KUMARAGURU COLLEGE OF TECHNOLOGY,

An autonomous Institution affiliated to Anna University, Chennai

COIMBATORE – 641 049.

B.E., AERONAUTICAL ENGINEERING

REGULATIONS 2018

CURRICULUM AND SYLLABI

I to VIII Semesters

Department of Aeronautical Engineering

VISION

To attain excellence and global reputation in Aeronautical Engineering Education and Research.

MISSION

- The department is committed to provide quality education in Aeronautical Engineering to students to build their career and do quality research and thus contribute to the field of Aviation and Aerospace.
- The department aims to prepare students for their higher studies and research to contribute to the advanced technological needs of Aeronautical engineering.
- Encourage faculty to update their knowledge and teaching-learning process through continuous learning.
- Undertake inter-disciplinary research to contribute and support the industry.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives of Aeronautical Engineering Undergraduate Program are to prepare the students:

I. To pursue a successful profession in leading organizations.

II. To pursue postgraduate degrees and conduct research at leading technological universities to contribute to the advancement in the field of Aviation and Aerospace industries.

III. To continue their professional development by utilizing educational and career building opportunities through their employer, educational institutions, or professional bodies.

PROGRAM OUTCOMES (POs)

Graduates of the Aeronautical Engineering Undergraduate Program should have the ability to:

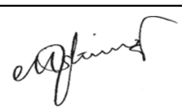
PO 1: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: 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.

PO 4: 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.

PO 5: 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.



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PO 6: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: 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.

PO 11: 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.

PO 12: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Graduates of the Aeronautical Engineering Undergraduate Program will have the ability to:

PSO 1: Apply fundamental principles of Aerodynamics, Structures, Propulsion, Materials, and Avionics to provide solutions to aerospace and non-aerospace industrial problems.

PSO 2: Use the software packages in the design, manufacturing, testing and maintenance of aeronautical and aerospace based components and systems

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B.E. AERONAUTICAL ENGINEERING

CURRICULUM

Semester I										Pre-requisite
S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	
1	U18ENI1201	Fundamentals of Communication-I	Embedded-Theory & Lab	HS	2	0	2	0	3	-------
2	U18MAI1201	Linear Algebra and Calculus	Embedded-Theory & Lab	BS	3	0	2	0	4	-------
3	U18PHI1201	Engineering Physics	Embedded-Theory & Lab	BS	3	0	2	0	4	-------
4	U18MEI1201	Engineering Graphics	Embedded-Theory & Lab	ES	2	0	2	0	3	-------
5	U18CSI1202	Problem Solving and Programming using C	Embedded-Theory & Lab	ES	2	0	2	0	3	-------
6	U18INI1600	Engineering Clinic 1	Embedded-Practical & Project	ES	0	0	4	2	3	-------
Total Credits									**20**	
Total Contact Hours/week									**28**	

Semester II										Pre-requisite
S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	
1	U18ENI2201	Fundamentals of Communication- II	Embedded-Theory & Lab	HS	2	0	2	0	3	U18ENI1201
2	U18MAI2201	Advanced Calculus and Laplace Transforms	Embedded-Theory & Lab	BS	3	0	2	0	4	U18MAI1201
3	U18CHI2201	Engineering Chemistry	Embedded-Theory & Lab	BS	3	0	2	0	4	-------
4	U18MET2003	Engineering Mechanics	Theory	ES	3	0	0	0	3	-------
5	U18CSI2201	Python Programming	Embedded-Theory & Lab	ES	2	0	2	0	3	U18CSI1202
6	U18AEI2201	Manufacturing Process	Embedded-Theory & Lab	PC	2	0	2	0	3	-------
7	U18INI2600	Engineering Clinic 2	Embedded-Practical & Project	ES	0	0	4	2	3	-------
Total Credits									**23**	
Total Contact Hours/week									**27**	

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Semester III										Pre-requisite
S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	
1	U18MAT3101	Partial Differential Equations and Transforms	Theory	BS	3	1	0	0	4	U18MAI2201
2	U18AEI3201	Fluid Mechanics	Embedded-Theory & Lab	PC	3	0	2	0	4	-------
3	U18AEI3202	Engineering Thermodynamics	Embedded-Theory & Lab	PC	3	0	2	0	4	-------
4	U18AEI3203	Mechanics of Solids	Embedded-Theory & Lab	PC	2	0	2	0	3	-------
5	U18EEI3202	Aircraft Electrical and Electronics Systems	Embedded-Theory & Lab	ES	2	0	2	0	3	-------
6	U18INI3600	Engineering Clinic 3	Embedded-Practical & Project	ES	0	0	4	2	3	-------
7	U18AEP3504	CAD Laboratory	Lab	PC	0	0	2	0	1	-------
Total Credits									**22**	
Total Contact Hours/week									**30**	

Semester IV										Pre-requisite
S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	
1	U18MAT4101	Numerical Methods and Probability	Theory	BS	3	1	0	0	4	U18MAT3101
2	U18AEI4201	Low Speed Aerodynamics	Embedded-Theory & Lab	PC	2	0	2	0	3	U18AEI3201
3	U18AEI4202	Automatic Control Systems	Embedded-Theory & Lab	PC	2	0	2	0	3	-------
4	U18AET4003	Aircraft Structures I	Theory	PC	3	0	0	0	3	U18AEI3203
5	U18AET4004	UAV System Design	Theory	PC	3	0	0	0	3	-------
6	U18AET4005	Aircraft Hardware and Materials	Theory	PC	3	0	0	0	3	-------
7	U18INI4600	Engineering Clinic 4	Embedded-Practical & Project	ES	0	0	4	2	3	-------
Total Credits									**22**	
Total Contact Hours/week									**27**	

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Semester V										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18AET5101	High Speed Aerodynamics	Theory	PC	2	1	0	0	3	U18AEI4201
2	U18AEI5202	Aircraft Structures II	Embedded-Theory & Lab	PC	2	0	2	0	3	U18AET4003
3	U18AET5003	Computational Fluid Dynamics	Theory	PC	3	0	0	0	3	U18AEI4201
4	U18AEI5204	Aircraft Systems and Instruments	Embedded-Theory & Lab	PC	2	0	2	0	3	-------
5	U18AEI5205	Aircraft Propulsion	Embedded-Theory & Lab	PC	2	0	2	0	3	U18AEI3202
6	OE I	Open Elective I	Theory	OE	3	0	0	0	3	-------
7	U18AEE00--	Professional Elective I	Theory	PE	3	0	0	0	3	-------
								Total Credits	**21**	
								Total Contact Hours/week	**24**	

Semester VI										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18AET6001	Flight Dynamics	Theory	PC	4	0	0	0	4	U18AEI4201
2	U18AET6002	Finite Element Method	Theory	PC	3	0	0	0	3	U18AEI3203
3	U18AET6003	Vibrations and Aeroelasticity	Theory	PC	3	0	0	0	3	U18AEI5202
4	U18AET6104	Rocket Propulsion	Theory	PC	2	1	0	0	3	U18AEI5205
5	OE II	Open Elective II	Theory	OE	3	0	0	0	3	-------
6	U18AEE00--	Professional Elective II	Theory	PE	3	0	0	0	3	-------
7	U18AEP6505	Design and Simulation Laboratory	Lab	PC	0	0	2	0	1	U18AET5003
8	U18AEP6506	Airframe and Aero Engine Maintenance Laboratory	Lab	PC	0	0	2	0	1	-------
								Total Credits	**21**	
								Total Contact Hours/week	**23**	

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Semester VII										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18AEI7201	Aircraft Design	Embedded-Theory & Lab	PC	3	0	2	0	4	U18AET6001
2	U18AET7002	Aviation Logistics and Supply Chain Management	Theory	PC	3	0	0	0	3	-------
3	U18AEI7203	Avionics	Embedded-Theory & Lab	PC	2	0	2	0	3	U18EEI3202
4	U18AEE00--	Professional Elective III	Theory	PE	3	0	0	0	3	-------
5	U18AEE00--	Professional Elective IV	Theory	PE	3	0	0	0	3	-------
6	U18AEE00--	Professional Elective V	Theory	PE	3	0	0	0	3	-------
7	U18AEP7704	Project Work – Phase I	Project	PW	0	0	0	6	3	-------
Total Credits									**22**	
Total Contact Hours/week									**27**	

Semester VIII										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18AEP8701	Project Work –Phase II	PROJECT	PW	0	0	0	24	12	U18AEP7705
Total Credits									**12**	
Total Contact Hours/week									**24**	

Total Credits 163

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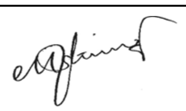
PROFESSIONAL ELECTIVES

Course Code	Course Title	Course category	Course Mode	L	T	P	J	C
U18AEE0001	Experimental Aerodynamics	Elective	Theory	3	0	0	0	3
U18AEE0002	Viscous Flow Theory	Elective	Theory	3	0	0	0	3
U18AEE0003	Hypersonic Aerodynamics	Elective	Theory	3	0	0	0	3
U18AEE0004	Cryogenic Engineering	Elective	Theory	3	0	0	0	3
U18AEE0005	Principles of Combustion	Elective	Theory	3	0	0	0	3
U18AEE0006	Heat and Mass Transfer	Elective	Theory	3	0	0	0	3
U18AEE0007	Composite Materials and Structures	Elective	Theory	3	0	0	0	3
U18AEE0008	Theory of Elasticity	Elective	Theory	3	0	0	0	3
U18AEE0009	Fatigue and Fracture Mechanics	Elective	Theory	3	0	0	0	3
U18AEE0010	Experimental Stress Analysis	Elective	Theory	3	0	0	0	3
U18AEE0011	Space Mechanics	Elective	Theory	3	0	0	0	3
U18AEE0012	Non Destructive Testing	Elective	Theory	3	0	0	0	3
U18AEE0013	Aircraft Maintenance Practices	Elective	Theory	3	0	0	0	3
U18AEE0014	Helicopter Aerodynamics	Elective	Theory	3	0	0	0	3
U18AEE0015	High Energetic Fuels and Propellants	Elective	Theory	3	0	0	0	3
U18AEE0016	Aircraft Structural Analysis	Elective	Theory	3	0	0	0	3
U18AEE0017	Autonomous Navigation	Elective	Theory	3	0	0	0	3
U18AEE0018	Additive Manufacturing and Tooling	Elective	Theory	3	0	0	0	3
U18AEE0019	Product Design and Development	Elective	Theory	3	0	0	0	3
U18AEE0220	Product Lifecycle Management	Elective	Theory	2	0	2	0	3
U18AEE0021	Computational Methods for Aeronautical Engineering	Elective	Theory	3	0	0	0	3
U18AEE0022	Grid Generation Techniques	Elective	Theory	3	0	0	0	3



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MANDATORY COURSES

S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Semester
1	U18CHT3000	Environmental Science and Engineering	Theory	MC	2	0	0	0	0	III
2	U18VET4101	Universal Human Values 2: Understanding Harmony	Theory	MC	2	1	0	0	3	IV
3	U18INT5000	Constitution of India	Theory	MC	2	0	0	0	0	V
4	U18AER0001	Introduction to Aeronautics	Theory	MC	2	0	0	0	0	-----

OPEN ELECTIVES*

S. No.	Course Code	Course Title	Category	Contact Hours	Hours per Week & Credits			
					L	T	P	C
1	U18AEO0001	Basics of Aeronautics	OE	3	3	0	0	3
2	U18AEO0002	Industrial Aerodynamics	OE	3	3	0	0	3
3	U18AEO0003	Non-destructive Testing for Engineering Applications	OE	3	3	0	0	3
4	U18AEO0004	Autonomous Flying Robots	OE	3	3	0	0	3
5	U18AEO0005	Wind Turbine Engineering	OE	3	3	0	0	3
6	U18AEO0006	Theory behind Airplane: From birds to Human Flight	OE	3	3	0	0	3
7	U18AEO0007	Satellite System and Application	OE	3	3	0	0	3
8	U18AEO0008	Basics of aeroplanes and human life	OE	3	3	0	0	3
9	U18AEO0009	Theory and Practice of Non Destructive Testing	OE	3	3	0	0	3

INDUSTRY-ORIENTED ONE CREDIT COURSES

S. No.	Course Code	Course Title	Category	Total Hours
1	U18AEC0201	Wind Turbine Design and Testing	PE	15
2	U18AEC0202	Theory and Practice of Aeronautics with Industrial Applications	PE	15
3	U18AEC0203	Aircraft Design Approach	PE	15
4	U18AEC0204	Introduction to CFD using RotCFD	PE	15
5	U18AEC0205	Satellite System and Application	PE	15
6	U18AEC0006	Smart Materials and Structures	PE	15

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SEMESTER I

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U18ENI1201	FUNDAMENTALS OF COMMUNICATION-I	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Communicate in English with correct grammar

CO2: Communicate effectively (Oral and Written)

CO3: Use communication skills in the real world

Pre-requisites : -

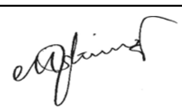
CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										**S**		**S**	-	-
CO2		**M**		**W**		**W**			**M**	**S**		**S**	-	-
CO3		**M**		**M**		**W**			**M**	**S**		**S**	-	-

Course Assessment methods

Direct
1. Continuous Assessment of Skills 2. Assignment 3. Written Test 4. End Semester Examination
Indirect
1. Course-end survey

No	Topic	Hours
	MODULE I - 12 Hrs	
1.1	Parts of Speech	2
1.2	Subject Verb Agreement	2
1.3	Speak up (Self Introduction, JAM)	4
1.4	Writing sentences using ‘Be-forms’	3
1.5	Test	1
	MODULE II - 12Hrs	
2.1	Articles, Gerunds, Infinitives	2
2.2	Speak up (Greetings & Polite English)	4
2.3	Dialogue Writing	3
2.4	Skimming & Scanning	2
2.5	Listening Skills - I	1
	MODULE III - 12 Hrs	
3.1	Tenses & Voice	2
3.2	Sentences & its kinds	2
3.3	Speak up (Narration & Description)	4
3.4	Summarizing & Note-making	3
3.5	Listening Skills - II	1
	MODULE IV - 12 Hrs	



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4.1	Framing Questions – 4 types	2
4.2	Speak up (Role play)	4
4.3	Letter writing – Formal and Informal & Email Writing	3
4.4	Reading Comprehension & Cloze test	2
4.5	Listening Skills - III	1
	MODULE V - 12 Hrs	
5.1	Degrees of Comparison	2
5.2	Clauses	2
5.3	Speak up (Power Point Presentation)	4
5.4	Writing (Picture perception)	3
5.5	Test	1
	Total	**60**

Theory: 30 Tutorial: Practical: 30 Project: 0 Total: 60 Hours

REFERENCES

1. A Modern Approach to Non Verbal Reasoning (English, Paperback, Dr. R S Aggarwal)
2. The Power of Words(Bloomsbury, UK, 2012, Hyacinth Pink)
3. Word Power Made Easy: The Complete Handbook for Building a Superior Vocabulary (By Norman Lewis)
4. Effective Technical Communication Tata Mc Graw Hills Publications (Ashraf Rizvi)
5. English and Soft skills Orient Black Swan Publishers (S. P. Dhanavel)
6. Know Your Grammar: Trans.in Tamil & Malayalam –A Bilingual Approach (Bloomsbury, UK, 2012, Hyacinth Pink)

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U18MAI1201	LINEAR ALGEBRA AND CALCULUS (Common to All branches)	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify eigenvalues and eigenvectors and apply Cayley Hamilton theorem.

CO2: Apply orthogonal diagonalisation to convert quadratic form to canonical form.

CO3: Solve first order ordinary differential equations and apply them to certain physical situations.

CO4: Solve higher order ordinary differential equations.

CO5: Evaluate the total derivative of a function, expand the given function as series and locate the maximum and minimum for multivariate function.

CO6: Determine Rank, Inverse, Eigenvalues, Eigenvectors of the given matrix, Maxima-Minima of the function and Solving Differential equations using MATLAB

Pre-requisites : Basics of Matrices, Differentiation and Integration

CO-PO and CO-PSO Mapping:

CO/PO Mapping S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S			M				M	M		M	S	
CO2	S	S			M				M	M		M	S	
CO3	S	S			M				M	M		M	S	
CO4	S	S			M				M	M		M	S	
CO5	S	S			M				M	M		M	S	
CO6	S	S			M				M	M		M		S

Course Assessment methods

DIRECT

1. Continuous Assessment Test I, II (Theory component)
2. Open Book Test; Cooperative Learning Report, Assignment; Journal Paper Review, Group Presentation, Project Report, Poster Preparation, Prototype or Product
3. Demonstration etc (as applicable) (Theory component)
4. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component)
5. Model Examination (lab component)
6. End Semester Examination (Theory and lab components)

INDIRECT

1. Course-end survey

<u>THEORY COMPONENT CONTENTS</u>

MATRICES **6 Hours**

Rank of a matrix – Consistency of a system of linear equations - Rouche's theorem - Solution of a system of linear equations - Linearly dependent and independent vectors– Eigenvalues and Eigenvectors of a real matrix – Properties of eigenvalues and eigenvectors – Cayley Hamilton theorem (excluding proof)

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DIAGONALISATION OF A REAL SYMMETRIC MATRIX — 6 Hours

Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by orthogonal transformation.

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS — 11 Hours

Leibnitz's equation – Bernoulli's equation – Equations of first order and higher degree - Clairauts form – Applications: Orthogonal trajectories.

HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS — 11 Hours

Linear equations of second and higher order with constant coefficients – Euler's and Legendre's linear equations – Method of variation of parameters – First order Simultaneous linear equations with constant coefficients – Applications.

FUNCTIONS OF SEVERAL VARIABLES — 11 Hours

Total derivative – Taylor's series expansion – Maxima and minima of functions of two variables – Constrained maxima and minima: Lagrange's multiplier method with single constraints – Jacobians.

REFERENCES

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 41st Edition, 2011.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.
3. Kreyzig E., "Advanced Engineering Mathematics", Tenth Edition, John Wiley and sons, 2011.
4. Veerarajan T., Engineering Mathematics (for First Year), Tata McGraw Hill Pub. Co. Ltd., New Delhi, Revised Edition, 2007
5. Kandasamy P., Thilagavathy K., and Gunavathy K., "Engineering Mathematics", S. Chand & Co., New Delhi, (Reprint) 2008
6. Venkataraman M.K., "Engineering Mathematics", The National Pub. Co., Chennai,2003
7. Weir, MD, Hass J, Giordano FR: Thomas' Calculus, Pearson education 12th Edition, 2015

LAB COMPONENT
List of MATLAB Programmes:

1. Introduction to MATLAB.
2. Matrix Operations - Addition, Multiplication, Transpose, Inverse
3. Rank of a matrix and solution of a system of linear equations
4. Characteristic equation of a Matrix and Cayley-Hamilton Theorem.
5. Eigenvalues and Eigenvectors of Higher Order Matrices
6. Curve tracing
7. Solving first order ordinary differential equations.
8. Solving second order ordinary differential equations.
9. Determining Maxima and Minima of a function of one variable.
10. Determining Maxima and Minima of a function of two variables.

Theory: 45	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 75 Hours**

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U18PHI1201	ENGINEERING PHYSICS (COMMON TO ALL B.E., B .TECH.)	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the principles of motion and rotation of a rigid body in the plane.

CO2: Enhance the fundamental knowledge in properties of matter and its applications relevant to various streams of Engineering and Technology.

CO3: Recognise the nature and role of the thermodynamic parameters.

CO4: Compute electrostatic field and electric potential due to point and distributed charges.

CO5: Use electrostatic & magneto static boundary conditions to relate fields in adjacent media.

CO6: Introduce and provide a broad view of the smart materials and Nano science to undergraduates.

Pre-requisites : High School Education

CO-PO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
Cos	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M										M	W	
CO2	S	M			S							M	M	
CO3	S	M			S							M	M	
CO4	S	M			S							M	S	
CO5	S	M			S							M	M	
CO6	S	M					M					M	W	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II (Theory component) 2. Cooperative learning report, Assignment; Group Presentation, Project report, Poster preparation, 3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (lab component) 4. Model examination (lab component) 5. End Semester Examination (Theory and lab component)
Indirect
1. Course-end survey

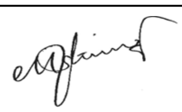
<u>THEORY COMPONENT</u>

KINEMATICS & RIGID BODY MOTION **9 Hours**

Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler’s laws of motion, their independence from Newton’s laws, and their necessity in describing rigid body motion; Examples.

