6
34-35	Universal joint, differential, rear axles	CLO 9	T1.6
36	Wheels and tyres	CLO 10	T1.9
37-38	Suspension System: Objects of suspension systems-rigid axle suspension system and torsion bar	CLO 10	T1.7
39-40	Shock absorber, independent suspension system	CLO 10	T1.7
41	Braking system: Mechanical brake system	CLO 11	T1.10
42-43	Hydraulic brake system, Master cylinder, Wheel cylinder	CLO 11	T1.10
44	Requirement of brake fluid, Pneumatic brakes	CLO 11	T1.10
45	Vacuum brakes	CLO 11	T1.11
46	Steering system: Steering geometry	CLO 12	T1.8
47-48	Camber, castor, king pin rake, Combined angle toein, Center point steering	CLO 12	T1.8
49-50	Ackerman steering mechanism, Davis steering mechanism, steering gears and steering linkages.	CLO 13	T1.8
51-52	Emission from automobiles: pollution standards National and international-pollution control techniques	CLO 14	T2.17
53	Multipoint fuel injection for SI Engines, Common rail diesel injection	CLO 14	T2.17
54-55	Energy alternatives-Solar, Photo-voltaic, hydrogen	CLO 16	T2.7
56-57	Biomass, alcohols, LPG, CNG	CLO 15	T2.17
58-60	Standard vehicle maintenance practice	CLO 15	T2.4

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyse the concepts	Seminars / Guest Lectures / NPTEL	PO 1	PSO 1
2	Concepts related to thermodynamic laws, working principles of IC Engines	Seminars / /NPTEL	PO 1, PO 3	PSO 1
3	Encourage students to solve real time problems like pollution controls	Guest Lectures	PO 8	PSO 1

Prepared by:
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HOD, MECHANICAL ENGINEERING

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AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**INTRODUCTION TO ROBOTICS**				
Course Code	AME553				
Programme	B.Tech				
Semester	VI	A E			
Course Type	OPEN ELECTIVE				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. B.VijayaKrishna, Assistant Professor				
Course Faculty	Mr. B. VijayaKrishna, Assistant Professor				

I. COURSE OVERVIEW:

In this course, students take on the roles of mechanical engineers, computer scientists and electrical engineers. Students research dynamics, kinematics and sensors. Subjects such as motion planning and obstacle avoidance, velocity and acceleration, serial chain mechanisms, pneumatic actuators, and drive circuits are covered. Students put knowledge into practice through projects where robots are created with teams. This is likely to be the first course in a robotics program. The subject makes understand the underline concepts used in design and building robot and make it working. The course covers kinematics and dynamics of motion robot arms. It covers feedback control systems, sensors; programming to make robotic work finally it undertakes to explain work in principles involved in industrial applications of robot.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS003	II	Computational Mathematics and Integral Calculus	4
UG	AME002	II	Engineering Mechanics	4
UG	AAE005	IV	Aircraft Materials and Production	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Introduction to Robotics	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 weight age in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

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

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

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

Table 1: Assessment pattern for CIA

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

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

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

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO1	Capability to apply the knowledge of Mathematics, science and Engineering in the field of Mechanical Engineering.	3	Assignments
PO2	An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering.	1	Assignments
PO3	Competence to design a system, component or process to meet societal needs within realistic constraints.	1	5 Min videos
PO4	To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	3	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills**: Professional skills Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for	3	Assignments
PSO 2	**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	Seminars
PSO 3	**Practical Implementation and Testing Skills**: 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	3	Term Papers
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	1	Seminars

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The objective of the course is to enable the student in:	
I.	Familiarize with the automation and brief history of robot and applications.
II.	Understand the kinematics of robots and knowledge about robot end effectors and their design.
III.	Apply robot actuators and feedback components to automation

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
CAME553.01	CLO 1	Describe various stages of Robot, development	P01 ,P02	3
CAME553.02	CLO 2	List various types of Robots used in industry	P01 ,P03	3
CAME553.03	CLO 3	Illustrate structure of Robotics	P01 , P011	2
CAME553.04	CLO 4	Explain automation and Robotics as apply to industry	P01 ,P02 P03	2
CAME553.05	CLO 5	Explain degrees of freedom	P01 ,P011	3
CAME553.06	CLO 6	Categorize various types of end effectors	P01 ,P02	2
CAME553.07	CLO 7	Explain for function of gripper & classify various types of gripper	P01 ,P03	3
CAME553.08	CLO 8	Explain considerations in selection & design of gripper.	P01 , P011	1
CAME553.09	CLO 9	Categorize various types of sensors	P01 ,P02,P03	1
CAME553.10	CLO 10	Explain Rotation matrices about X Y & Z axis.	P02	1
CAME553.11	CLO 11	Describe Euler angles & equivalent angles about axis.	P01	2
CAME553.12	CLO 12	Describe Homogeneous transformation matrix	P01 ,P02	2
CAME553.13	CLO 13	Explain D.H Rotation	P01 ,P03	1
CAME553.4	CLO 14	Describe kinematics of Robotics in forward and reverse using matrix.	P01 , P011	3
CAME553.15	CLO 15	Explain Differential kinematics.	P01 ,P02,P03	2
CAME553.16	CLO 16	Explain jacobian matrix	P03	1
CAME553.17	CLO 17	Describe Dynamic equation of robot or motion for different configurations	P02,PO4	1
CAME553.18	CLO 18	Explain various terms used in Newton-Euler formulation	P01 ,P02	2
CAME553.19	CLO 19	Describe various types of motion of end effector in space	P01 ,P03	3
CAME553.20	CLO 20	Explain polynomial equation of fit for robot motion	P01 , P011	2
CAME553.21	CLO 21	Describe various types of actuators	P01 ,P02	2
CAME553.22	CLO 22	Explain role of robots in manufacture	P01 ,P03,PO4	3
CAME553.23	CLO 23	Describe various configuration of robots for manufacturing assembling inspection purpose	P01 , P011	1
CAME553.24	CLO 24	Explain robot cell design	P01 ,P02 ,P03	2
CAME553.25	CLO 25	Describe work volume and robots screen concepts	P01 ,P03	3