PROPERTIES OF MATTER AND MATERIALS TESTING **9 Hours**

Properties of matter: Hooke's Law Stress - Strain Diagram - Elastic moduli - Relation between elastic constants - Poisson's Ratio - Expression for bending moment and depression - Cantilever - Expression for Young's modulus by Non uniform bending and its



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experimental determination.
Materials testing: Mechanism of plastic deformation, slip and twinning – types of fracture – Vickers Hardness test - fatigue and creep test.

HEAT **9 Hours**

Specific heat capacity, thermal capacity. Temperature rise. Coefficient of linear thermal expansion. Methods of measurement of thermal expansion. Thermal stresses in composite structures due to non-homogeneous thermal expansion. Applications -The bimetallic strip. Expansion gaps and rollers in engineering structures. Thermal conductivity: differential equation of heat flow. Lee's disc apparatus for determination of thermal conductivity. Thermal Insulation. Convection and radiation. Applications to refrigeration and power electronic devices.

ELECTROSTATICS & MAGNETOSTATICS **10 Hours**

ELECTROSTATICS : Maxwell’s equation for electrostatics – E due to straight conductors, circular loop, infinite sheet of current - electric field intensity (D) - Electric potential - dielectrics - dielectric polarization - internal field – Clasious - Mosotti equation - dielectric strength - applications.

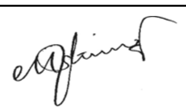
MAGNETOSTATICS: Maxwell’s equation for magnetostatics - B in straight conductors, circular loop, infinite sheet of current - Lorentz force, magnetic field intensity (H) – Biot–Savart’s Law – Ampere’s Circuit Law –Magnetic flux density (B) – magnetic materials – Magnetization – Applications.

NEW ENGINEERING MATERIALS AND NANO TECHNOLOGY **8 Hours**

New Engineering Materials: Metallic glasses – preparation, properties and applications – Shape memory alloys (SMA) – characteristics, properties of NiTi alloy applications - advantages and disadvantages of SMA.
Nano Materials: synthesis - Ball milling - Sol-gel - Electro deposition — properties of nano particles and applications. – Carbon Nano Tubes – fabrication by Chemical Vapour Deposition - structure, properties & applications.

REFERENCES:

1. Elements of Properties of Matter, Mathur D.S., Shyamlal Charitable Trust, New Delhi, 1993.
2. Properties of matter, brijlal and Subharamaniam, S.Chand and Co, New Delhi, 2004.
3. Fundamentals of General Properties of Matter by Gulati H.R., R. Chand & Co., New Delhi, 1982.
4. Engineering Mechanics (2nd ed.), Harbola M. K., Cengage publications, New Delhi, 2009.
5. Introduction to Mechanics, Verma M. K. (CRC Press), University Press, 2000.
6. Thermodynamics: An Engineering Approach (SI Units), yunus a. cengel & michael a. boles 7^{th} edition, mcgraw-hill companies 2014.
7. Engineering Electromagnetics, W. H. Hayt and John A. Buck, 6th Edition, Tata McGraw Hill, New Delhi, 2014.
8. Electromagnetic Field Theory, 5th Edition, Gangadhar K.A. and Ramanathan P.M., Khanna Publishers, New Delhi, 2013.
9. Problems and Solutions in Electromagnetics, 1st Edition, J.A. Buck and W. H. Hayt,



Signature of BOS chairman, AE

Tata McGraw Hill, New Delhi, 2010.
10. Theory and Problems of Electromagnetic Schaum’s Outline Series, 5th Edition, Joseph A. Edminister, Tata McGraw Hill Inc., New Delhi, 2010.
11. Engineering Physics, Rajendran V., Tata McGraw-Hill Education Pvt. Ltd., 2010
12. Nano – the Essentials, Pradeep T., McGraw-Hill Education, Pvt. Ltd., 2007.

Lab component:

LIST OF EXPERIMENTS

1. Determination of thermal conductivity of a bad conductor - Lee’s disc
2. Determination of Acceleration due to Gravity – Compound Pendulum
3. Determination of wavelength of light, Numerical aperture and acceptance of optical fibre
4. Determination of band gap of a semiconductor
5. Determination of compressibility of a given liquid - Ultrasonic Interferometer
6. Determination of thickness of thin sheet – Air wedge
7. Determination of frequency of an electrically maintained turning fork – Melde’s string
8. Determination of wavelength of mercury source using diffraction grating - Spectrometer
9. Determination of solar cell efficiency using Lux Meter
10. Determination of Young’s Modulus – Non-uniform bending

Experiments for Demonstration:

1. Hall effect
2. Hardness Test
3. Four probe experiment
4. Hysteresis curve

Theory: 45	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 75 Hours**

REFERENCES

1. Laboratory Manual of Engineering Physics, Dr. Y. Aparna & Dr. K. Venkateswara Rao, V.G.S Publishers.
2. Practical Physics, G.L. Squires, Cambridge University Press, Cambridge, 1985.
3. Great Experiments in Physics, M.H. Shamos, Holt, Rinehart and Winston Inc., 1959.
4. Experiments in Modern Physics, A.C. Melissinos, Academic Press, N.Y., 1966.

U18MEI1201	ENGINEERING GRAPHICS	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Construct various plane curves.
CO2: Construct projection of points and projection of lines.
CO3: Develop projection of surfaces and solids.
CO4: Solve problems in sections of solids and development of surfaces.
CO5: Apply free hand sketching and concepts of isometric in engineering practice.
CO6: Draw engineering drawing in AutoCAD with dimensions.

Pre-requisites : -

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M											M	
CO2	S	S									W		M	
CO3	S	S									M		M	
CO4	S	S											S	
CO5	S	S											S	
CO6	S													S

Course Assessment methods

Direct
1. Continuous Assessment Test I, II (Theory component) 2. Open Book Test, Assignment, Group Presentation 3. Viva, Experimental Report for each Experiment (lab Component) 4. Model Examination (lab component) 5. End Semester Examination (Theory and lab components)
Indirect
1. Course-end survey

PLANE CURVES, PROJECTION OF POINTS, LINES AND PLANES **10 Hours**

Importance of graphics in design process, visualization, communication, documentation and drafting tools, Construction of curves - ellipse, parabola, and hyperbola by eccentricity method only. Orthographic projection of points.

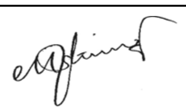
Projections of straight lines located in first quadrant - determination of true length and true inclinations.

Projections of plane surfaces - polygonal lamina and circular lamina, located in first quadrant and inclined to one reference plane.

PROJECTION AND SECTION OF SOLIDS **10 Hours**

Projection of simple solids - prism, pyramid, cylinder and cone. Drawing views when the axis of the solid is inclined to one reference plane.

Sectioning of simple solids - prisms, pyramids, cylinder and cone. Obtaining sectional views



and true shape when the axis of the solid is vertical and cutting plane inclined to one reference plane.

DEVELOPMENT OF SURFACES, ISOMETRIC PROJECTIONS AND FREE-HAND SKETCHING — 10 Hours

Development of lateral surfaces of truncated prisms, pyramids, cylinders and cones.
Isometric projection, Isometric scale, Isometric views of simple solids, truncated prisms, pyramids, cylinders and cones.
Free hand sketching techniques, sketching of orthographic views from given pictorial views of objects, including free-hand dimensioning.

INTRODUCTION TO AUTOCAD — 15 Hours

Introduction to Drafting Software (AutoCAD) & its Basic Commands. Introduction to coordinate systems, object selection methods, selection of units and precession. Sketching – line, circle, arc, polygon, rectangle and ellipse. Working with object snaps, layers and object properties. Editing the objects – copy, move, trim, extend, working with arrays, mirror, scale, hatch, fillet and chamfer.

ISOMETRIC VIEWS WITH AUTOCAD — 15 Hours

Building drawings – Single and double bed room house (sectional Top view only). Introduction to Motion path animation. Isometric views of simple solid blocks.

Theory: 30 Hours	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 60 Hours**

REFERENCES

1. Basant Agrawal and CM Agrawal, Engineering Drawing, McGraw-Hill, New Delhi, First Edition, 2008.
2. Venugopal K. and Prabhu Raja V., Engineering Graphics, New Age International (P) Limited, New Delhi, 2008.
3. Nataraajan K.V., Engineering Drawing and Graphics, Dhanalakshmi Publisher, Chennai, 2005.
4. Warren J. Luzadder and Jon. M. Duff, Fundamentals of Engineering Drawing, Prentice Hall of India Pvt. Ltd., New Delhi, Eleventh Edition, 2005.
5. Gopalakirishna K.R., Engineering Drawing (Vol. I & II), Subhas Publications, 2001.
6. James Leach, AutoCAD 2017 Instructor, SDC Publications, 2016.

U18CSI1202	PROBLEM SOLVING AND PROGRAMMING USING C	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Acquire knowledge on different problem solving techniques.
CO2: Use appropriate data types and control structures for solving a given problem.
CO3: Execute different array and string operations.
CO4: Experiment with the usage of pointers and functions.
CO5: Organize data using structures and unions.

Pre-requisites : -

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M							W				W	
CO2	S	M							W	W				S
CO3	S	W			W	W			W	W		W		S
CO4	M	W	M	W	W	W			W	W		M		S
CO5	M	W	M	W	W	W			W	W		M		S

Course Assessment methods

Direct
1. Continuous Assessment Test I, II (Theory Component) 2. Assignment (Theory Component) 3. Group Presentation (Theory Component) 4. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (lab component) 5. Model examination (lab component) 6. End Semester Examination (Theory and lab component)
Indirect
1. Course-end survey

<u>THEORY COMPONENT CONTENTS</u>

STRUCTURED PROGRAMMING **6 Hours**

Algorithms, building blocks of algorithms (instructions/statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration). Introduction to C Programming – Operators and Expressions – Data Input and Output – Control Statements.

ARRAYS AND STRINGS **6 Hours**

Defining an array – Processing an array –Multidimensional Arrays Character Arithmetic – Defining a string – Initialization of Strings – Reading and Writing Strings – Processing Strings –Searching and Sorting of Strings

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FUNCTIONS, STORAGE CLASSES **6 Hours**

Defining a function – Accessing a function – Function prototypes – Passing arguments to a function – Passing arrays to functions – Function with string - Recursion – Storage classes

POINTERS **7 Hours**

Pointer Fundamentals – Pointer Declaration – Passing Pointers to a Function – Pointers and one dimensional arrays – operations on pointers– Dynamic memory allocation.

STRUCTURES AND UNIONS **5 Hours**

Structures and Unions: Defining a Structure – Processing a Structure – User defined data types (Typedef) – Unions

Theory: 30 Hours	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 30 Hours**

REFERENCES

1. Byron S Gottfried and Jitendar Kumar Chhabra, “Programming with C”, Tata McGraw Hill Publishing Company, Third Edition, New Delhi, 2011.
2. Pradip Dey and Manas Ghosh, “Programming in C”, Second Edition, Oxford University Press, 2011.
3. Kernighan,B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2006
4. Ashok N. Kamthane, “Computer programming”, Pearson Education, 2007.
5. Reema Thareja, “Programming in C”, Second Edition, Oxford University Press, 2011.

LAB COMPONENT CONTENTS

LIST OF EXPERIMENTS

1. Writing algorithms, flowcharts and pseudo codes for simple problems.
2. Programs on expressions and conversions
3. Programs using if, if-else, switch and nested if statements
4. Programs using while, do-while, for loops
5. Programs on one dimensional arrays, passing arrays to functions and array operations
6. Programs using two dimensional arrays, passing 2D arrays to functions
7. Programs using String functions
8. Programs using function calls, recursion, call by value
9. Programs on pointer operators, call by reference, pointers with arrays
10. Programs using structures and unions.

Theory: 0	**Tutorial: 0**	**Practical: 30 Hours**	**Project: 0**	**Total: 30 Hours**

REFERENCES

1. Byron S Gottfried and Jitendar Kumar Chhabra, “Programming with C”, Tata McGraw Hill Publishing Company, Third Edition, New Delhi, 2011.
2. Pradip Dey and Manas Ghosh, “Programming in C”, Second Edition, Oxford University Press, 2011.
3. Kernighan,B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2006
4. Ashok N. Kamthane, “Computer programming”, Pearson Education, 2007.

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U18INI1600	ENGINEERING CLINIC - I	L	T	P	J	C
		0	0	4	2	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify a practical problems and find a solution

CO2: Understand the project management techniques

CO3: Demonstrate their technical report writing and presentation skills

Pre-requisites : -

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S	S	
CO2											S		W	
CO3										S			W	

Course Assessment methods

Direct	Indirect
1. Project reviews 50%	1. Course Exit Survey
2. Workbook report 10%	
3. Demonstration & Viva-voce 40%	

Content:

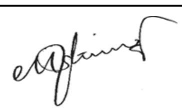
The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the I semester, students will focus primarily on IOT with C programming using Audino

GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the ‘Engineering Clinics Expo’ at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total: 90 Hours



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SEMESTER II

U18ENI2201	FUNDAMENTALS OF COMMUNICATION - II	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Read, understand, and interpret material on technology.

CO2: Communicate knowledge and information through oral and written medium.

CO3: Compare, collate and present technical information according to the audience and purpose.

Pre-requisites : -

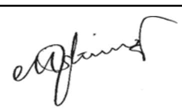
CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation)S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		W		S					S	S		S	W	-
CO2				S					S	S		W	W	-
CO3				M					S	S		S	-	-

Course Assessment methods

Direct
1. Continuous Assessment of Skills 2. Assignment 3. Written Test 4. End Semester Examination
Indirect
1. Course-end survey

No	TOPIC	
	MODULE I	**12 Hrs**
1.1	Introduction to Technical Writing Technical Definitions	2
1.2	Writing Instructions / Instruction Manual	2
1.3	Writing Recommendations	2
1.4	Speaking Activity I	6
	MODULE II	**12 Hrs**
2.1	Process Writing	2
2.2	Review Writing I - Product	2
2.3	Review Writing II – Article	2
2.4	Speaking Activity II	6
	MODULE III	**12 Hrs**
3.1	Interpreting and Transcoding Graphics	2
3.2	Types of Report / Writing a Report	2
3.3	Reading & Responding to texts	2
3.4	Speaking Activity III	6
	MODULE IV	**12 Hrs**
4.1	Drafting a project proposal	2



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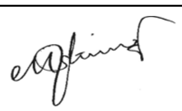
4.2	Listening to technical talks	2
4.3	Preparing a survey Questionnaire	2
4.4	Speaking Activity IV	6
	MODULE V	**12 Hrs**
5.1	Writing Memos, Circulars, Notices	2
5.2	Writing Agenda and Minutes	2
5.3	Inferential Reading	2
5.4	Speaking Activity V	6
	Total	**60**

Theory: 30 Hours Tutorial: 0 Practical: 30 Project: 0 Total: 60 Hours

REFERENCES

1. Technical English Workbook, VRB Publishers Pvt. Ltd (Prof. Jewelcy Jawahar, Dr.P.Ratna)
2. Effective Technical Communication, Tata McGraw Hills Publications (Ashraf Rizvi)
3. Technical Communication – English Skills for Engineers, Oxford Higher Education (Meenakshi Raman, Sangeeta Sharma)



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U18MAI2201	ADVANCED CALCULUS AND LAPLACE TRANSFORMS	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Evaluate double and triple integrals in Cartesian coordinates and apply them to calculate area and volume.

CO2: Apply various integral theorems for solving engineering problems involving cubes and rectangular parallelepipeds.

CO3: Construct analytic functions of complex variables and transform functions from z-plane to w-plane and vice-versa, using conformal mappings.

CO4: Apply the techniques of complex integration to evaluate real and complex integrals over suitable closed paths or contours.

CO5: Solve linear differential equations using Laplace transform technique.

CO6: Determine multiple integrals, vector differentials, vector integrals and Laplace transforms using MATLAB.

Pre-requisites : U18MAI1201 - Linear Algebra And Calculus

CO-PO and CO-PSO Mapping:

CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**PROGRAMME OUTCOMES (POs)**												**PSOs**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S	S			M				M	M		M	S	
CO2	S	S			M				M	M		M	S	
CO3	S	S			M				M	M		M	S	
CO4	S	S			M				M	M		M	S	
CO5	S	S			M				M	M		M	S	
CO6	S	S			S				M	M		M		S

Course Assessment methods

DIRECT
1. Continuous Assessment Test I, II (Theory component) 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc (as applicable) (Theory component) 3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (lab component) 4. Model examination (lab component) 5. End Semester Examination (Theory and lab component)
INDIRECT
1. Course-end survey

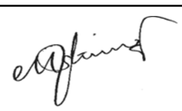
THEORY COMPONENT CONTENTS

MULTIPLE INTEGRALS **9 Hours**

Double integration – Cartesian coordinates – Change of order of integration - Triple integration in Cartesian coordinates – Applications: Area as double integral and Volume as triple integral.

VECTOR CALCULUS **9 Hours**

Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector



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fields - Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (excluding proofs) – Verification of theorem and simple applications.

ANALYTIC FUNCTIONS **9 Hours**

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy-Riemann equations in Cartesian coordinates and sufficient conditions (excluding proofs)– Properties of analytic function – Construction of analytic function by Milne Thomson method – Conformal mapping : $w = z + c$, cz , $1/z$ – Bilinear Transformation

COMPLEX INTEGRATION **9 Hours**

Cauchy's integral theorem – Cauchy's integral formula –Taylor's and Laurent's series – Singularities –Residues –Residue theorem –Application of residue theorem for evaluation of real integrals – Contour Integration (excluding poles on the real axis).

LAPLACE TRANSFORMS **9 Hours**

Definition - Properties: Superposition, Shift in t or Time Delay, Shift in s, Time Derivatives, Time Integral-Initial Value Theorem - Final Value Theorem - Transform of periodic functions - Inverse transforms - Convolution theorem – Applications: Solution of linear ordinary differential equations of second order with constant coefficients.

REFERENCES

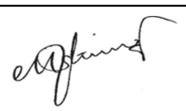
1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 41st Edition, 2011.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.
3. Veerarajan T., Engineering Mathematics (for First Year), Tata McGraw Hill Pub. Co. Ltd., New Delhi, Revised Edition, 2007.
4. Kandasamy P., Thilagavathy K., and Gunavathy K., "Engineering Mathematics", S. Chand & Co., New Delhi, (Reprint) 2008.
5. Kreyzig E., "Advanced Engineering Mathematics", Tenth Edition, John Wiley and sons, 2011.
6. Venkataraman M.K., "Engineering Mathematics", The National Pub. Co., Chennai, 2003.
7. Weir, MD, Hass J, Giordano FR: Thomas' Calculus Pearson education 12th ED, 2015.

LAB COMPONENT

List of MATLAB Programmes:

1. Evaluating double integral with constant and variable limits.
2. Area as double integral
3. Evaluating triple integral with constant and variable limits
4. Volume as triple integral
5. Evaluating gradient, divergence and curl
6. Evaluating line integrals and work done
7. Verifying Green's theorem in the plane
8. Evaluating Laplace transforms and inverse Laplace transforms of functions including impulse.
9. Heaviside functions and applying convolution.
10. Applying the technique of Laplace transform to solve differential equations.

Theory: 45	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 75 Hours**



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U18CHI2201	ENGINEERING CHEMISTRY	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the basic principles of chemistry at the atomic and molecular level.

CO2: Analyze the impact of engineering solutions from the point of view of chemical principles

CO3: Apply the chemical properties to categorize the engineering materials and their uses

CO4: Integrate the chemical principles in the projects undertaken in field of engineering and technology

CO5: Develop analytical proficiency through lab skill sets to demonstrate in professional practice.

Pre-requisites : -

CO-PO and CO-PSO Mapping:

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M											S	
CO2	S	M		M									S	
CO3	S	M		S									S	
CO4	S	M		S									S	
CO5	M	S		S									M	

Course Assessment methods

Direct
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group 3. Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc (as applicable) 4. End Semester Examination
Indirect
1. Course-end survey

THEORY COMPONENT CONTENTS

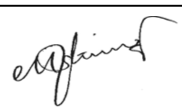
CHEMICAL BONDING **7 Hours**

Bonding: Introduction – Ionic bonding - Van der Waal's forces (dipole - dipole, dipole - induced dipole, induced dipole - induced dipole interactions) - hydrophobic interaction.

Bonding in organic molecules: covalent and co-ordinate bonds (overview only) - hybridization (sp, sp2, sp3) - hydrogen bonding and its consequences.

THERMODYNAMICS **7 Hours**

Introduction - Thermodynamic process – Internal energy – Enthalpy – limitations of First law of thermodynamics – Second law of thermodynamics - Entropy - Third law of thermodynamics – Free Energy and Work Function – Clausius-Clapeyron equation – Maxwell's relations – Kirchhoff's equation.



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ELECTROCHEMISTRY AND CORROSION **7 Hours**

Electrodes - Electrode Potential – Nernst equation and problems - Galvanic cell - Electrochemical Series.

Corrosion: Classification and mechanism of chemical and electrochemical corrosion - Factors influencing corrosion

Corrosion control: Inhibitors – Cathodic protection (Sacrificial anodic protection, Impressed current cathodic protection) – Protective coating: Electroplating (Au) and Electroless plating (Ni).

WATER TECHNOLOGY **6 Hours**

Introduction - soft/hard water - Disadvantages of hard water in industries– scale, sludge, priming and foaming, caustic embrittlement.

Treatment of hard water: External treatment (Ion exchange method) - Internal treatment (colloidal, carbonate, phosphate and calgon conditioning) - Desalination (Reverse osmosis, Electrodialysis)

ENGINEERING MATERIALS **9 Hours**

Polymer: Introduction – Preparation, Properties and Applications of PMMA, PET, PVC.

Composites: Constituents of Composites – Polymer Composites - Metal Matrix Composites - Ceramic Matrix Composites – Applications

Lubricants: Classification - Functions - Properties (viscosity index, flash and fire point, oiliness, carbon residue, aniline point, cloud point and pour point) - Semi solid lubricant (greases with calcium based, sodium based, lithium based) - Solid lubricants (graphite, molybdenum disulphide)

SURFACE CHEMISTRY AND CATALYSIS **9 Hours**

Adsorption: Types of adsorption – Adsorption isotherms: Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – Applications of adsorption on pollution abatement.

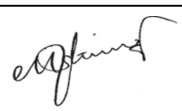
Catalysis: Catalyst – catalytic poisoning and catalytic promoters - autocatalysis –- acid base catalysis – enzyme catalysis – Michaelis-Menten equation – applications.

Chemical kinetics: Introduction – first order, pseudo first order, second order, zero order equations – parallel reactions – opposing reactions.

Theory: 45 Hours	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Jain P.C. and Jain. M., Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, Reprint 2017.
2. Puri B.R., Sharma L.R., Pathania, M.S. Principles of physical chemistry, Vishal Publishing Co., 2017
3. Atkins, P. and de Paula, J., Atkin's Physical Chemistry, 9th ed., Oxford Univ. Press, 2009.
4. Glasstone S., An introduction to Electrochemistry, 10th Edition, Affiliated to East West Press Private Limited, 2007.
5. Samir Sarkar., Fuels and Combustion, 3rd Edition, Orient Longman, India, 2009.
6. Dara S.S. and Umare S.S., A text book of Engineering Chemistry, S.Chand and Company Limited, New Delhi, 2014.
7. Engineering Chemistry, Wiley India Editorial Team, Wiley, 2018.



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LAB COMPONENT CONTENTS

LIST OF EXPERIMENTS

1. Preparation of Standard solutions
2. Conductometric estimation of mixture of acids vs strong base
3. Estimation of extent of corrosion of Iron pieces by Potentiometry
4. Estimation of the extent of dissolution of Copper / Ferrous ions by spectrophotometry.
5. Estimation of acids by pH metry.
6. Determination of total, temporary and permanent hardness by EDTA method.
7. Estimation of DO by Winkler’s method
8. Estimation of Alkalinity by Indicator method.
9. Estimation of Chloride by Argentometric method
10. Estimation of Sodium and Potassium in water by Flame photometry.
11. Determination of Flash and Fire point of lubricating oil
12. Determination of Cloud and Pour point of lubricating oil
13. Determination of relative and kinematic viscosities of lubricating oil at different temperatures
14. Determination of corrosion rate on mild steel by Weight loss method
15. Morphological studies of corrosion on mild steel by microscopic techniques

Theory: 0	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 30 Hours**

REFERENCES

1. Jeffery G.H., Bassett J., Mendham J. and Denny R.C., Vogel’s Text Book of Quantitative Chemical Analysis, Oxford, ELBS, London,2012.
2. Shoemaker D.P. and C.W. Garland., Experiments in Physical Chemistry, Tata McGraw-Hill Pub. Co., Ltd., London, 2003.

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U18MET2003	ENGINEERING MECHANICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the fundamental concepts in determining the effect of forces on a particle.
CO2: Make use of various principles in the determination of effect of forces in a rigid body.
CO3: Determine the geometry dependant properties of solids and sections
CO4: Solve problems in static friction.
CO5: Identify motion and determine the velocity and acceleration of a particle.
CO6: Apply the principles of kinetics in solving problems in dynamics.

Pre-requisites : -

CO-PO and CO-PSO Mapping:

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S								M	M			S	
CO2	S								M	M			S	
CO3	S								M	M			S	
CO4	S								M	M			S	
CO5	S								M	M			S	
CO6	S								M	M			S	

Course Assessment methods

Direct
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
Indirect
1. Course-end survey

STATICS OF PARTICLES **9 Hours**

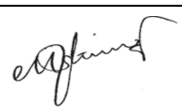
Introduction - Laws of Mechanics, Parallelogram and triangular Laws of forces – Coplanar Forces - Resolution and Composition of forces – Free body diagram - Equilibrium of a particle – Lami's theorem – Equilibrium of a particle in space.

STATICS OF RIGID BODIES **9 Hours**

Principle of transmissibility – Moment of force about a point – Varignon's theorem – Moment of a couple – Equivalent couple – Moment of force about an axis – Coplanar non-concurrent forces acting on rigid bodies – Resultant and equilibrium – Resolution of a given force into force couple system – Equilibrium in three dimensions – Reactions and supports.

GEOMETRY DEPENDANT PROPERTIES **9 Hours**

Centre of gravity, Centre of mass and Centroid – Moment of Inertia of simple and complex areas – Transfer formula – Radius of gyration – Polar moment of inertia – Product of inertia - Mass moment of Inertia of simple solids.



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FRICTION **6 Hours**

Laws of friction – coefficient of friction – Dry friction – wedge friction – ladder friction – rolling resistance.

DYNAMICS OF PARTICLES **12 Hours**

Kinematics – Rectilinear and curvilinear motion – projectile motion
Kinetics – Newton's second law – D'Alembert's Principle – Work Energy method – Principle of Impulse momentum – Impact of Elastic Bodies.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Beer F P and Johnson E R, "Vector Mechanics for Engineers, Statics and Dynamics", Tata Mc-Graw Hill Publishing Co. Ltd., New Delhi, 2006.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3. J.L. Meriam & L.G. Karige, Engineering Mechanics: Statics (Volume I) and Engineering Mechanics: Dynamics (Volume II), 7th edition, Wiley student edition, 2013.
4. P. Boresi & J. Schmidt, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
5. Irving H. Shames, G. Krishna Mohana Rao, Engineering Mechanics - Statics and Dynamics, Fourth Edition – PHI / Pearson Education Asia Pvt. Ltd., 2006.
6. Rajasekaran S and Sankarasubramanian G, "Engineering Mechanics-Statics and Dynamics", Vikas Publishing House Pvt. Ltd., New Delhi, 2006

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U18CSI2201	PYTHON PROGRAMMING	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Classify and make use of python programming elements to solve and debug simple logical problems.(K4,S3)
CO2: Experiment with the various control statements in Python.(K3,S2)
CO3: Develop Python programs using functions and strings.(K3,S2)
CO4: Analyze a problem and use appropriate data structures to solve it.(K4,S3)
CO5: Develop python programs to implement various file operations and exception handling.(K3,S2)

Pre-requisites : -

CO-PO and CO-PSO Mapping:

CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
Cos	PROGRAMME OUTCOMES (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		S			M					M		M		
CO2			M							M		M		
CO3			M							M		M		M
CO4	S	S	M		M					M		M	M	M
CO5			M							M		M		

Course Assessment methods

DIRECT
1. Continuous Assessment Test I, II (Theory component) 2. Open Book Test, Assignment 3. Viva, Experimental Report for each Experiment (lab Component) 4. Model Examination (lab component) 5. End Semester Examination (Theory and lab components)
INDIRECT
Course-end survey

THEORY COMPONENT CONTENTS

BASICS OF PYTHON PROGRAMMING **6 Hours**

Introduction-Python Interpreter-Interactive and script mode -Values and types, operators, expressions, statements, precedence of operators, Multiple assignments, comments.

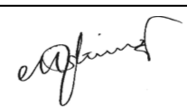
CONTROL STATEMENTS AND FUNCTIONS IN PYTHON **6 Hours**

Conditional (if), alternative (if-else), chained conditional (if-elif-else)-Iteration-while, for, break, continue, pass – Functions - Introduction, inbuilt functions, user defined functions, passing parameters, return values, recursion, Lambda functions.

DATA STRUCTURES: STRINGS, LISTS and SETS **7 Hours**

Strings-String slices, immutability, string methods and operations -Lists-creating lists, list operations, list methods, mutability, aliasing, cloning lists, list and strings, list and functions-list processing-list comprehension, searching and sorting, Sets-creating sets, set operations.

DATA STRUCTURES: TUPLES, DICTIONARIES **5 Hours**



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Tuples-Tuple assignment, Operations on Tuples, lists and tuples, Tuple as return value-Dictionaries-operations and methods, Nested Dictionaries.

FILES, MODULES, PACKAGES **6 Hours**

Files and Exception-Text files, reading and writing files, format Operator-Modules-Python Modules-Creating own Python Modules-packages, Introduction to exception handling.

REFERENCES

1. Ashok Namdev Kamthane, Amit Ashok Kamthane, “Programming and Problem Solving with Python” , Mc-Graw Hill Education,2018.
2. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, Second edition, Updated for Python 3, Shroff / O’Reilly Publishers, 2016.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python: An Inter-disciplinary Approach”, Pearson India Education Services Pvt. Ltd., 2016.
4. Timothy A. Budd,” Exploring Python”, Mc-Graw Hill Education (India) Private Ltd., 2015.
5. Kenneth A. Lambert, “Fundamentals of Python: First Programs”, CENGAGE Learning, 2012.
6. Charles Dierbach, “Introduction to Computer Science using Python: A Computational Problem Solving Focus”, Wiley India Edition, 2013.

E BOOKS AND ONLINE LEARNING MATERIALS

1. www.mhhe.com/kamthane/python
2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Second edition, Updated for Python 3, Shroff / O’Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)

LAB COMPONENT CONTENTS

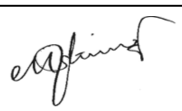
LIST OF EXPERIMENTS

1. Implement simple python programs using interactive and script mode.
2. Develop python programs using id() and type() functions
3. Implement range() function in python
4. Implement various control statements in python.
5. Develop python programs to perform various string operations like concatenation, slicing, Indexing.
6. Demonstrate string functions using python.
7. Implement user defined functions using python.
8. Develop python programs to perform operations on list
9. Implement dictionary and set in python
10. Develop programs to work with Tuples.
11. Create programs to solve problems using various data structures in python.
12. Implement python program to perform file operations.
13. Implement python programs using modules and packages.

Theory: 30 Hours	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 60 Hours**

ONLINE COURSES AND VIDEO LECTURES:

http://nptel.ac.in
https://www.edx.org/course/introduction-to-python-fundamentals-1
https://www.edx.org/course/computing-in-python-ii-control-structures-0
https://www.edx.org/course?search_query=Computing+in+Python+III%3A+Data+Structures



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U18AEI2201	MANUFACTURING PROCESS	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Describe the different casting processes starting from the part design.

CO2: Explain the basic use and operation of various welding methods.

CO3: Describe metal cutting processes using conventional machines.

CO4: Explain the principle of working, mechanism of metal removal in unconventional machining processes.

CO5: Explain the principle of working and mechanism of various types of forging processes.

Pre-requisites : -

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													PSO Mapping	
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	M			S									M
CO 2	S	M			S									M
CO 3	S	M			S									M
CO 4	S	M			S									M
CO 5	S	M			S									M

Course Assessment methods

Direct
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc (as applicable) 3. End Semester Examination
Indirect
1. Course-end survey

<u>THEORY COMPONENT CONTENTS</u>

CASTING **6 Hours**

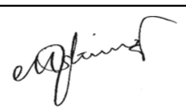
Methods of production processes – comparison - sand casting -mould, pattern, die - pattern allowances - materials - types - 2 and 3 box molding process-steps involved - core function and core making - runner, riser ,gate purpose - construction, principle, merits, demerits and applications of following casting processes: sand mould, shell mould, investment molding, permanent mould casting, casting defects and their remedy.

WELDING **6 Hours**

Classification of welding processes, principles of gas welding, metal arc welding, submerged arc welding, tungsten inert gas welding, metal inert gas welding, resistance welding, soldering and brazing, welding discontinuities and their remedy.

MACHINING **6 Hours**

Machine tools - construction - parts and working of lathe, drilling machine, shaper, milling machine and grinding machine. Machining operations performed on lathe and drilling machines. Introduction to CNC machines.



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UNCONVENTIONAL MACHINING PROCESS **6 Hours**

Working principle and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining – advantages and disadvantages.

METAL FORMING **6 Hours**

Principles and applications of the following processes: Forging, Rolling, Extrusion, Wire drawing and Spinning.

REFERENCES

1. S.K Hajra Choudhury, 'Elements of Workshop Technology', Vol. I and II, Media Promoters and Publishers Pvt. Ltd., Mumbai, 2001.
2. R. K. Jain and S. C. Gupta, 'Production Technology', Sixteenth Edition, Khanna Publishers, 2001.
3. H. M. T. Bangalore, 'Production Technology – Hand Book', Tata McGraw-Hill Education, 2001.
4. Serope Kalpajian and Steven R. Schimid, 'Manufacturing Engineering and Technology', Pearson Education, Inc., 2002.
5. M P Grover, Modern Manufacturing Processes, John Wiley (2002).
6. R S Parmar, Welding process and technology, Khanna Publisher, New Delhi (2004).

   P N Rao, Manufacturing Technology Vol. I & II, Tata McGraw Hill (2009)

LAB COMPONENT CONTENTS

LIST OF EXPERIMENTS

1. Mould with solid, split pattern and loose-piece pattern
2. Mould with Core
3. SMAW of different types of joints
4. MIG and TIG Welding of different types of joints
5. Facing, plain and step turning
6. Taper turning using compound rest method
7. Drilling, reaming and tapping for a given dimension of hole
8. Boring and internal thread cutting.
9. Dove tail machining using shaper machine
10. Spur Gear cutting using Milling machine
11. Cylindrical grinding of a shaft
12. Conversion of round rod in to square rod
13. Conversion of round rod in to rectangular rod

Theory: 30 Hours	Tutorial: 0	Practical: 30 Hours	Project: 0	Total: 60 Hours

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U18INI2600	ENGINEERING CLINIC - II	L	T	P	J	C
		0	0	4	2	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify a practical problems and find a solution

CO2: Understand the project management techniques

CO3: Demonstrate their technical report writing and presentation skills

Pre-requisites :

1. U18INI1600 - Engineering Clinic - I

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S	S	
CO2											S		W	
CO3										S			W	

Course Assessment methods

Direct	Indirect
1. Project reviews 50%	1. Course Exit Survey
2. Workbook report 10%	
3. Demonstration & Viva-voce 40%	

Content:

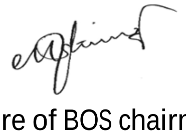
The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the II semester, students will focus primarily on Raspberry pi based controllers with Python programming

GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the ‘Engineering Clinics Expo’ at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total: 90 Hours



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SEMESTER III

U18MAT3101	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS	L	T	P	J	C
		3	1	0	0	4

(Common to AE/AUE/CE/ME/MCE/EEE)

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO1: Form partial differential equations and solve certain types of partial differential equations.

CO2: Determine the Fourier Series and half range Fourier Series of a function

CO3: Solve one dimensional wave equation, one dimensional heat equation in steady state using Fourier series.

CO4: Apply Fourier series to solve the steady state two dimensional heat equation in cartesian coordinates.

CO5: Identify Fourier transform, Fourier sine and cosine transform of certain functions and use Parseval's identity to evaluate integrals.

CO6: Evaluate Z – transform of sequences and inverse Z – transform of functions and solve difference equations.

Pre-requisite: -

CO-PO and CO-PSO Mapping:

CO/PO Mapping (Subject to vary from dept to dept.) (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M			M				M	M		S	M	
CO2	S	M		M									M	
CO3	S	S	S		S				M	M		S	S	
CO4	S	M	M									M	S	
CO5	S	M	M		S								S	
CO6	S	S			S				M	M		S	S	

Course Assessment Methods:

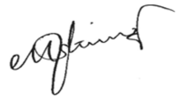
Direct
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
Indirect
1. Course-end survey

PARTIAL DIFFERENTIAL EQUATIONS 9+3 Hours

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of PDE by variable separable method – Solution of standard types of first order partial differential equations (excluding reducible to standard types) – Lagrange's linear equation – Linear homogeneous partial differential equations of second and higher order with constant coefficients.

FOURIER SERIES 9+3 Hours

Dirichlet's conditions – General Fourier series – Odd and Even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic Analysis.



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BOUNDARY VALUE PROBLEMS – ONE DIMENSIONAL EQUATIONS **5+2 Hours**

Classification of second order quasi linear partial differential equations –Solution of one dimensional wave equation – One dimensional heat equation (excluding insulated ends) – Fourier series solutions in Cartesian coordinates.

BOUNDARY VALUE PROBLEMS – TWO DIMENSIONAL EQUATIONS **4+1 Hours**

Steady state solution of two-dimensional heat equation (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

FOURIER TRANSFORM **9+3 Hours**

Statement of Fourier integral theorem – Infinite Fourier transforms – Sine and Cosine Transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval’s identity.

Z –TRANSFORM **9+3 Hours**

Z-transform - Elementary properties – Convolution theorem- Inverse Z – transform (by using partial fractions, residues and convolution theorem) – Solution of difference equations using Z - transform.

Theory : 45 Hours	**Tutorial: 15 Hours**	**Practical: 0**	**Project: 0**	**Total: 60 Hours**

REFERENCES:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 44th Edition. 2014.
2. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
3. Kandasamy P., Thilagavathy K. and Gunavathy K., “Engineering Mathematics Volume III”, S.Chand & Company ltd., New Delhi, 2006.
4. Ian Sneddon., “Elements of partial differential equations”, McGraw – Hill, New Delhi, 2003.
5. Arunachalam T., “Engineering Mathematics III”, Sri Vignesh Publications, Coimbatore 2013.

U18AEI3201	FLUID MECHANICS	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO 1: Apply the principles of fluid statics to solve problems involving forces on submerged surfaces.

CO 2: Analyze the different fluid flow patterns using Lagrangian and Eulerian descriptions and flow visualization techniques.

CO 3: Evaluate the effectiveness of dimensional analysis methods like Buckingham's π theorem in predicting fluid behavior.

CO 4: Analyze models to demonstrate boundary layer behavior and evaluate its impact on drag force in practical applications.

CO 5: Analyze and compare the force exerted by jets on various plate configurations to assess their performance.

CO 6: Demonstrate experimental techniques to determine fluid properties and validate theoretical principles in fluid mechanics.

Pre-requisites : -

CO-PO and CO-PSO Mapping:

CO/PO & PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M									S			
CO2	S	M		S						M				
CO3	S	M									S		M	
CO4		M									S		M	
CO5	S	M									S	M		
CO6	S			S	W								S	

Course Assessment methods

Direct	
1. Internal Test I 2. Internal Test II 3. Assignments 4. End Semester Exam	1. Lab Workbook 2. Viva-voce 3. Model Practical Exams
Indirect	
1. Course-end survey	

FLUID STATICS **10 Hours**

Introduction to Fluid — Units and Dimensions – Mass density – Specific weight – Specific volume – Specific gravity – Energy and Specific heats – Viscosity – Compressibility – Surface tension – Capillarity – Vapor pressure and Cavitation.