3 = High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3	3											3		3	
CLO 2	3		3										3		3	
CLO 3	2										2		3		3	
CLO 4	2	2	2										3		3	

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

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 3, PO 4	SEE Exams	PO 1,PO 2 PO 3,PO 4	Assignments	PO 1	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES – INDIRECT

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

XIII. SYLLABUS

Unit-I	**INTRODUCTION TO ROBOTICS**
Introduction: Automation and robotic, an over view of robotics, classification by coordinate system and control systems; Components of the industrial robotics: Degrees of freedom, end effectors: Mechanical gripper, magnetic, vacuum cup and other types of grippers, general consideration on gripper selection and design.	
Unit-II	**MOTION ANALYSIS AND KINEMATICS**
Motion analysis: Basic rotation matrices, composite rotation matrices, Euler angles, equivalent angle and axis, homogeneous transformation, problems; Manipulator kinematics: D-H notations, joint coordinates and world coordinates, forward and inverse kinematics, problems	
Unit-III	**KINEMATICS AND DYNAMIC**
Differential kinematics: Differential kinematics of planar and spherical manipulators, Jacobians, problems. Robot dynamics: Lagrange, Euler formulations, Newton-Euler formulations, problems on planar two link manipulators.	
Unit-IV	**TRAJECTORY PLANNING AND ACTUATORS**
Trajectory planning: Joint space scheme, cubic polynomial fit, avoidance of obstacles, types of motion**:** Slew motion, joint interpolated motion, straight line motion, problems; Robot actuators and feedback components; Actuators: pneumatic and hydraulic actuators.	
Unit-V	**ELECTRIC ACTUATORS AND ROBOTIC APPLICATIONS**
Electric actuators: DC servo motors, stepper motors, feedback components: position sensors, potentiometers, resolvers and encoders, velocity sensors, tactile sensors; Robot application in manufacturing: Material handling, assembly and inspection.	
Text Books:	
1. Groover M. P, ―Industrial Robotics‖, Tata McGraw-Hill, 1st Edition, 2013. 2. J. J Craig,‖ Introduction to Robotic Mechanics and Control‖, Pearson, 3rd Edition, 2013.	
Reference Books:	
1. Richard D. Klafter, ―Robotic Engineering‖, Prentice Hall, 1st Edition, 2013. 2. Fu K S, ―Robotics‖, McGraw-Hill, 1st Edition, 2013.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	History of development of robots in chronological order	CLO1	T2:1.1
2-3	Robotic classification by co-ordinate and control system	CLO2	T2:1.5
4	Components of robotics	CLO3	T2:1.6
5	Automation and robotics. Need for this technologies in manufacture.	CLO1	R1:1.7
6	Description of various robots with degrees of freedom	CLO4	T2:1.7
7	Description of various types of endeffector	CLO6	T1:1.9

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
8-10	Illustration of gripper mechanism course analysis	CLO7	T2:1.12
11-13	Requirement of gripper selection features	CLO8	T2:3.1
14-15	Description and function of various types of sensors.	CLO9	R2:1.13
16-18	Derivation of transformation matrix about X Y and Z axis. Composite rotation matrix.	CLO10	T2:1.15
19-21	Derivation of matrix using Euler angles,	CLO11	T2:3.1
22-23	Problem related to transformation in various axis.	CLO12	T1:3.1
24-25	Description of D-H Variables, Describe procedure for forward kinematic motion analysis.	CLO13	T2:3.1
26-28	Problem related to D-H and matrix. Derivational of transformation matrix for small; incremental motion	CLO14	T2:2.9
29-30	Problems on differential motion derivation of jacobian matrix for various configuration	CLO15	T2:2.12
31-34	Derivation of lagrange-Euler equation Solution of problems different configuration of robots	CLO16	R2:2.15
35-38	Joint space motion for both straight line and point to point motions slew motion interpolated motion.	CLO18	T2:2.15
39-41	Explanation of polynomial equation for various types of motion and solution of problems in various types of trajectories. Description of functional aspects of each actuator and application	CLO20	T2:2.11
42-44	Function wise description of various configuration of robots for different application.	CLO23	T2:2.1
45	Applications of robots in manufacturing	CLO25	T1:2.3

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

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To introduce coding and analyze the concepts.	Guest lectures	PO 1, PO 4	PSO 1
2	To introduction of artificial intelligence	Seminars / NPTEL	PO 4, PO3	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO 1

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HOD, MECHANICAL ENGINEERING