Hydrostatic equation – Forces on plane and curved surfaces – Buoyancy – Metacentre – Simple and differential manometers – Mechanical pressure gauges – Relative equilibrium.

FLUID DYNAMICS **10 Hours**

Lagrangian vs Eulerian descriptions, Classification of fluid flows - Flow Visualization – Path line – Stream line – Streak line – Stream and Potential functions – Flownets.

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Governing equations: Continuity equation – Momentum equation – Energy equation – Euler's equation – Bernoulli's equation – Applications.

DIMENSIONAL ANALYSIS AND SIMILITUDE **9 Hours**

Rayleigh's method – Buckingham's π theorem – Geometric, Kinematic, and Dynamic similitude – Scale effect – Dimensionless parameters – Mach Number, Reynolds Number, Prandtl Number – Model laws.

BOUNDARY LAYER FLOW **9 Hours**

Boundary layer, Boundary layer thickness: Displacement, Momentum and Energy thickness. Drag force on a flat plate due to boundary layer –Turbulent boundary layer on a flat plate - Deduction of Governing equations of boundary layer from Navier Stoke's Equation – Separation of boundary layer.

IMPACT OF JETS **7 Hours**

Force exerted by the jet on a stationary vertical plate, Hinged plate and moving plates.

REFERENCES

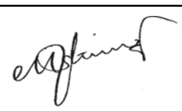
1. Yunus A. Cengel and John M. Cimbala, 'Fluid Mechanics: Fundamentals and Applications', Fourth Edition, McGraw-Hill, 2017.
2. Frank M. White, 'Fluid Mechanics', McGraw Hill Education India Private Limited, Eighth Edition, 2017.
3. Philip J. Pritchard, Fox and McDonald, 'Introduction to Fluid Mechanics', John Wiley & Sons Inc, Ninth Edition, 2015.
4. Pijush K. Kundu, Ira M. Cohen and David R. Dowling, 'Fluid Mechanics', Sixth Edition, Academic Press, 2015.
5. S K Som, Gautam Biswas, and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, McGraw Hill Education, Third edition, 2017.
6. R. K Bansal, "A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi Publications; Tenth edition, 2018.
7. Egon Krause, 'Fluid Mechanics with Problems and Solutions, and an Aerodynamic Laboratory', Springer Publications, 2010.
8. Ethirajan Rathakrishnan , Fluid Mechanics: An Introduction, PHI, Third edition, 2012.

WEBSITE REFERENCES

1. http://nptel.ac.in/courses/101103004/ Principles of Fluid Dynamics
2. https://nptel.ac.in/courses/112104118/ Fluid Mechanics
3. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-01-unified-engineering-i-ii-iii-iv-fall-2005-spring-2006/fluid-mechanics/

LIST OF EXPERIMENTS

1. Determination of Darcy's friction factor
2. Determination of coefficient of discharge of Venturimeter
3. Determination of coefficient of discharge of Orificemeter
4. Determination of minor losses
5. Determination of coefficient of discharge of notches
6. Determination of coefficient of discharge of mouthpiece – variable head
7. Determination of coefficient of discharge of orifice– constant head
8. Determination of coefficient of discharge of Rotometer
9. Verification of Bernoulli's theorem



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10. Determination of Reynolds Number

Theory: 45 Tutorial: 0 Practical: 30 Project: 0 Total: 75 Hours

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U18AEI3202	ENGINEERING THERMODYNAMICS	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the basic concepts of thermodynamics to analyze and solve problems related to closed and open systems.

CO2: Apply the second law of thermodynamics for various engineering systems.

CO3: Analyse and evaluate the performance of Otto, Diesel, Dual and Bryton cycle under various operating conditions.

CO4: Explain about operating principle of various refrigeration cycles.

CO5: Calculate the stoichiometric air fuel ratio for different fuels.

CO6: Conduct experiments on various thermodynamics systems.

Pre-requisites : -

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													**PSO Mapping**	
COs	**Programme Outcomes (POs)**												**PSOs**	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	S												M	
CO 2	S	M											M	
CO 3	S		S										M	
CO 4			M	S									M	
CO 5		S											S	
CO 6				S	S								S	

Course Assessment methods

Direct
1. Continuous Assessment Test I, II (Theory component).
2. Assignment (Theory component).
3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (lab component)
4. Model examination (lab component)
5. End Semester Examination (Theory and lab component)
Indirect
1. Course-end survey

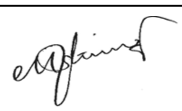
<u>THEORY COMPONENT CONTENTS</u>

BASIC CONCEPTS AND FIRST LAW **12 Hours**

Concept of continuum, macroscopic approach, and thermodynamic systems – Property, state, path and process-quasi-static process - work, Zeroth law of thermodynamics – Concept of temperature and heat, internal energy, specific heat capacities, enthalpy – Concept of ideal and real gases – First law of thermodynamics and its applications to closed and open systems – Introduction heat transfer - Numerical problems.

SECOND LAW AND ENTROPY **9 Hours**

Second law of thermodynamics – Kelvin planck and clausius statements of second law – Reversibility and irreversibility – Carnot theorem – Carnot cycle, Reversed Carnot cycle, Efficiency– Thermodynamic temperature scale – Clausius inequality, concept of entropy, entropy of ideal gas - principle of increase of entropy-Numerical problems.



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AIRCYCLES 10 Hours

Otto, Diesel, Dual and Brayton cycles – P-V and T-S diagrams, description -Air standard efficiency - Mean effective pressure. Comparison of Otto, Diesel and Dual cycle, introduction to modified Brayton cycle and Jet Propulsion cycle -Numerical problems.

REFRIGERATION CYCLES 6 Hours

Vapor compression refrigeration, Absorption refrigeration and Gas refrigeration Cycles. Introduction to air conditioning system.

I LAW APPLICATION TO CHEMICALLY REACTING SYSTEMS 8 Hours

Theoretical (Stoichiometric) air for combustion of fuels. Excess air, mass balance, Exhaust gas analysis, A/F ratio. Energy balance for a chemical reaction, enthalpy of formation - Adiabatic flame temperature.

REFERENCES

1. Cengel, Y. A. and Boles, M. A., Thermodynamics: An Engineering Approach, 8th ed., McGraw-Hill (2014).
2. Moran, M. J., Shapiro, H. N., Boettner, D. D., and Bailey, M. B., Principles of Engineering Thermodynamics (SI Version), 8th ed., Wiley (2015).
3. Spalding, D. B. and Cole, E. H., Engineering Thermodynamics, 3rd ed., Edward Arnold (1973).
4. Nag, P. K., Engineering Thermodynamics, 5th edition. Tata McGraw-Hill (2013).
5. D. P. Mishra, Fundamentals of Combustion, PHI Learning Pvt. Ltd. Revised 1st edition 2007.
6. Borgnakke, C. and Sonntag, R. E., Fundamentals of Thermodynamics, 8th ed., Wiley (2013).
7. Balmer, R. T., Modern Engineering Thermodynamics, Academic Press (2011)

WEBSITE REFERENCES

1. https://www.edx.org/learn/thermodynamics
2. https://www.coursera.org/learn/thermodynamics-intro
3. https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/index.htm
4. http://nptel.ac.in/courses/101104063/#

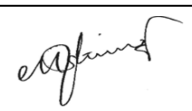
<u>LAB COMPONENT CONTENTS</u>

LIST OF EXPERIMENTS

1. Determination of viscosity in a given fuel.
2. Determination of flash and fire point in a given fuel.
3. Determination of Thermal Conductivity of solid.
4. Valve Timing and Port Timing Diagrams.
5. COP test on a vapour compression refrigeration test rig.
6. Performance Test on Diesel Engine by Hydraulic loading.

LIST OF EQUIPMENTS

1. Redwood viscometer.
2. Flash and Fire point apparatus.



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3. Conductive Heat Transfer set up.
4. Cut Section of 4-Stroke and 2-Stroke Engine.
5. Vapour compression refrigeration test rig.
6. Single cylinder 4-stroke Diesel engine with Hydraulic loading.

Theory: 45	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 75 Hours**

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U18AEI3203	MECHANICS OF SOLIDS	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the concepts of stress and strain to analyze deformation in simple and compound bars.

CO2: Analyze shear force and bending moment diagrams to determine the stresses in beams under various loading conditions.

CO3: Evaluate beam deflection and slope using different methods to understand beam behavior under loads.

CO4: Analyze the torsional behavior of circular bars to calculate shear stress distribution and torsional stiffness.

CO5: Evaluate biaxial stress conditions using Mohr's circle to predict principal stresses and maximum shear stress.

CO6: Demonstrate the determination of material properties through laboratory experiments to validate theoretical principles.

Pre-requisites: -

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**												**PSOs**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	M	W										M	
CO 2	S	M	W										M	
CO 3	S	M	W										M	
CO 4	S	M	W										M	
CO 5	S	M	W										M	
CO 6	S	M	W										M	

Course Assessment methods

Direct
1. Continuous Assessment Test I, II 2. Assignment; Group Presentation 3. Model Practical; Viva voice 4. End Semester Examination
Indirect
1. Course-end survey

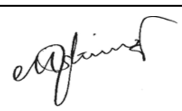
<u>THEORY COMPONENT CONTENTS</u>

STRESS, STRAIN AND DEFORMATION OF SOLIDS — 6 Hours

Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses; Tensile, Compressive and Shear – Strain – Poisson’s ratio – Lateral strain – Deformation of simple and compound bars under axial load – Thermal stress – Elastic constants – Strain energy and unit strain energy – Numerical Problems.

BEAMS – LOADS AND STRESSES — 6 Hours

Types of beams: Supports and Loads – Shear force and Bending Moment in beams – Cantilever and Simply supported beams– Stresses in beams – Theory of simple bending – Bending stress distribution in the beam section.– Numerical Problems.



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BEAM DEFLECTION **6 Hours**

Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Double integration method, Macaulay Method -Numerical Problems.

TORSION **6 Hours**

Analysis of torsion of circular bars – Shear stress distribution – Bars of solid and hollow circular section – Twist and torsion stiffness – Compound shafts – Numerical Problems.

ANALYSIS OF STRESSES IN 2D ELEMENTS **6 Hours**

Biaxial state of stresses at a point – Stresses on inclined plane – Principal planes and stresses – Mohr's circle for biaxial stresses – Maximum shear stress – Numerical Problems.

REFERENCES

1. S. Timoshenko, "Strength of Materials", Vol. II, CBS Publishers, 2002.
2. F. P. Beer, E. R. Johnston and J. T. DeWolf, "*Mechanics of Materials*", McGraw-Hill Publication, NY, 2012.
3. Srinath L.S., "Advanced Mechanics of Solids", Tata McGraw-Hill Publishing Co., New Delhi, 2003.
4. William A. Nash, "Schaum's Outline of Theory and Problems of Strength of Materials", Tata McGraw-Hill Publishing Co., New Delhi, 2007.

WEBSITE REFERENCES

1. https://ocw.mit.edu/courses/mechanical-engineering/2-001-mechanics-materials-i-fall-2006/index.htm
2. https://cosmolearning.org/courses/mechanics-solids-structural-mechanics/
3. http://nptel.ac.in/courses/112107146/
4. http://www.engineeringcorecourses.com/solidmechanics1/

LAB COMPONENT CONTENTS

LIST OF EXPERIMENTS

1. Determination of Young's Modulus using deflection of Cantilever beam.
2. Determination of Young's modulus and fracture strength of steel using UTM
3. Determination beam support reaction
4. Verification of Principle of Superposition.
5. Verification of Maxwell's Reciprocal theorem.
6. Determination of Stresses of constant strength beam.
7. Charpy Impact tests on different materials.

LIST OF EQUIPMENTS:

S. No.	Name of the equipment	Quantity Required
1	Universal Testing Machine	1
2	Beam Test set up	3
3	Constant Strength Beam Setup	1
4	Charpy Impact Testing Machine	1

Theory: 30	Tutorial: 0	Practical: 30	Project: 0	Total: 60 Hours

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		L	T	P	J	C
U18EEI3202	**AIRCRAFT ELECTRICAL AND ELECTRONICS SYSTEMS**	**2**	**0**	**2**	**0**	**3**

Course Outcomes

After successful completion of this course, the students will be able to

CO 1: Discuss the fundamentals of DC circuits and its applications in aircraft systems.

CO 2: Explain the relationships among current, voltage and power in AC circuits and their role in aircraft systems.

CO 3: Explain the construction, working principle of electrical machines and their applications in aircraft systems.

CO 4: Explain the working of semiconductor devices and their role in aircraft systems.

CO 5: Apply the fundamentals of digital electronics to digital circuits.

Pre-requisite(s): -

CO-PO and CO-PSO Mapping:

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**												**PSOs**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	M		W	-	-	-	-	-	-	-	W	M	-
CO 2	S	M		W	-	-	-	-	-	-	-	W	M	-
CO 3	S	M		W	-	-	-	-	-	-	-	W	M	-
CO 4	S	M		W	-	-	-	-	-	-	-	W	M	-
CO 5	S	M		W	-	-	-	-	-	-	-	W	M	-

Course Assessment Methods

Direct Assessment
1. Internal Tests 2. Assignments 3. Practical Exams 4. End Semester Exam
Indirect Assessment
Course exit survey

<u>Theory Component:</u>

DC CIRCUITS — 6 Hours

Basic circuit elements and sources, Ohms law, Kirchhoff's laws, Series and parallel connection of circuit elements, Power, Work, Energy, Capacitance, Energy stored in a capacitor, DC circuits in Aircraft systems.

AC CIRCUITS — 6 Hours

Alternating voltages and current, Sinusoidal waveform, Cycle and frequency, RMS value, Alternating current through Resistance, Inductance and Capacitance, Power factor, Active and Reactive power, AC circuits in Aircraft systems.

ELECTRICAL MACHINES (Qualitative Treatment Only) — 7 Hours

Construction and working Principle of DC Machines, Single phase Transformers, Alternators and single phase induction motors, Application of Electrical machines in Aircraft systems.

SEMICONDUCTOR DEVICES AND CIRCUITS — 5 Hours

Construction and working Principle of PN junction diode, Zener Diode, Half wave and Full wave rectifiers, BJT, JFET, Integrated circuits in Aircrafts.

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DIGITAL CIRCUITS **6 Hours**

Binary number system, Logic Gates, Boolean algebra, Half adder, Full Adder/ Subtractor, Multiplexer, Demultiplexer.

Lab Component:

List of Experiments/Exercises

1. Verification of Kirchoff's Voltage and Current Laws.
2. Load test on DC shunt motor.
3. Load test on single phase transformer.
4. Load test on single phase induction motor.
5. Open Circuit Characteristics of Three-Phase Alternator.
6. Characteristics of PN junction diode and Zener diode.
7. Full wave rectifier with and without filter.
8. Verification of truth tables.
9. Inspection of Electrical circuit in Cessna 172 aircraft.
10. Inspection of Electrical circuit in Hansa aircraft.

Theory: 30 Hours	Tutorial: 0	Practical: 30 Hours	Project: 0	Total: 60 Hours

REFERENCES

1. Mike Tooley and David Wyatt, 'Aircraft Electrical and Electronic Systems Principles, Operation and Maintenance', Elsevier, 2009.
2. Theraja B.L., 'Fundamentals of Electrical Engineering and Electronics', S. Chand Publishing, 2012.
3. Muthusubramanian R, Salivahanan S and Muraleedharan K A, 'Basic Electrical, Electronics and Computer Engineering', Second Edition, Tata McGraw Hill, 2006.
4. Thomas L Floyd, 'Electronic Devices', Sixth Edition, Pearson Education, 2003.
5. Sedha R.S., 'Applied Electronics', S. Chand and Co., 2006.

WEBSITE REFERENCES

1. NPTEL Online course materials on Semiconductor Devices and Circuits: https://nptel.ac.in/courses/108108112/
2. NPTEL Online course materials on Electrical Machines-I: https://nptel.ac.in/courses/108105017/
3. NPTEL Online course materials on Basic Electrical Technology: https://nptel.ac.in/downloads/108105053/
4. NPTEL Online course materials on Digital Circuits and Systems: https://nptel.ac.in/courses/117106114/

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U18AEP3504	CAD LABORATORY	L	T	P	J	C
		0	0	2	0	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Use the CATIA software program to create drawings from scratch and to modify, manipulate, copy, delete and save drawings.

CO2: Design simple and critical components using CATIA modeling software.

CO3: Assemble and animate the three dimensional complex parts.

CO4: Design the surface model of critical shape components.

CO5: Use the full range of CATIA commands and options and employ shortcuts and time-saving strategies to operate the program at a level of efficiency acceptable for employment as a CAD Engineer.

Pre-requisites:-

CO-PO and CO-PSO Mapping:

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1					S									M
CO 2					S									M
CO 3					S									M
CO 4					S									M
CO 5					S									M

Course Assessment methods

Direct
1. Pre-or Post-experiment Test/Viva; Experimental Report for each experiment; Comprehensive report / Model Examination 2. End Semester Examination
Indirect
1. Course-end survey

List of Experiments

1. Study of modeling software (CATIA)
2. Part modeling of simple mechanical components.
3. Part modeling of upper housing of a blower
4. Part modeling of helical gear.
5. Assembly of universal coupling.
6. Assembly of plummer block
7. Study of surface modeling
8. Animation of slider crank mechanism
9. Animation of I.C Engine
10. Drafting

Theory: 0 Tutorial: 0 Practical: 30 Project: 0 Total: 30Hours

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U18INI3600	ENGINEERING CLINIC - III	L	T	P	J	C
		0	0	4	2	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify a practical problems and find a solution

CO2: Understand the project management techniques

CO3: Demonstrate their technical report writing and presentation skills

Pre-requisites : U18INI2600 - Engineering Clinic - II

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak																
COs	Programme Outcomes(POs)														PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S			S	
CO2											S				W	
CO3										S					W	

Course Assessment methods

Direct	Indirect
1. Project reviews 50%	1. Course Exit Survey
2. Workbook report 10%	
3. Demonstration & Viva-voce 40%	

Content:

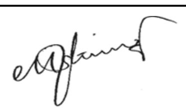
The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the III semester, students will focus primarily on Design project combining concepts learnt in Engineering clinics I and II

GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total: 90 Hours



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U18CHT3000	ENVIRONMENTAL SCIENCE AND ENGINEERING (COMMON TO ALL BRANCHES)

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Analyze the impact of engineering solutions in a global and societal context.
CO2: Discuss contemporary issues that results in environmental degradation and would attempt to provide solutions to overcome those problems.
CO3: Highlight the importance of ecosystem and biodiversity.
CO4: Consider issues of environment and sustainable development in his/her personal and professional undertakings.
CO5: Paraphrase the importance of conservation of resources.
CO6: Play an important role in transferring a healthy environment for future generations.

Pre-requisites : -

CO-PO and CO-PSO Mapping:

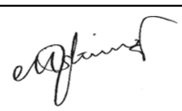
CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M					S		M				W	-
CO2						M				M			-	-
CO3							M						-	-
CO4						M	S						-	-
CO5							S						-	-
CO6			W				S					M	-	-

Course Assessment methods

Direct
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation 5. End Semester Exam
Indirect
Course end survey

INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES **14 Hours**

Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies – Timber extraction, mining, dams and their effects on forests and tribal people.
Water resources: Use and overutilization of surface and ground water, conflicts over water, dams – benefits and problems – Water conservation, rain water harvesting, watershed management.
Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, case studies.
Energy resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources, case studies.



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Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification, Wasteland reclamation – Role of an individual in conservation of natural resources.

ECOSYSTEMS AND BIODIVERSITY **9 Hours**

ECOSYSTEM: Concept of an ecosystem – Structure and function of an ecosystem: Producers, consumers and decomposers, Food chain, Food web, Energy flow in the ecosystem and Ecological pyramids – Ecological succession – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

BIODIVERSITY: Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity – Bio geographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic values – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

ENVIRONMENTAL POLLUTION **8 Hours**

Definition – Causes, effects and control measures of: (a) Air pollution – Organic and inorganic pollution – cyclone separator, electrostatic precipitator (b) Water pollution (c) Heavy metal pollution (d) Noise pollution (e) Thermal pollution (f) Nuclear hazards – Role of an individual in prevention of pollution – Pollution case studies – Solid waste and hazardous Management: Causes, effects and control measures from factories, small scale and large scale industries – Waste minimization – Disaster management: floods, earthquake, cyclone and landslides.

SOCIAL ISSUES AND THE ENVIRONMENT **7 Hours**

From Unsustainable to Sustainable development – Urban problems related to energy – Resettlement and rehabilitation of people; its problems and concerns, case studies – Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Human Rights.

HUMAN POPULATION AND THE ENVIRONMENT **7 Hours**

Population growth and explosion – Welfare Program – Environment and human health – Communicable disease – Role of Information Technology in Environment and human health – Case studies.

Theory: 45 Hours	**Tutorial:**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. G. Tyler Miller and Scott Spoolman, 'Environmental Science', Fourteenth Edition, Brooks Cole, 2012.
2. Gilbert M. Masters and Wendell P. Ela, 'Introduction to Environmental Engineering and Science', Third Edition, Pearson Education, 2013.
3. Bharucha Erach, 'The Biodiversity of India', Mapin Publishing Pvt. Ltd., Ahmedabad, 2002.
4. Trivedi R.K and P.K.Goel, 'Introduction to Air Pollution', Techno-Science

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Publications, 2003.
5. Trivedi R.K., 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media, 1996.
6. Cunningham, W.P.Cooper and T.H.Gorhani, 'Environmental Encyclopedia', Jaico Publication House, Mumbai, 2001.
7. Wager K.D., 'Environmental Management', W.B. Saunders Co., Philadelphia, USA, 1998.
8. Colin R. Townsend, Michael Begon and John L. Harper, 'Essentials of Ecology', Third Edition, Blackwell Publishing, 2008.

SEMESTER IV

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U18MAT4101	NUMERICAL METHODS AND PROBABILITY	L	T	P	J	C
		3	1	0	0	4

(Common to AE/AUE/CE/ME/MCE/EEE)

COURSE OUTCOMES

After successful completion of this course, the students will be able to

CO1: Apply various numerical techniques for solving non-linear equations and systems of linear equations.

CO2: Analyze and apply the knowledge of interpolation and determine the integration and differentiation of the functions by using the numerical data.

CO3: Predict the dynamic behaviour of the system through solution of ordinary differential equations by using numerical methods.

CO4: Solve PDE models representing spatial and temporal variations in physical systems through numerical methods.

CO5: Apply the concepts of probability to random variables.

CO6: Construct probabilistic models for observed phenomena through distributions which play an important role in many engineering applications.

Pre-requisite: -

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S											S	
CO2	S	S											S	
CO3	S	S							M				S	
CO4	S	S											S	
CO5	S	S							M				S	
CO6	S	S											S	

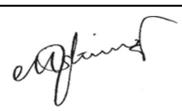
Course Assessment Methods:

Direct
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
Indirect
1. Course-end survey

SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 9+3 Hours

Linear interpolation method – Iteration method – Newton's method – Solution of linear system by Gaussian elimination and Gauss-Jordan methods - Iterative methods: Gauss Jacobi and Gauss - Seidel methods – Inverse of matrix by Gauss – Jordan method – Eigenvalues of a matrix by Power method.

INTERPOLATION, NUMERICAL DIFFERENTIATION AND 9+3 Hours



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INTEGRATION

Lagrange's and Newton's divided difference interpolation – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal and Simpson's rules.

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS **9+3 Hours**

Single step methods: Taylor's series method – Euler and Improved Euler methods for solving a first order equations – Fourth order Runge-Kutta method for solving first and second order equations – Multistep method: Milne's predictor and corrector method.

BOUNDARY VALUE PROBLEMS IN PARTIAL DIFFERENTIAL EQUATIONS **9+3 Hours**

Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain–Solution of one dimensional heat equation using Bender Schmidt and Crank Nicholson difference schemes –Solution of one dimensional wave equation by explicit scheme.

PROBABILITY AND RANDOM VARIABLES **9+3 Hours**

Axioms of probability - Conditional probability – Total probability – Bayes' theorem – Random variable – Distribution function – properties – Probability mass function- Probability density function – moments - Binomial, Poisson and Normal distributions – Properties.

Theory: 45 Hours	**Tutorials: 15 Hours**	**Practical: 0**	**Project: 0**	**Total: 60 Hours**

REFERENCES

1. Grewal, B.S. and Grewal,J.S., " Numerical methods in Engineering and Science", 9th Edition, Khanna Publishers, New Delhi, 2007.
2. Gerald, C. F. and Wheatley, P. O., "Applied Numerical Analysis", 7th Edition, Pearson Education Asia, New Delhi, 2007.
3. Chapra, S. C and Canale, R. P. "Numerical Methods for Engineers", 7th Edition, Tata McGraw-Hill, New Delhi, 2016.
4. R.A. Johnson and C.B. Gupta, "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2016.
5. R.E. Walpole, R.H. Myers, S.L. Myers, and K Ye, "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th edition, 2017.
6. Gupta S.C, and Kapur V.K "Fundamentals of Applied Statistics", Sultan Chand, New Delhi, 4th Edition, 2014.

U18AEI4201	LOW SPEED AERODYNAMICS	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Analyze aerodynamic forces and moments using Bernoulli's equation and Pitot tube measurements.

CO2: Evaluate the effects of elementary flows and their combinations on lift generation using the Kutta-Joukowski theorem.

CO3: Analyze and apply conformal transformations to solve fluid flow problems involving complex potentials.

CO4: Analyze airfoil characteristics and the effects of vortex systems on induced drag using thin airfoil theory.

CO5: Evaluate the performance of fixed and variable pitch propellers using Froude momentum and blade element theories.

CO6: Demonstrate experimental methods to measure pressure distribution and aerodynamic parameters of airfoils and cylinders.

Pre-requisites : U18AEI3201 / Fluid Mechanics

CO-PO and CO-PSO Mapping:

CO/PO & PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M		M										
CO2	S													
CO3	S	M											M	
CO4		S											M	
CO5	S	M												
CO6				S									S	

Course Assessment methods

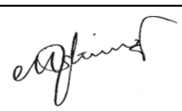
Direct	
1. Internal Test I 2. Internal Test II 3. Assignment / Tutorial 4. Seminar / Presentation 5. End Semester Exam	1. Lab Workbook 2. Viva-voce 3. Model Practical Exams
Indirect	
1. Course-end survey	

INTRODUCTION TO AERODYNAMICS 7 Hours

Importance of Aerodynamics – Aerodynamic forces and moments – Pressure distribution on an airfoil – Types of drag – Flow similarity, Types of flow – Continuity, momentum and energy equations – Incompressible-inviscid flow – Irrotational flow – Circulation and Vorticity – Euler's equation – Bernoulli's Equation – Pitot tube: Measurement of airspeed. Pressure Coefficient.

TWO DIMENSIONAL POTENTIAL FLOWS 7 Hours

Elementary flows – Uniform, Source, Sink, Doublet and Vortex flow, Combination of a uniform flow with a source and sink, Non lifting flow over a circular cylinder, Lifting flow over a cylinder,



Kutta Joukowski theorem and Generation of lift, Flow over a flat plate, D'Alembert Paradox, Magnus effect.

CONFORMAL TRANSFORMATION **5 Hours**

Complex potential, Cauchy-Riemann equation, Joukowski transformation and its application to fluid flow problems, Karman-Trefftz Profiles.

AIRFOIL AND WING THEORY **7 Hours**

Airfoil Nomenclature – Airfoil characteristics – Kutta condition – Thin airfoil theory and its applications – Aerodynamic Center – Horse shoe vortex, Biot and Savart law – Downwash and induced drag – Helmholtz theorems, Lifting line theory and its limitations.

PROPELLER THEORY **4 Hours**

Froude momentum and Blade element theories – Propeller coefficients – Performance of fixed and variable pitch propeller.

REFERENCES

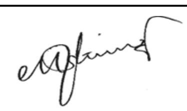
1. Anderson, J.D., 'Fundamentals of Aerodynamics', Sixth Edition, McGraw-Hill Education, 2016.
2. Clancy, L.J., 'Aerodynamics', Shroff, 2006.
3. Ethirajan Rathakrishnan , Theoretical Aerodynamics, Wiley; First Edition, 2013.
4. A.M. Kuethe and C-Y Chow, 'Foundations of Aerodynamics: Bases of Aerodynamic Design', Wiley India Pvt Ltd, Fifth edition, 2009.
5. Theodore A. Talay, 'NASA's Flight Aerodynamics Introduction', NASA, 2013.
6. Kunal Ghosh, Low Speed Aerodynamics, PHI Learning Private Limited, 2017.
7. Charles E. Dole, and James E. Lewis, Flight Theory and Aerodynamics: A Practical Guide for Operational Safety, Wiley India Pvt Ltd, Second edition, 2009.
8. E. L. Houghton, P. W. Carpenter, Steven H. Collicott, and Daniel T. Valentine, 'Aerodynamics for Engineering Students', Seventh Edition, Butterworth-Heinemann, 2016.
9. Alan Pope, 'Basic Wing and Airfoil Theory', Dover Publications, 2009.
10. John J. Bertin and Russell M. Cummings, 'Aerodynamics for Engineers', Sixth Edition, Pearson, 2013.
11. Ira H. Abbott and Albert E. Von Doenhoff, 'Theory of Wing Sections', Dover Publications Inc., 1960.

WEBSITE REFERENCES

1. https://nptel.ac.in/courses/101105059/Introduction to Aerodynamics
2. https://www.edx.org/course/introduction-to-aerodynamics
3. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005/
4. https://www.class-central.com/tag/aerodynamics
5. https://ocw.tudelft.nl/course-lectures/1-fundamentals-aerodynamics/

LIST OF EXPERIMENTS

1. Pressure distribution over smooth cylinder.
2. Pressure distribution over rough cylinder
3. Pressure distribution over symmetrical airfoil.
4. Pressure distribution over cambered airfoil.
5. Force measurement on symmetrical airfoil.
6. Force measurement on cambered airfoil.



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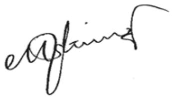
7. Flow visualization over a flat plate/ airfoil at different angles of attack.
8. Flow visualization studies in low speed flows over cylinders.
9. Determination of Aerodynamic coefficients of airfoils using analysis tools
10. Determination of Aerodynamic parameters using FoilSim

LIST OF EQUIPMENT

S. No.	Name of the equipment	Quantity Required
1	Subsonic Wind Tunnel	1 No.
2	Airfoil sections (Symmetrical and cambered airfoils)	4 Nos.
3	Cylinder models (Rough and Smooth)	2 Nos.
4	Wind Tunnel balances (3 or 6 components)	1 No.
5	Smoke Generator	1 No.
6	Water flow channel	1 No.
7	Flat plate, Cylinder & Airfoil models for flow visualization	3 Nos

Theory: 30 Tutorial: 0 Practical: 30 Project: 0 Total: 60 Hours



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U18AEI4202	AUTOMATIC CONTROL SYSTEMS	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO 1: Compare the performance of open-loop and closed-loop control systems.

CO 2: Apply the Laplace transform to develop the mathematical model of physical systems.

CO 3: Analyse the time response of first order and second order LTI systems.

CO 4: Design controllers and compensators using root locus to get the desired response for LTI systems.

CO 5: Explain the behavior of aircraft autopilot systems and analyse their responses in MATLAB.

Pre-requisite(s): -

CO-PO and CO-PSO Mapping:

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	M	-	-	-	-	-	-	-	-	-	-	M	-
CO 2	-	S	-	-	-	-	-	-	-	-	-	-	S	-
CO 3	-	-	M	-	S	-	-	-	-	-	-	-	-	S
CO 4	-	S	-	-	S	-	-	-	-	-	-	-	-	S
CO 5	M	-	-	-	S	-	-	-	-	-	-	-	-	M

Course Assessment Methods

Direct Assessment
1. Internal Tests 2. Assignments 3. Practical Exams 4. End Semester Exam
Indirect Assessment
Course exit survey

<u>**Theory Component:**</u>

INTRODUCTION **6 Hours**

Control System and its Components, Open-loop and Closed-loop (Feedback) Control systems, Feedback and its Effects, Types of Feedback Control Systems, Servo mechanism, Mathematical Modeling and Transfer Functions.

TIME-DOMAIN ANALYSIS OF CONTROL SYSTEMS **6 Hours**

Test Signals for Time Response of Control Systems, Unit-step Response and Time-Domain Specifications, Transient Response of First-order and Second-order Systems, Steady-state Error, Time Response of Positional Control System.

CONTROL SYSTEMS DESIGN **6 Hours**

Root Locus Analysis, Lag Compensation, Lead Compensation, Proportional-Integral Control, Proportional-Derivative Control, Proportional-Integral-Derivative Control.

AUTOMATIC FLIGHT CONTROL SYSTEMS **6 Hours**

Introduction to Autopilot, Longitudinal displacement autopilot, Yaw orientation control system with Dutch roll damper and Sideslip elimination, Velocity (Airspeed) Control System, Altitude

Hold Mode, Automatic Flare Control.

CNC MACHINES **6 Hours**

Role of NC/CNC in CAM, Applications, Benefits and Limitations of CNC, Basic Components of CNC system, Machine control unit, Interpolators, Programming with Basic functions, Part programming and Machine Tool.

Lab Component:

List of Experiments/Exercises

1. Analysis of Time Response of First-order and Second-order Systems in MATLAB.
2. Design of compensators for given specifications for control systems in MATLAB.
3. Analysis of longitudinal displacement autopilot for conventional transport aircraft in MATLAB.
4. Analysis of velocity (airspeed) control system (Auto-throttle) in MATLAB.
5. Analysis of Altitude hold mode of flight control system in MATLAB.
6. Analysis of coordination turn with Dutch roll damper and Sideslip elimination in MATLAB.
7. Analysis of Automatic Flare Control System in MATLAB.
8. CNC Lathe programs – Step turning and Taper Turning.
9. CNC Milling Programs – Linear and Circular Interpolation.
10. CNC Drilling operations.
11. Measuring various aircraft components using Coordinate-measuring machine.

List of Equipment:

1. CNC vertical machining center
2. CNC horizontal machining center
3. Coordinate-measuring machine (CMM)
4. Desktop computer with MATLAB software installed

Theory: 30 Hours	**Tutorial: 0**	**Practical: 30 Hours**	**Project: 0**	**Total: 60 Hours**

REFERENCES

1. Norman S. Nise, 'Control Systems Engineering', Sixth Edition, John Wiley and Sons, 2011.
2. Farid Golnaraghi and Benjamin C. Kuo, 'Automatic Control Systems', Ninth Edition, John Wiley and Sons, 2010.
3. Donald McLean, 'Automatic Flight Control Systems', Prentice Hall International, 1990.
4. John H. Blakelock, 'Automatic Control of Aircraft and Missiles', Second Edition, John Wiley and Sons, 1991.
5. Koren Y, 'Computer Control of Manufacturing Systems', McGraw Hill, 1986.
6. Reinbold U, Blume C and Dilmann R, 'Computer Integrated Manufacturing Technology and Systems', Marcel Dekker, 1985.

WEBSITE REFERENCES

1. NPTEL Lecture Notes on Control Engineering: https://nptel.ac.in/courses/108102043/

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U18AET4003	AIRCRAFT STRUCTURES-I	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the methods of joints and matrix displacement to analyze plane and space trusses.

CO2: Analyze the behavior of statically indeterminate structures using Clapeyron's Three Moment Equation and Moment Distribution Method.

CO3: Evaluate strain energy methods including Castigliano's theorem and Maxwell's reciprocal theorem for calculating displacements and moments in various structures.

CO4: Analyze the stability and load-bearing capacity of columns with various end conditions using Euler's and Rankine's formulas.

CO5: Evaluate failure theories to predict and analyze structural failures in aircraft components.

Pre-requisites :

1. U18AEI3203 / Mechanics of Solids

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	M											S	
CO 2		S		M									M	
CO 3		S	M										S	
CO 4	S			M									M	
CO 5	M												S	

Course Assessment methods

Direct
1. Continuous Assessment Test I, II 2. Assignment; Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

STATICALLY DETERMINATE STRUCTURES **9 Hours**

Analysis of plane truss – Method of joints – 3D (Space) Truss – Matrix Displacement method for Trusses.

STATICALLY INDETERMINATE STRUCTURES **9 Hours**

Composite beam – Clapeyron's Three Moment Equation – Moment Distribution Method.

ENERGY METHODS **9 Hours**

Strain Energy due to axial, bending and torsional loads – Castigliano's theorem for displacements and moments – Maxwell's reciprocal theorem, Unit load method – Application to beams, trusses, frames, rings, etc.

COLUMNS **9 Hours**

Columns with various end conditions – Euler's Column curve – Rankine's formula – Column with initial curvature – Eccentric loading – Beam column.

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FAILURE THEORIES **9 Hours**

Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum strain energy theory – Application to aircraft structural problems.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Howard D. Curtis, “Fundamentals of Aircraft Structural Analysis”, McGraw Hill Higher Education Group, 1996.
2. Megson, T.H.G., “Aircraft Structures for Engineering Students”, Fifth Edition (Rev.), Butterworth-Heinemann, 2012.
3. David J. Peery, “Aircraft Structures (Dover Books on Aeronautical Engineering)”, Dover Publications,2013.
4. Timoshenko, S., “Strength of Materials”, Vol. II, CBS Publishers, 2002.
5. S. S. Bhavikatti, “Strength of Materials”, Third Edition, Vikas Publishing House Pvt. Ltd, 2009.

WEBSITE REFERENCES

1. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-050-solid-mechanics-fall-2004/index.htm
2. http://nptel.ac.in/courses/112106141/
3. https://www.edx.org/course/introduction-to-aerospace-structures-and-materials
4. https://cosmolearning.org/courses/introduction-aerospace-structures/
5. https://ocw.mit.edu/courses/mechanical-engineering/2-001-mechanics-materials-i-fall-2006/index.htm

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U18AET4004	UAV SYSTEM DESIGN	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO 1: Discuss the configuration, performance parameters, and design aspects of unmanned aerial vehicle (UAV).
CO 2: Compare the sensors, payloads and actuators suitable for various UAVs.
CO 3: Explain the working of UAV propulsion systems.
CO 4: Discuss the communication and navigation systems in UAV.
CO 5: Explain the practical limitations in the design and development of an UAV.

Pre-requisite(s):-

CO-PO and CO-PSO Mapping:

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**												**PSOs**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	-	W	-	-	-	-	-	-	-	-	-	M	-
CO 2	M	-	-	-	-	-	-	-	-	-	-	-	S	-
CO 3	W	-	-	-	-	-	-	-	-	-	-	-	W	-
CO 4	M	-	-	-	-	-	-	-	-	-	-	-	W	-
CO 5	-	-	W	-	-	-	S	-	-	-	-	-	W	-

Course Assessment methods

Direct Assessment
1. Internal Tests 2. Assignments 3. End Semester Exam
Indirect Assessment
Course exit survey

INTRODUCTION **6 Hours**

Overview of UAV Systems, Classes of UAVs, Configuration of UAVs, Introduction to System Design, UAV Performance parameters, Introduction to Selection of UAV systems, System design aspects.

SENSORS AND ACTUATORS **9 Hours**

Position and Motion sensors, Altitude sensors, Airspeed sensors, Attitude sensors, Electronic Speed Controllers, Servomotors.

PAYLOADS **6 Hours**

Electro-optic payloads, Radar Imaging payloads, Dispensable payloads, Payload actuators, Payload Control.

PROPULSION AND POWER-PLANTS **6 Hours**

Thrust generation, Internal Combustion engines, Rotary engines, Gas turbine engines, Electric Motors, Batteries, Solar cells.

COMMUNICATIONS AND CONTROL **9 Hours**

Communication Media, Radio Communication, Data Link, Mission Planning and Control Station, Modes of UAV Control, Flight Control loops, Autopilot, Autonomy.

NAVIGATION **9 Hours**

GPS, Differential GPS, Navigation with Inertial Sensors, Radio Tracking, Way-point Navigation, Laser Range Finder.

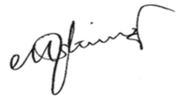
Theory: 45 Hours	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Thomas James Gleason and Paul Gerin Fahlstrom, 'Introduction to UAV Systems', Fourth Edition, John Wiley and Sons, 2012.
2. Reg Austin, 'Unmanned Aircraft Systems: UAVs Design, Development, and Deployment', John Wiley and Sons, 2010.
3. Mohinder S. Grewal, Lawrence R. Weill and Angus P. Andrews, 'Global Positioning Systems, Inertial Navigation, and Integration', Second Edition, John Wiley and Sons, 2007.
4. K. Nonami, F. Kendoul, S. Suzuki, W. Wang, and D. Nakazawa, 'Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Aerial Vehicles', Springer Science, 2010.

WEBSITE REFERENCES

1. http://batteryuniversity.com/learn/article/battery_test_equipment
2. http://batteryuniversity.com/learn/article/what_is_the_c_rate
3. http://www.modelaviation.com/inside-esc
4. http://rcstate.com/how-electronic-speed-control-esc-works/
5. http://www.stefanv.com/electronics/escprimer.html
6. https://hobbyking.com/en_us/news/brushed-brushless-electronic-speed-controllers-work?___store=en_us
7. http://www.rclab.info/2013/02/the-basics-of-electric-power-escs.html
8. http://www.hooked-on-rc-airplanes.com/servo-tutorial.html
9. http://electronoobs.com/eng_circuitos_tut4.php
10. http://learningrc.com/motor-kv/



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U18AET4005	AIRCRAFT HARDWARE AND MATERIALS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO 1: Apply knowledge of characteristics and properties of ferrous and non-ferrous materials to select appropriate alloys for specific aircraft applications.

CO 2: Analyze the various methods for testing the hardness, tensile strength, fatigue strength, and impact resistance of materials to ensure suitability for aircraft components.

CO 3: Evaluate different types of corrosion and their identification techniques to recommend effective corrosion prevention measures for aircraft materials.

CO 4: Apply the preservation techniques and construction methods for the maintenance and repair of wooden and composite aircraft structures.

CO 5: Design a comprehensive system for the selection and application of fasteners, pipes, and connectors, ensuring compatibility with aircraft hydraulic and pneumatic systems.

Pre-requisites : -

CO-PO and CO-PSO Mapping:

COs	**CO/PO Mapping** (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													
	Program Outcomes(POs) and Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		S											M	
CO2		S											M	
CO3	S												M	
CO4		S											M	
CO5			S										M	

Course Assessment methods

Direct
1. Continuous Assessment Test I, II. 2. Journal paper review, Assignment, Group Presentation 3. End Semester Examination.
Indirect
1. Course-end survey

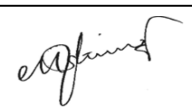
<u>Theory Component Contents</u>

FERROUS , NON-FERROUS MATERIALS AND CORROSION **12 Hours**

Characteristics, properties and identification of common alloy steels and non-ferrous materials used in aircraft-Heat treatment and application of alloy steels and non-ferrous materials - Testing of ferrous materials and non-ferrous materials for hardness, tensile strength, fatigue strength and impact resistance. Formation by, galvanic action process, microbiological, stress-Types of corrosion and their identification-Causes of corrosion - Material types, susceptibility to corrosion.

COMPOSITE AND NON- METALLIC MATERIALS **9 Hours**

Characteristics, properties and identification of common composite, wood, glue, types of



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fabrics, and other non-metallic used in aircraft-Sealant and bonding agents-The detection of defects/deterioration in composite, wood, types of fabric and other non-metallic -Construction methods of wooden airframe structures-Preservation and maintenance of wooden structure-Repair of wooden structure, fabric covering, composite and other non-metallic material.

FASTENERS, PIPES AND UNIONS **7 Hours**

Screw threads-Bolts, Nuts, studs and screws-Locking devices-Aircraft rivets- Types of rigid and flexible pipes and their connectors used in aircraft- Standard unions for aircraft hydraulic, fuel, oil, pneumatic and air system pipes.

SPRINGS, BEARINGS AND TRANSMISSIONS **7 Hours**

Types of springs, bearings and gears- materials, characteristics and their applications-Purpose of bearings, loads, construction-Gear ratios, reduction and multiplication gear systems, driven and driving gears, idler gears, mesh patterns-Belts and pulleys, chains and sprockets.

CONTROL CABLES, ELECTRICAL CABLES AND CONNECTORS **10 Hours**

Types of control cables-End fittings, turn buckles and compensation devices-Pulleys and cable system components-Bowden cables-Aircraft flexible control systems- Electrical cable types, construction and their characteristics-High tension and co-axial cables-Crimping. Connector types, pins, plugs, sockets, insulators, current and voltage rating, coupling, identification codes.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

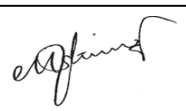
REFERENCES

1. George Francis Titterton, ‘Aircraft Material and Processes’, Fifth Edition, Sterling Book House, Mumbai, 1998.
2. Lalit Gupta, ‘Aircraft General Engineering’, Sixth Reprint, Himalayan Books, New Delhi, 2010.
3. Earl R. Parker, ‘Materials for Missiles and Spacecraft’, McGraw-Hill, 1963.
4. C G Krishnadas Nair, ‘Handbook of Aircraft Materials’, First Edition, Interline Publishers, Bangalore, 1993.

WEBSITE REFERENCES

1 http://avstop.com/ac/Aviation_Maintenance_Technician_Handbook_General/ch5.html

2 http://www.flight-mechanic.com/aircraft-materials-processes-and-hardware/



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U18INI4600	ENGINEERING CLINIC - IV	L	T	P	J	C
		0	0	4	2	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify a practical problems and find a solution

CO2: Understand the project management techniques

CO3: Demonstrate their technical report writing and presentation skills

Pre-requisites : U18INI3600 - Engineering Clinic - III

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Program Outcomes(POs) and Program Specific Outcomes (PSOs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S	S	
CO2											S		W	
CO3										S			W	

Course Assessment methods

Direct	Indirect
1. Project reviews 50%	1. Course Exit Survey
2. Workbook report 10%	
3. Demonstration & Viva-voce 40%	

Content:

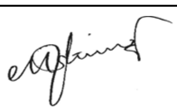
The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the IV semester, students will focus primarily on Reverse engineering project to improve performance of a product

GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total: 90 Hours



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U18VET4101	UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY	L	T	P	J	C
		2	1	0	0	3

COURSE OUTCOMES:

After successful completion of this course, the students shall be able to

CO1:	Develop a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
CO 2:	Understand (or develop clarity) of the harmony in the human being, family, society and nature/existence
CO 3:	Strengthen their self-reflection.
CO 4:	Develop commitment and courage to act.

Pre-requisites: - None. Universal Human Values 1 (Desirable)

CO-PO AND CO-PSO MAPPING:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						M	M	M	S			M	-	-
CO2						S	M		S	S		S	-	-
CO3								M	M		W	S	-	-
CO4								S	M		M	M	-	-

COURSE ASSESSMENT METHODS

Direct
1. Assessment by faculty mentor 2. Self-assessment 3. Socially relevant project/Group Activities/Assignments 4. End Semester Examination
Indirect
1. Assessment by peers (Survey form)

COURSE CONTENTS:

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I.
2. Self-Exploration–what is it? - Its content and process; ‘Natural Acceptance’ and Experiential Validation- as the process for self-exploration.
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations

4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

1. Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’.
2. Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility.
3. Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer).
4. Understanding the characteristics and activities of ‘I’ and harmony in ‘I’.
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available tome. Identifying from one’s own life.

Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students’ lives.

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and self-regulation in nature.
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
4. Holistic perception of harmony at all levels of existence.
5. Include practice sessions to discuss human being as cause of imbalance in nature (film “Home” can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order:

   a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
   b. At the level of society: as mutually enriching institutions and organizations
7. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

COURSE DURATION:

No	MODULE	HOURS
1	Module 1	[7 Theory+ 3 Tutorial] 10 Hrs
2	Module 2	[6 Theory+ 3 Tutorial] 9 Hrs
3	Module 3	[7 Theory+ 3 Tutorial] 10 Hrs
4	Module 4	[5 Theory+ 3 Tutorial] 8 Hrs
5	Module 5	[5 Theory+ 3 Tutorial] 8 Hrs
	Total	**45**

Theory: 30 Hours	**Tutorial:15**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

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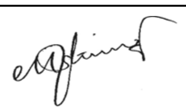
TEXT BOOK:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE BOOKS:

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)
14. https://www.youtube.com/watch?v=E1STJoXCXUU&list=PLWDeKF97v9SP_Kt6jqzA3pZ3yA7g_OAQz
15. https://www.youtube.com/channel/UCo8MpJB_aaVwB4LWLAx6AhQ
16. https://www.uhv.org.in/uhv-ii



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SEMESTER V

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U18AET5101	HIGH SPEED AERODYNAMICS	L	T	P	J	C
		2	1	0	0	3

Course Outcomes

After successful completion of this course, the students would be able to

CO 1: Apply the basic principles of aerodynamics and thermodynamics to solve problems involving compressible flow.

CO 2: Analyze the integral forms of continuity, momentum, and energy equations to interpret quasi-one-dimensional flow.

CO 3: Evaluate the one-dimensional flow equations and normal shock relations to predict the behavior of supersonic flows.

CO 4: Distinguish between oblique shock waves and Prandtl-Meyer expansion waves to examine their effects on supersonic flows.

CO 5: Analyze solutions using small perturbation potential theory for applications in transonic and supersonic aerodynamics.

Pre-requisite(s): 1. U18AEI4201 / Low Speed Aerodynamics

CO-PO and CO-PSO Mapping:

CO/PO &PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Program Outcomes (POs) and Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	M											M	
CO 2	S	S											M	W
CO 3	S	S	M	M									M	W
CO 4	S	S	M	M									S	W
CO 5		S											M	

Course Assessment Methods:

Direct
1. Internal Test I 2. Internal Test II 3. Assignment (Written and Experimental) 4. Tutorial 5. Seminar / Presentation 6. End Semester Exam
Indirect
1. Course end survey

REVIEW OF BASIC PRINCIPLES 6+3 Hours

Aerodynamics variables and flow physics – Surface pressure and surface shear stress – Brief Review of Thermodynamics – Governing equations – Definition of compressible flow – Adiabatic steady state flow equations – Equation of State – Speed of sound and Mach Number, Area-velocity relation – Choked flow – Numerical Problems.

COMPRESSIBLE FLOW 6+3 Hours

Integral form of continuity, momentum and energy equations – Euler's equations, Integral forms of the conservation equations for inviscid flows – Alternative forms of energy equations – Quasi-one dimensional flow – Isentropic flow of a calorically perfect gas through variable-area ducts.

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ONE DIMENSIONAL FLOW **6+3 Hours**

One dimensional flow equations – Normal Shock relations – Prandtl relation for normal shocks – Hugoniot equation – One dimensional flow with heat transfer and friction – Rayleigh and Fanno Flow – Flow physics of shock waves, Pitot static tube, Compressibility correction, Supersonic flow through nozzles, Supersonic wind tunnel, Introduction to Shock tube, Open jet, Shadowgraph techniques – Numerical Problems using gas tables.

OBLIQUE SHOCK AND EXPANSION WAVES **6+3 Hours**

Source of Oblique waves – Introduction of Oblique shock waves – Oblique shock relations – Comparison between the wave angle and the Mach angle – Attached and detached shocks – Supersonic flows over wedges and cones, Prandtl-Meyer expansion wave, Introduction to viscous flow, Introduction to boundary-layers.

LINEARIZED FLOW **6+3 Hours**

Small perturbation potential theory – Perturbation-velocity potential equation – Linearized pressure coefficient – Compressibility corrections– Critical Mach number, Lower and upper critical Mach numbers, Lift and drag divergence, Characteristics of swept wings, Transonic area rule, Tip effects, Supersonic airfoils, Introduction to hypersonic flows.

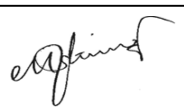
Theory: 30	**Tutorial: 15**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. John D. Anderson, 'Modern Compressible Flow: With Historical Perspective', Third Edition, McGraw-Hill Book Co., New York, 2012.
2. Yahya S.M., 'Fundamentals of Compressible Flow', Sixth Edition, New Age International, 2018.
3. Shapiro, A.H., 'Dynamics and Thermodynamics of Compressible Fluid Flow', Ronold Press, 1982.
4. Zucrow, M.J. and Anderson, J.D., 'Elements of Gas Dynamics', McGraw-Hill Book Co., New York, 1989.
5. Barnes W. McCormick, 'Aerodynamics, Aeronautics and Flight Mechanics', Second Edition, John Wiley, New York, 1994.
6. Rathakrishnan, E., 'Gas Dynamics', Prentice Hall of India, 2017.
7. Kuethe, A.M., and Chow, C.Y., 'Foundations of Aerodynamics', John Wiley and Sons, 1982.

WEBSITES

1. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-120-compressible-flow-spring-2003/
2. https://ocw.mit.edu/courses/mechanical-engineering/2-26-compressible-fluid-dynamics-spring-2004/
3. https://nptel.ac.in/courses/112104118/38



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U18AEI5202	AIRCRAFT STRUCTURES-II	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO1: Analyze the response of structures due to unsymmetrical bending.
CO2: Analyze bending, shear and torsion of open and closed thin-walled sections.
CO3: Analyze the failure modes occur in thin walled plates structures.
CO4: Analyze behavior of aircraft structural components under various types of loads.
CO5: Determine the stress fringe value for photo-elastic materials

Pre-requisites :

1. U18AET4003/ Aircraft Structures-I

CO-PO and CO-PSO Mapping:

COs	CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													
	Program Outcomes(POs) and Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		S		S									M	
CO2		S		S									M	
CO3		S											M	
CO4		S											M	
CO5				S										M

Course Assessment methods

Direct
1. Continuous Assessment Test I, II (Theory component). 2. Assignment, Group Presentation 3. Pre/Post - Experiment Test/Viva; Experimental Report for each experiment (lab component). 4. Model examination (lab component) 5. End Semester Examination (Theory and lab component)
Indirect
1. Course-end survey

<u>Theory Component contents</u>

UNSYMMETRICAL BENDING **6 Hours**

Bending stresses in beams of unsymmetrical sections (K-method, Neutral axis method and Principal axis Method) – Bending of symmetric sections with skew loads.

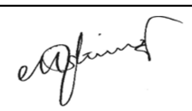
SHEAR FLOW IN OPEN SECTIONS **7 Hours**

Thin walled beams – Concept of shear flow – Shear centre – Elastic axis – One axis of symmetry – Wall effective and ineffective in bending – Unsymmetrical beam sections.

SHEAR FLOW IN CLOSED SECTIONS **7 Hours**

Bredt-Batho formula – Single and Multi-cell structures – Shear flow in single, multi-cell structures under torsion – Shear flow in single and multi-cell under bending with walls effective and ineffective.

BUCKLING OF PLATES **5 Hours**



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Rectangular sheets under compression – Local buckling stress of thin walled sections – Crippling stresses by Needham's and Gerard's methods– Sheet stiffener panels – Effective width – Inter rivet and sheet wrinkling failures.

STRESS ANALYSIS IN WING AND FUSELAGE 5 Hours

Tension field web beams (Wagner Beam) –Loads on aircraft structural components – Lift distribution – V-n diagram.

Lab component:

List of Experiments

1. Unsymmetrical bending of cantilever beam.
2. Shear centre location for open section.
3. Shear centre location for closed section.
4. Determination of stresses of constant strength beam.
5. Stresses in circular disc using photo elastic model.
6. Stresses in rectangular beam using photo elastic model.
7. Determination of Stress concentration factor for a flat plate with hole using photoelasticity.
8. Vibration of a cantilever beam.
9. Flexibility matrix of a cantilever beam.
10. Fabrication of composite laminate.

List of Equipments:

1. Photoelastic apparatus
2. Vibration Beam Setup
3. Vacuum Bagging Layup setup

Theory: 30	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 60 Hours**

REFERENCES

1. Bruhn. E.H., 'Analysis and Design of Flight vehicles Structures', Tri-state off set company, USA, 1985.
2. Megson, T.H.G., 'Aircraft Structures for Engineering Students', Fifth Edition (Rev.), Butterworth-Heinemann, 2012.
3. Bruce K. Donaldson., 'Analysis of Aircraft Structures', Second Edition, Cambridge University Press., 2008.
4. Peery, D.J., and Azar, J.J., 'Aircraft Structures', Second Edition, McGraw-Hill, 1993.
5. G. Lakshmi Narasaiah, 'Aircraft Structures', CRC Press, 2011.
6. C T Sun, 'Mechanics of Aircraft Structures', Second Edition, Wiley publisher, April 2006.

WEBSITE REFERENCES

1 https://ocw.mit.edu/courses/mechanical-engineering/2-080j-structural-mechanics-fall-2013/course-notes/MIT2_080JF13_Lecture11.pdf

2 https://www.youtube.com/watch?v=jwTrStB_8Lg

3 https://www.youtube.com/watch?v=WCEsOI9m97o&t=542s

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U18AET5003	COMPUTATIONAL FLUID DYNAMICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the basic equations of fluid dynamics to solve problems in high-speed aerodynamics.

CO2: Analyze different grid generation schemes and numerical methods to interpret their application in CFD codes.

CO3: Evaluate the use of source and vortex panel methods to assess non-lifting and lifting flow scenarios.

CO4: Examine the stability properties of numerical methods to analyze their effectiveness in solving boundary layer equations.

CO5: Examine solutions using flux splitting schemes and pressure correction solvers for advanced turbulence modeling techniques.

Pre-requisites : U18AEI4201 – Low Speed Aerodynamics

CO-PO and CO-PSO Mapping:

CO/PO/PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Program Outcomes(POs) and Program Specific Outcomes (PSOs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S													
CO2				M										
CO3						M							S	
CO4		S			S	S								S
CO5			S				S							

Course Assessment methods

Direct
1. Continuous Assessment Test I, II 2. Assignment / project presentation 3. End Semester Examination
Indirect
1. Course-end survey

FUNDAMENTAL CONCEPTS **10 Hours**

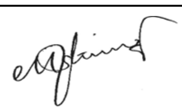
Introduction – Basic Equations of Fluid Dynamics-conservative & non-conservative forms – Introduction to governing equations usage in CFD codes with suitable examples.

DISCRETIZATION, TRANSFORMATION AND GRIDS **10 Hours**

Introduction to different types of grid generation schemes - Finite Difference Method – Finite Element Method & Finite Volume Method. Introduction to transformations basics in CFD. The Lax-Wendroff method, MacCormack's Method basics - examples of the specific methods in CFD codes.

PANEL METHODS **5 Hours**

Introduction to – Source panel method using examples (Non-lifting flows). Introduction to Vortex panel method using examples (Lifting flows)



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BOUNDARY LAYER EQUATIONS – STABILITY PROPERTIES 10 Hours

Introduction to Boundary layer Equations, Implicit time dependent methods, Concept of numerical dissipation, Stability properties of explicit and implicit methods, Conservative upwind discretization for hyperbolic systems, Leapfrog scheme. Application of these schemes in CFD codes using suitable examples

INTRODUCTION TO SIMPLE, PESO SCHEMES & EXAMPLE PROBLEMS 10 Hours

Introduction to Flux splitting schemes, pressure correction solvers – SIMPLE, PISO – Introduction to turbulence modeling. Application of these schemes in CFD codes using suitable examples

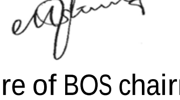
Theory: 45 Hours	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. T. J. Chung, “Computational Fluid Dynamics”, Second Edition, Cambridge University Press, 2014.
2. Suhas V. Patankar, “Numerical Heat Transfer and Fluid Flow”, CRC Press, 1980.
3. John D Anderson Jr., ‘Computational Fluid Dynamics – The Basics with Applications’, McGraw-Hill Education, New York, 1995.
4. Fletcher, C.A.J., “Computational Techniques for Fluid Dynamics”, Vol. 1 and Vol. 2, Second Edition, Springer-Verlag, Berlin, 2013.
5. Charles Hirsch, “Numerical Computation of Internal and External Flows”, Vols. 1 and 2, Second Edition, John Wiley and Sons, New York, 2007.
6. John F. Wendt (Editor), “Computational Fluid Dynamics: An Introduction”, Third Edition, Springer-Verlag, Berlin, 2008.
7. Joel H. Ferziger and Milovan Peric, “Computational Methods for Fluid Dynamics”, Third Edition, Springer, 2002.
8. Pieter Wesseling, “Principles of Computational Fluid Dynamics”, Springer, 2001.
9. Klaus A. Hoffmann and Steve T. Chiang, “Computational Fluid Dynamics”, Vol. 1, Fourth Edition, Engineering Education System, 2000.
10. Klaus A. Hoffmann and Steve T. Chiang, “Computational Fluid Dynamics for Engineers”, Vol. 2, Engineering Education System, 1993.
11. ANSYS Help manual
12. ROTCFD Help manual

WEBSITE REFERENCES

1.http://nptel.ac.in/courses/101106045/1
2.http://nptel.ac.in/courses/112107080/
3.http://nptel.ac.in/courses/103106073/
4.http://nptel.ac.in/courses/112105045/
5.https://ocw.mit.edu/courses/mechanical-engineering/2-29-numerical-fluid-mechanics-spring-2015/index.htm
6. https://confluence.cornell.edu/display/SIMULATION/FLUENT+Learning+Modules



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U18AEI5204	AIRCRAFT SYSTEMS AND INSTRUMENTS	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO 1: Apply the principles of conventional aircraft systems to analyze their functions and interactions.

CO 2: Solve complex issues related to conventional engine control systems by applying the relevant techniques and methods.

CO 3: Illustrate the functionalities of advanced avionic systems and analyze their impact on aircraft operations.

CO 4: Evaluate the operation and effectiveness of various aircraft instruments and their integration into the flight control system.

CO 5: Compare and contrast the ergonomic and functional aspects of cockpit layouts to recommend improvements.

CO 6: Evaluate the functionality of aircraft systems through practical laboratory exercises, including troubleshooting and assembly.

Pre-requisite(s): -

CO-PO and CO-PSO Mapping:

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**												**PSOs**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	M	-	-	-	-	-	-	-	-	-	-	-	W	-
CO 2	S	-	-	-	-	-	-	-	-	-	-	-	S	-
CO 3	-	-	M	-	-	-	-	-	-	-	-	-	M	-
CO 4	-	-	-	-	M	-	-	-	-	-	-	-	-	M
CO 5	-	-	-	-	S	-	-	-	-	-	-	-	-	S
CO 6	-	-	-	-	S	-	-	-	-	-	-	-	-	W

Course Assessment Methods

Direct Assessment
1. Internal Tests 2. Assignments 3. Practical Exams 4. End Semester Exam
Indirect Assessment
Course exit survey

Theory Component:

CONVENTIONAL AIRCRAFT SYSTEMS **7 Hours**

Conventional flight control system, Hydraulic and Pneumatic systems, Electrical Power generation and distribution system, Environmental control system, De-icing and anti-icing systems, Landing gear system, and Aircraft fuel systems.

CONVENTIONAL ENGINE CONTROL SYSTEMS **6 Hours**

Fuel systems of Piston engine and Jet engine, Main engine components and functions of jet engines, Engine lubrication systems, Engine starting system, Thrust reversing and Thrust vector control.

AVIONIC SYSTEMS **5 Hours**

Autopilot systems, Advanced flight control systems, Flight Management System, Communication and Navigation systems, Full Authority Digital Engine Control (FADEC) system.

AIRCRAFT INSTRUMENTS **6 Hours**

Flight instruments, Navigation and Communication instruments, Gyroscope, Airspeed indicator, Multi-Function Display, Attitude director indicator, Primary Flight Display, Engine instruments and display, Operation and principles, Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR).

COCKPIT LAYOUT **6 Hours**

Ergonomic layout, Controls and Indications, Display systems, Self-test and Built-In Test Equipment (BITE), Cockpit air-conditioning and pressurization, Challenges posed by cockpit to the designer, Failure warning system.

Lab Component:

List of Experiments/Exercises

1. Inspection of primary and secondary control of Cessna 172 Aircraft.
2. Demonstrate and testing of aircraft hydraulic system.
3. Demonstrate and testing of aircraft pneumatic system.
4. Demonstrate and testing of aircraft electrical system.
5. Dismantling and assembly of aircraft piston engine.
6. Dismantling and assembly of jet engine.
7. Inspection of aircraft instruments and its function in Cessna 172 aircraft.
8. Troubleshoot various systems of aircraft.

Theory: 30 Hours	**Tutorial: 0**	**Practical: 30 Hours**	**Project: 0**	**Total: 60 Hours**

List of Equipment

1. Aircraft hydraulic test rig
2. Aircraft pneumatic test rig.
3. Aircraft electrical test rig.
4. Piston engine.
5. Cut section of jet engine.

REFERENCES

1. E. H. J. Pallett, ‘Aircraft Instruments – Principles and Applications’, Second Edition, Longman House, 1981.
2. E. H. J. Pallett and S. Coyle, ‘Automatic Flight Control’, Fourth Edition, Blackwell Science Ltd, 1993.
3. Irwin Treager, ‘Aircraft Gas Turbine Engine Technology’, Third Edition, McGraw Hill, 1997.
4. James Powell, ‘Aircraft Radio Systems’, Shroff Publishers, 2006.
5. Ian Moir and Allan Seabridge, ‘Aircraft Systems – Mechanical, electrical and avionics subsystems integration’, Second Edition, Professional Engineering Publishing Limited, 2001.
6. Ian Moir, Allan Seabridge and Malcolm Jukes, ‘Civil Avionics Systems’, Second Edition, Wiley, 2013.

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7. 'General Hand Book of Airframe and Powerplant Mechanics', U.S. Dept. of Transportation, Federal Aviation Administration, English Book Store, New Delhi, 1995.

WEBSITE REFERENCES

1. https://www.princeton.edu/~stengel/MAE331Lecture10.pdf
2. http://okigihan.blogspot.com/2017/04/aircraft-hydraulic-system.html
3. http://okigihan.blogspot.com/2017/06/aircraft-pneumatic-systems.html
4. home.iitk.ac.in/~mohite/Basic_construction.pdf
5. https://science.ksc.nasa.gov
6. Pilot's Handbook of Aeronautical Knowledge:
   https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/
7. MIT Open Courseware lectures notes on Aircraft Systems Engineering:
   https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-885j-aircraft-systems-engineering-fall-2004/lecture-notes/
8. NPTEL Online course materials on Aircraft Maintenance:
   https://nptel.ac.in/courses/101104071/

U18AEI5205	AIRCRAFT PROPULSION	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the basic concepts of thermodynamics and to analyze the performance of various types of aircraft engines.

CO2: Explain the relation between area ratio and external deceleration ratio for diffuser.

CO3: Calculate the performance of axial and centrifugal flow compressors using velocity triangles.

CO4: Understand about combustion mechanisms of gas turbine engine.

CO5: Analyze the performance of axial and radial flow turbine and nozzles.

CO6: Experiment the performance of aircraft engine components.

Pre-requisites :

1. U18AEI3202 / Engineering Thermodynamics

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													**CO/PSO Mapping**	
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		S											S	
CO2		S											M	
CO3	M	S											M	
CO4		S											M	
CO5			M										S	
CO6				S	M								M	

Course Assessment methods

Direct
1. Continuous Assessment Test I, II (Theory component). 2. Assignment, 3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (lab component). 4.Model examination (lab component) 5.End Semester Examination (Theory and lab component)
Indirect
1. Course-end survey

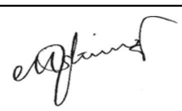
<u>Theory Component contents</u>

FUNDAMENTALS OF AIR-BREATHING ENGINES **5 Hours**

Operating principles of piston engines – Classification of piston engines –Working principle of gas turbine engine – Thrust equation – Factors affecting thrust – Effect of atmospheric air on engine– Methods of thrust augmentation – Comparison of turboprop, turbofan and turbojet engines-Numerical problems.

INLETS **5 Hours**

Internal compressible through subsonic inlets – Boundary layer separation – Relation between minimum area ratio and external deceleration ratio – Diffuser performance – Supersonic inlets – Starting problem on supersonic inlets – Shock swallowing by area



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variation – Mode of inlet operation.

COMPRESSORS **6 Hours**

Compressible flow over moving vanes-Velocity diagram- Work done –working principle of Axial and Centrifugal compressors –Diffuser vane design considerations – Concepts of prewhirl, Rotation stall –Degree of reaction –Performance characteristics-Numerical problems.

COMBUSTION CHAMBERS **5 Hours**

Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling – Flame stabilization – Use of flame holders and after burners.

TURBINES **6 Hours**

Principle of operation of axial flow turbines – Limitations of radial flow turbines – Performance characteristics– Turbine blade cooling methods – Basic blade profile design considerations – Matching of compressor and turbine-Numerical problems

NOZZLES **3 Hours**

Theory of flow in isentropic nozzles – Convergent / Convergent - divergent nozzles – Nozzle throat conditions – Nozzle efficiency – Losses in nozzles – Over expanded and under-expanded nozzles – Thrust reversal.

BOOK REFERENCES

1. Philip Hill and Carl Peterson, ‘Mechanics and Thermodynamics of Propulsion’, Second Edition, Pearson Education, 2009.
2. Saravanamuttoo, H.I.H., Paul Straznicky, Henry Cohen and Gordon Rogers, ‘Gas Turbine Theory’, Seventh Edition, Pearson Education, 2008.
3. Jack D. Mattingly, ‘Elements of Propulsion: Gas Turbines and Rockets’, AIAA Education Series, 2016.
4. V. Ganesan, ‘Gas Turbines’, Third Edition revised, Tata McGraw-Hill, 2017.
5. Saeed Farokhi, ‘Aircraft Propulsion’, Second Edition, John Wiley and Sons, 2014.
6. C. Jaganathan and S.K Jain, “Jet Engines”, Yes Dee, First edition, 2016.

WEBSITE REFERENCES

1. https://nptel.ac.in/courses/101101002/
2. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-50-introduction-to-propulsion-systems-spring-2012/.
3. https://www.grc.nasa.gov/www/k-12/UEET/StudentSite/engines.html
4. https://www.rolls-royce.com/products-and-services/civil-aerospace.aspx
5. https://nptel.ac.in/syllabus/101104018/
6. https://www.geaviation.com/commercial/engines

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Lab component:

List of Experiments

1. Effect of varying back pressure on mass flow rate and performance in convergent nozzle.
2. Performance analysis of propeller.
3. Performance analysis of free jet and wall jet.
4. Determination of flame speed for various air fuel ratios.
5. Performance analysis of diffuser.
6. Demonstration of ramjet
7. Study of an aircraft piston engines.
8. Study of an aircraft jet engines.

List of Equipment

1. Nozzle pressure distribution and performance Test Rig.
2. Propeller performance Test Rig.
3. Free jet and Wall jet Test setup.
4. Flame propagation Test Rig.
5. 2D-Diffuser setup.
6. Ram jet setup
7. Piston engine cut section
8. Jet engine cut section

Theory: 30	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 60 Hours**

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U18INT5000	CONSTITUTION OF INDIA (Mandatory course)	L	T	P	J	C
		2	0	0	0	0

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1: Gain Knowledge about the Constitutional Law of India

CO2: Understand the Fundamental Rights and Duties of a citizen

CO3: Apply the concept of Federal structure of Indian Government

CO4: Analyze the Amendments and Emergency provisions in the Constitution

CO5: Develop a holistic approach in their life as a Citizen of India

Pre-requisites :-

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													**CO/PSO Mapping**	
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						M			W			S	-	-
CO2						S		S				M	-	-
CO3									M	S		W	-	-
CO4								W	M			M	-	-
CO5						M		M				S	-	-

Course Assessment methods

Direct
1. Group Activity / Quiz/ Debate / Case studies 2. Class test / Assignment
Indirect
Surveys

THEORY COMPONENT:

MODULE.1: INTRODUCTION TO INDIAN CONSTITUTION **4 Hours**

Meaning of the constitution law and constitutionalism - Historical perspective of the Constitution - characteristics of the Constitution of India

Module.2: Fundamental Rights **8 hours**

Scheme of the fundamental rights - Right to Equality - Fundamental Right under Article 19 - Scope of the Right to Life and Liberty - Fundamental Duties and its legal status - Directive Principles of State Policy – Its importance and implementation

Module.3: Federal Structure **8 hours**

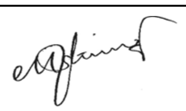
Federal structure and distribution of legislative and financial powers between the Union and the States - Parliamentary Form of Government in India - The constitutional powers and status of the President of India

Module.4: Amendment to Constitution **6 hours**

Amendment of the Constitutional Powers and Procedure - The historical perspectives of the constitutional amendments in India

Module.5: Emergency Provisions **4 hours**

National Emergency, President Rule, Financial Emergency Local Self Government –



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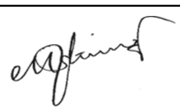
Constitutional Scheme in India

Theory: 30	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 30 hours**

REFERENCES

1. **Constitution of India - Ministry of Law & Justice** – PDF format
   awmin.nic.in/coi/coiason29july08.pdf
2. **Introduction to the Constitution of India by Durgadas Basu**
3. The Constitution of India – Google free material -
   www.constitution.org/cons/india/const.html
4. Parliament of India **– PDF format** *download.nos.org/srsec317newE/317EL11.pdf*
5. The Role of the President of India – By Prof.Balkrishna
6. **Local Government in India – E Book -** Pradeep Sachdeva
   https://books.google.com/books/.../Local_Government_in_In...



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SEMESTER VI

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U18AET6001	FLIGHT DYNAMICS	L	T	P	J	C
		4	0	0	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the principles of flight to solve problems related to the forces and moments acting on a flight vehicle.

CO2: Analyze the performance metrics of aircraft in level, climbing, and gliding flight to optimize range and endurance.

CO3: Evaluate the factors affecting accelerating flight to assess the take-off, landing, and turning performance of an aircraft.

CO4: Examine the concepts of longitudinal stability and control to determine the static and dynamic stability of an aircraft.

CO5: Analyze control strategies for lateral and directional stability to enhance aircraft safety and maneuverability in various flight conditions.

Pre-requisites :

1. U18AEI4201 / Low Speed Aerodynamics

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													**CO/PSO Mapping**	
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		S			M							M	
CO2			M										M	
CO3			M										M	
CO4				W									M	
CO5			M										M	

Course Assessment methods

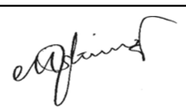
Direct
1. Continuous Assessment Test I, II 2. Assignment 3. End Semester Examination
Indirect
1. Course-end survey

PRINCIPLES OF FLIGHT **10 Hours**

Physical properties and structure of the atmosphere – International Standard Atmosphere – Temperature, Pressure and Altitude relationship – Forces and Moments acting on a flight vehicle – Equilibrium conditions – Equation of motion of a rigid flight vehicle - Measurement of speed – True, Indicated, Calibrated and Equivalent Air Speed – Streamlined and bluff bodies – Various Types of drag in airplanes, Drag polar, Methods of drag reduction of airplanes.

AIRCRAFT PERFORMANCE IN LEVEL, CLIMBING AND GLIDING FLIGHT **12 Hours**

Straight and level flight, Thrust required and available, Power required and available, Effect



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of altitude on thrust and power, Conditions for minimum drag and minimum power required, Gliding and Climbing flight – Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide, Range and Endurance.

ACCELERATING FLIGHT **10 Hours**

Take-off and Landing performance, Turning performance, Horizontal and vertical turn, Pull up and pull down, maximum turn rate, minimum turn radius, V-n diagram.

LONGITUDINAL STABILITY AND CONTROL **15 Hours**

Degrees of freedom of an aircraft, Static and Dynamic stability, Static longitudinal stability, Contribution of individual components, Neutral point, Static margin, Hinge moment, Elevator control effectiveness, Power effects, Elevator angle to trim, Stick force gradient, Aerodynamic balancing, Aircraft Equations of motion, Stability derivatives, Stability quartic, Phugoid motion.

LATERAL, DIRECTIONAL STABILITY AND CONTROL **13 Hours**

Yaw and side-slip, Dihedral effect, Contribution of various components,Lateral control, Aileron control power, Strip theory, Aileron reversal, Weather cock stability, Directional control, Rudder requirements, Dorsal fin, One engine inoperative condition, Dutch roll, Spiral and directional divergence, Autorotation and spin.

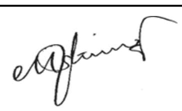
Theory: 60	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 60 Hours**

REFERENCES

1. John D. Anderson Jr., ‘Aircraft Performance and Design’, Tata - McGrawHill First edition, 2011
2. Robert C. Nelson, ‘Flight Stability and Automatic Control’, Second Edition, McGraw-Hill, 2007.
3. Bandu N. Pamadi, ‘Performance, Stability, Dynamics, and Control of Airplanes’, Third Edition, AIAA Education Series, 2015.
4. H H Hurt Jr ‘Aerodynamics for Naval Aviators’ FAA 2012 Second edition
5. Courtland D. Perkins and Robert E. Hage, ‘Airplane Performance, Stability and Control’, John Wiley and Sons, 1966.
6. Bernard Etkin and Lloyd Duff Reid, ‘Dynamics of Flight: Stability and Control’, Third Edition, John Wiley and Sons, 1996.
7. Martin E. Eshelby, “Aircraft Performance Theory and Practice”, Elsevier, First edition, 2012.

Web References:

1. https://nptel.ac.in/courses/101106041/
2. https://nptel.ac.in/courses/101106043/
3. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall-2004/
4. http://www.princeton.edu/~stengel/MAE331Lectures.html



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U18AET6002	FINITE ELEMENT METHOD	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify the mathematical model for simple and complex engineering problems using FEM approach.
CO2: Calculate stress, strain, and displacement value of simple 1-D problems.
CO3: Solve complex axisymmetric problems under various boundary conditions.
CO4: Apply finite element concept to Isoperimetric Element.
CO5: Analyse heat transfer and torsional problems.

Pre-requisites :

1. U18AET4003/Aircraft Structures I

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													**CO/PSO Mapping**	
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	S											S	M
CO2		S											S	M
CO3		S											S	M
CO4		M												S
CO5		S												S

Course Assessment methods

Direct
1. Continuous Assessment Test I, II. 2. Assignment. 3. End Semester Examination.
Indirect
1. Course-end survey

INTRODUCTION **7 Hours**

Review of various approximate methods – Rayleigh Ritz's, Galerkin and finite difference methods – Governing equation and convergence criteria of finite element method.

DISCRETE ELEMENTS **10 Hours**

Bar element with uniform section and varying section – Mechanical and thermal loading – Truss analysis – Beam element – Problems for various loading and boundary conditions – Use of local and natural coordinates.

CONTINUUM ELEMENT **10 Hours**

Plane stress, Plane strain and axisymmetric problems – Constant strain Triangular elements- Stiffness matrix -Introduction to Linear strain triangular element – Axisymmetric load vector.

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ISOPARAMETRIC ELEMENT **9 Hours**

Introduction to isoparametric elements – Shape function for 4, 8 and 9 nodal quadrilateral elements – Stiffness matrix and consistent load vector – Gaussian Integration.

FIELD PROBLEMS **9 Hours**

One dimensional Heat transfer problems – Steady state heat transfer in fin – Derivation of element matrices for two dimensional problems – Torsion problems.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Tirupathi.R. Chandrupatla and Ashok D. Belegundu, ‘Introduction to Finite Elements in Engineering’, Fourth Edition, Prentice Hall India, 2012.
2. Robert D Cook, David S Malkus, and Michael E Plesha, ‘Concepts and Applications of Finite Element Analysis’, Fourth Edition, John Wiley and Sons, Inc., 2008.
3. Reddy J. N., ‘An Introduction to Finite Element Method’, 4 edition, 2018.
4. Larry J. Segerlind, ‘Applied Finite Element Analysis’, Second Edition, John Wiley and Sons, Inc., 1985.
5. Daryl L. Logan, ‘A First Course in the Finite Element Method’, Seventh Edition, Cengage Learning, 2017.
6. H.V. Lakshminarayana and S.R. Srivatsa, “Finite Element Modelling for Engineering Analysis”, Yes Dee, First edition, 2017.

WEBSITE REFERENCES

1. https://nptel.ac.in/courses/112104115/
2. http://homepage.usask.ca/~ijm451/finite/fe_resources/fe_resources.html
3. https://nptel.ac.in/courses/112104116/
4. https://www.coursera.org/learn/finite-element-method
5. https://www.class-central.com/tag/finite-element-method
6. https://www.open.edu/openlearn/science-maths-technology/introduction-finite-element-analysis.

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U18AET6003	VIBRATIONS AND AEROELASTICITY	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO 1: Analyze the principles of free vibration.

CO 2: Evaluate the effects of damping in forced vibrations.

CO 3: Apply methods to analyze multi-degree of freedom systems.

CO 4: Demonstrate techniques for finding natural frequencies in continuous systems.

CO 5: Generalize strategies for preventing aeroelastic instabilities.

Pre-requisites :

1. U18AEI5202/ Aircraft Structures II

CO-PO and CO-PSO Mapping:

COs	CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													
	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M											M	
CO2		M											M	
CO3		S											M	
CO4		S											M	
CO5		M											M	

Course Assessment methods

Direct
1. Continuous Assessment Test I, II. 2. Journal paper review, Assignment, Group Presentation 3. End Semester Examination.
Indirect
1. Course-end survey

<u>Theory Component contents</u>

SINGLE DEGREE OF FREEDOM SYSTEMS – FREE VIBRATION **10 Hours**

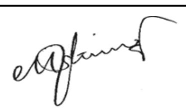
Terminologies – Simple harmonic motion – Newton’s Law – D’ Alembert’s principle – Energy Methods – Free vibrations – Damped vibrations.

SINGLE DEGREE OF FREEDOM SYSTEMS – FORCED VIBRATION **10 Hours**

Forced Vibrations – With and without damping – Support excitation – Vibration measuring instruments.

MULTI DEGREES OF FREEDOM SYSTEM **7 Hours**

Two degrees of freedom systems – Static and Dynamic couplings – Vibration absorber – Principal co-ordinates – Principal modes and orthogonal condition – Eigen value problems – Hamilton’s principle – Lagrangian equation and application.



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CONTINUOUS SYSTEMS **8 Hours**

Vibration of elastic bodies – Vibration of strings – Longitudinal, Lateral and Torsional vibrations – Approximate methods – Rayleigh and Holzer Methods to find natural frequencies.

ELEMENTS OF AEROELASTICITY **10 Hours**

Concepts – Collar’s triangle – Aero elastic instabilities and their prevention – Basic ideas on wing divergence – Loss and reversal of aileron control – Flutter and its prevention.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Singiresu S. Rao, ‘Mechanical Vibrations’, Fifth Edition, Prentice Hall, 2011.
2. V. P. Singh, ‘Mechanical Vibrations’, Fourth Edition, Dhanpat Rai and Co., 2014.
3. Leonard Meirovitch, ‘Fundamentals of Vibrations’, Tata McGraw Hill, 2001.
4. Tse. F.S., Morse, I.F., and Hunkle, R.T., ‘Mechanical Vibrations’, Prentice Hall, New York, 1984.
5. Bisplinghoff R.L., Ashley H and Hogman R.L., ‘Aero elasticity’, Addition Wesley Publication, New York, 1983.
6. Fung Y.C., ‘An Introduction to the Theory of Aero elasticity’, John Wiley and Sons, New York, 1995.

WEBSITE REFERENCES

1 https://nptel.ac.in/courses/112103111/

2 https://www.youtube.com/watch?v=pi5hAK0FdWA&t=2571s

3. https://www.youtube.com/watch?v=j-zczJXSxnw

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U18AET6104	ROCKET PROPULSION	L	T	P	J	C
		2	1	0	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO 1: Apply the operating principles of chemical rockets to solve numerical problems related to rocket thrust and specific impulse.

CO 2: Analyze different ignition systems in rockets to distinguish between pyrotechnic and pyrogen igniters.

CO 3: Evaluate the selection criteria and design considerations of solid propellant rockets.

CO 4: Apply the fundamentals of thermodynamics to evaluate the performance of liquid propellant rockets.

CO 5: Explain about operating principles of various advanced rocket propulsion systems.

Pre-requisite(s):

U18AEI5205 / Aircraft Propulsion

CO-PO and CO-PSO Mapping:

CO/PO &PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs) and Programme Specific Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	M											M	
CO 2	S	S											M	
CO 3	S	S	M										M	
CO 4	S	S	M										S	
CO 5		S											M	

Course Assessment Methods

Direct
1. Internal Test I 2. Internal Test II 3. Assignment 4. Tutorial 5. End Semester Exam
Indirect
Course end survey

DEFINITIONS AND FUNDAMENTALS 6+3 Hours

Operating principle of chemical rockets – Definitions: Rocket thrust, Exhaust velocity, Specific Impulse, Characteristic velocity, Thrust coefficient, Rocket nozzle classifications. – Numerical Problems.

IGNITION SYSTEMS IN ROCKETS 9+0 Hours

Types of solid propellant rocket igniters – Pyrotechnic igniters and pyrogen igniters – Igniter Design Considerations, Deflagration and Detonation, Hypergolic ignition.

SOLID PROPELLANT ROCKETS 6+3 Hours

Selection criteria of solid propellants – Important hardware components of solid rockets – Propellant grain design considerations – Burn rate – Internal ballistics, Erosive burning – Rocket performance considerations – Staging of rockets – Thrust vector control – Numerical

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problems.

LIQUID PROPELLANT ROCKETS **6+3 Hours**

Liquid propellant rocket engine fundamentals – Liquid propellants – Propellant feed systems – Selection of liquid propellants, Injectors, combustion chamber and nozzle, Combustion Instability, Secondary injection thrust vector control in liquid rockets – Cooling in liquid rockets – Numerical Problems.

ADVANCED PROPULSION TECHNIQUES **9+0 Hours**

Hybrid rockets, Cryogenic rockets, Electric rockets, Nuclear rockets, Satellite thrusters, Ion propulsion techniques, Solar sail, Anti-matter propulsion, Nozzle less propulsion, Interplanetary missions.

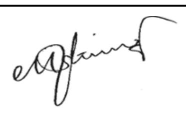
Theory: 36 Hours	**Tutorial: 9 Hours**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. George P. Sutton and Oscar Biblarz, 'Rocket Propulsion Elements', ngth Edition, John Wiley and Sons Inc., New York, 2017.
2. Kou. K. K and Summerfield. M., "Fundamental Aspects of Solid Propellant Rockets", Progress in Astronautics and Aeronautics, AIAA, Vol. 90, 1982.
3. Norazila Othman, Subramaniam Krishnan, and Wan Khairuddin Wan Ali, 'Design and Development of Hydrogen Peroxide Monopropellant Thruster: Basic Theory and Performance Calculations', Lambert Academic Publishers, 2011.
4. Barrere. M, 'Rocket Propulsion', Elsevier Publishing Company, New York, 1960.
5. Hill, P.G. and Peterson, C.R., 'Mechanics and Thermodynamics of Propulsion', Second Edition, Pearson Education, 1999.
6. Gordon Oates, 'Aero Thermodynamics of Gas Turbine and Rocket Propulsion', AIAA Education Series, New York, 1989.
7. J. W. Cornelisse, H. F. R. Schoyer, and K. F. Wakker, 'Rocket Propulsion and Spaceflight Dynamics', Pitman, London, 1979.

WEBSITES

1. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-512-rocket-propulsion-fall-2005/
2. https://nptel.ac.in/courses/101104019/



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U18AEP6505	DESIGN AND SIMULATION LABORATORY	L	T	P	J	C
		0	0	2	0	1

Course Outcomes

After successful completion of this course, the students will be able to

CO1: Analyze the structural behaviour of different elements.
CO2: Evaluate the apparent stress distribution over a structural component.
CO3: Analyze the nonlinearity condition problems over a structural element.
CO4: Construct grids for various geometries using commercial meshing codes like ICEMCFD, ANSYS Workbench.
CO5: Predict fluid flow properties using commercial codes like ANSYS Fluent, CFX, RotCFD.
CO6: Choose the suitable modeling approaches for turbo-machinery components.

Pre-requisite(s): U18AET5003 / Computational Fluid Dynamics

CO-PO and CO-PSO Mapping:

CO / PO / PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs) / Programme Specific Outcomes (PSO)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1					S									S
CO 2		M			S				M		W			S
CO 3	M				S									S
CO 4					S									S
CO 5	M			M	S									S
CO 6		W	S		M		S		M					M

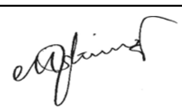
Course Assessment Methods

Direct	Indirect
1. Lab Exercises 2. Lab Observation / Record 3. Viva-voce / Model Practical Exams 4. End Semester Exam	Course end survey

LIST OF EXCERCISES

1. Static Analysis of a Stepped Composite Bar Element
2. Coupled Structural / Thermal Analysis
3. Comparative Nonlinear analysis of a Beam Element
4. Stress Analysis of an Axisymmetric component
5. Estimation of Crippling load in column.
6. Impact analysis of Bullet using Explicit Dynamics
7. Computing flow in a process of 3-D injection mixing pipe using ANSYS CFX
8. External flow analysis on the Automotive vehicle using Ansys CFX
9. Structural grid generation and Computing flow analysis in the Convergent - Divergent Nozzle using ANSYS Fluent
10. Structured grid generation and multiphase simulation of flow through Can Combustor using ANSYS Fluent
11. Computational Analysis of Flow and Acoustics around a turbo machinery components using ANSYS Fluent
12. Transient Analysis in the turbo machinery components using ANSYS Fluent [MRF approach

Theory: 0	Tutorial:	Practical: 30 Hours	Project: 0	Total: 30 Hours



Signature of BOS chairman, AE

U18AEP6506	AIRFRAME AND AERO ENGINE MAINTENANCE LABORATORY	L	T	P	J	C
		0	0	2	0	1

Course Outcomes

After successful completion of this course, the students will be able to

CO1: Apply various types of welding for different parts of an aircraft.

CO2: Remove and install aircraft wings and empennage required for maintenance.

CO3: Remove and install the undercarriage of an aircraft required for maintenance.

CO4: Identify the defects in an aircraft's piston engine and jet engine.

CO5: Start the piston and jet engines of an aircraft with the help of user manuals.

Pre-requisite(s):

CO-PO and CO-PSO Mapping:

CO / PO / PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs) / Programme Specific Outcomes (PSO)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	M		S											S
CO 2			M											S
CO 3			M											S
CO 4	S													S
CO 5			M											S

Course Assessment Methods

Direct	Indirect
1. Lab Exercises 2. Lab Observation / Record 3. Viva-voce / Model Practical Exams 4. End Semester Exam	Course end survey

LIST OF EXCERCISES

AIRFRAME MAINTENANCE

1. Welded patch repair by TIG, MIG and Riveting.
2. Removal and fitment of wings.
3. Removal and fitment of Empennage.
4. Removal and fitment of undercarriage.
5. Brake unit Removal and fitment.

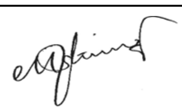
AERO ENGINE MAINTENANCE

6. Stripping of a piston engine and reassembly.
7. Piston Engine - cleaning, visual inspection, and NDT checks.
8. Piston Engine Components - dimensional checks.
9. Propeller Pitch Setting and balancing.
10. Jet Engine – Identification of components and defects.
11. Piston and Jet Engine starting procedure.

LIST OF EQUIPMENTS

1. Stand for empennage.
2. Piston Engine.
3. Jet Engine.
4. Standard tools for dismantling and assembly.
5. Non-destructive Testing equipment.

Theory: 0	Tutorial:	Practical: 30 Hours	Project: 0	Total: 30 Hours



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SEMESTER VII

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U18AEI7201	AIRCRAFT DESIGN	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the principles of conceptual aircraft design to create initial airplane layouts and three-view drawings.

CO2: Analyze the effect of wing loading on various flight parameters to optimize aerodynamic design using spreadsheets.

CO3: Evaluate the design considerations for the wing, fuselage, and tail to estimate drag and improve aerodynamic efficiency.

CO4: Evaluate propulsion systems by selecting appropriate engines and calculating thrust-to-weight ratios for different flight conditions.

CO5: Assess performance parameters such as take-off, climb, and landing distances to ensure compliance with minimum specifications.

CO6: Analyze and evaluate conceptual models of aerodynamic components, including wings and fuselages, with detailed CAD design reports.

Pre-requisites :

1. U18AET6001/ Flight Dynamics

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													**CO/PSO Mapping**	
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		M			M			S				W	
CO2	S		S						S				S	
CO3			S						S				S	
CO4			S						S				S	
CO5			S						S				S	
CO6			W						S				S	

Course Assessment methods:

Direct
1. Continuous Assessment Test I, II 2. Assignment, Group Project. 3. End Semester Examination
Indirect
1. Course-end survey

CONCEPTUAL AIRCRAFT DESIGN **8 Hours**

Design process, flow chart, survey of various types of airplanes, over-view of design process – Airplane configuration description - Initial Airplane layout – Three view drawings – Take-off weight – Preliminary Estimate – Spread sheet approach.

PRELIMINARY AERODYNAMIC DESIGN **8 Hours**

Selection of wing loading – Arrangement of surfaces, balance diagram – Wing loading effect on take-off, landing, climb, acceleration, range, combat, flight ceiling, and glide rate – Spread sheets.

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DESIGN OF WING, FUSELAGE AND TAIL **9 Hours**

Main plane: Airfoil cross-section shape, taper ratio selection, sweep angle selection, wing drag estimation – Spread sheet for wing design. Fuselage: Volume consideration, quantitative shapes, air inlets, wing attachments – Aerodynamic considerations and drag estimation – Spread sheets. Tail arrangements: Horizontal and vertical tail sizing – Tail planform shapes – Airfoil selection type – Tail placement – Spread sheets for tail design.

DESIGN OF PROPULSION SYSTEM **7 Hours**

Propulsion selection, thrust to weight ratio, number of engines, engine rating, turbo-jet engine sizing – Installed thrust corrections, spread sheets – Propeller propulsive systems – Propeller design for cruise, static thrust – Turboprop propulsion – Propeller spread sheets.

PERFORMANCE ESTIMATION **8 Hours**

Take-off phases, minimum take-off specification, climb gradients – Balanced field length – Landing approach – Free roll and braking – Spread sheet for take-off and landing distance – Enhance lift considerations – passive lift enhancement, trailing edge flap configuration– Active lift enhancement Control surface sizing –Aileron sizing, Rudder area sizing.

STRUCTURAL DESIGN **5 Hours**

Estimation of loads on complete aircraft components – Structural design of fuselage, wings – Materials for modern aircraft

REFERENCES

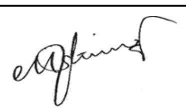
1. Thomas C Corke, ‘Design of Aircraft’, Pearson Education, Second edition.,2003
2. Snorri Gudmundsson,’General Aviation Aircraft Design: Applied Methods and Procedures’ first edition ,Elsevier, 2013
3. Darrol Stinton D. ‘The Design of the Aeroplane’, Second Edition, Black Well Science, 2001.
4. Daniel P. Raymer, ‘Aircraft Design: A Conceptual Approach’, Fifth Edition, AIAA Education Series, 2012.
5. John P Fielding, ‘Introduction to Aircraft Design’, second edition Cambridge University Press, 2017.
6. Jane's All the World's Aircraft 2010 - 2011 (IHS Jane's All the World's Aircraft) 2010-2011 Edition
7. Mohammad H. Sadraey ‘Aircraft Design: A Systems Engineering Approach’ 2012 first edition

WEBSITE REFERENCE:

1. http://www.aircraftdesign.com
2. http://airfoiltools.com/
3. https://www.airliners.net/
4. https://nptel.ac.in/courses/101106035/

List of Experiments

1. Comparative configuration study of different types of airplanes study on specification and performance details.
2. Comparative graphs preparation and selection of main parameters for the design.
3. Preliminary weight estimation.
4. Design point calculation to find wing loading and Thrust/Power loading
5. Power plant selection, Aerofoil selection, Wing and tail design.



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6. Detailed performance calculations and stability estimates.
7. Construction of V-n diagram and Gust envelope.
8. Estimation of loads on wings and fuselage.
9. Design of wings and fuselage components.
10. Preparation of a detailed design report with CAD drawings

Theory: 45	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 75 Hours**

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U18AET7002	AVIATION LOGISTICS AND SUPPLY CHAIN MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes:

After successful completion of this course, the students will be able to

CO 1: Describe the role of logistics in a market-oriented society.

CO 2: Explain the objectives, types, drivers, and other important factors of supply chain management.

CO 3: Discuss the types of airport and demonstrate supply chain management and its relevance to today's global business decision making.

CO 4: Describe the role of cargo handling agents and cold chain business.

CO 5: Recognize the role of cargo security, risks involved, trends and technology in aviation logistics.

Pre-requisite(s): -

CO-PO and CO-PSO Mapping:

COs	Programme Outcomes(POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1											S	M		M
CO2								M	S	S	S	M		M
CO3											S	M		M
CO4											S	M		M
CO5											S	M		M

Course Assessment methods

Direct
1. Continuous Assessment Test I, II 2. Assignment; Written & Group Presentation. 3. End Semester Examination
Indirect Assessment
Course exit survey

LOGISTICS AND COMPETITIVE STRATEGY — 9 Hours

Logistics management and Supply Chain management - Definition, Evolution, Importance. The concepts of logistics. Logistics relationships. Functional applications – HR, Marketing, Operations, Finance, IT. Logistics Organization - Logistics in different industries

SUPPLY CHAIN MANAGEMENT — 9 Hours

Supply Chain definition – Objectives – Types – Various definitions – Drivers – Need for SCM – SCM as a profession – SCM decisions and skills – Strategy formulation in SCM – Value in Supply Chain – Tradeoffs – CRM Strategy relationship matrix

AVIATION LOGISTICS AND AIRPORT CONNECTIONS — 9 Hours

Air cargo evolution- the growth of air freight- Globalization- Airport Types- Integrators- Regulations and agreements.

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CARGO HANDLING AGENTS AND COOL LOGISTICS 9 Hours

History- change factor- Role of general handling agent- Cool chain business- Case study- Changes in trading pattern.

CARGO SECURITY- RISK AND FUTURE 9 Hours

Role of cargo security- Risks - Environmental issues- Innovation and trends in air logistics- Regulation bodies

Theory: 45 Hours	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Aviation Logistics: The Dynamic Partnership of Air Freight and Supply Chain, By Michael Sales, 2016.
2. Logistics & Supply Chain Management, By Martin Christopher, fifth edition, 2015
3. Mohanty R.P, S.G Deshmuki “Supply Chain Management” Biztantra, New Delhi
4. Bowersox, Logistical Management, Mc-Graw Hill, 2000
5. Sahay B S, Supply Chain Management for Global Competitiveness, Macmillan India Ltd., New Delhi.
6. Reguram G, Rangaraj N, Logistics and Supply Chain Management Cases and Concepts, Macmillan India Ltd., New Delhi, 1999.

WEBSITE REFERENCES

1. http://dgca.nic.in/licencing/syl-ind.htm
2. https://www.mro-network.com/supply-chain-logistics/supply-chain-logistics
3. http://gmcstream.com/articles-on-aerospace-defense-technology-%7C-gmc-stream/aerospace-logistics-supply-chain-management.html
4. https://www.mdpi.com

U18AEI7203	AVIONICS	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO 1: Present the functional description of typical avionics systems in aircraft.
CO 2: Categorize the components and architectures of avionics systems.
CO 3: Interpret the data communication word in avionic data buses.
CO 4: Illustrate the working principle of aircraft communication, surveillance and navigation systems.
CO 5: Analyse the performance of the aircraft flight control systems.
CO 6: Compare the working principle of aircraft landing systems and components.

Pre-requisite(s): U18EEI3202 / Aircraft Electrical and Electronics Systems

CO-PO and CO-PSO Mapping:

CO-PO and CO-PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	-	-	-	S	-	-	-	-	-	-	-	M	-
CO 2	-	-	W	-	M	-	-	-	-	-	-	-	M	-
CO 3	M	-	-	-	M	-	-	-	-	-	-	-	W	-
CO 4	M	-	-	-	-	-	-	-	-	-	-	-	W	-
CO 5	-	-	-	-	W	-	-	-	-	-	-	-	-	M
CO 6	M	-	-	-	-	-	-	-	-	-	-	-	W	-

Course Assessment methods

Direct Assessment
1. Internal Tests 2. Assignments 3. Practical Exams 4. End Semester Exam
Indirect Assessment
Course exit survey

Theory Component:

INTRODUCTION TO AVIONICS 5 Hours

Avionics for Civil Aviation, Tactical Avionics, Typical Aircraft Avionics Systems, Avionics System Requirements, Avionics Systems Integration, Digital computers and its electronics, Architecture of Microprocessors.

AIRBORNE AND ONBOARD COMMUNICATIONS 6 Hours

Basics of communication, Frequency Band for Aviation, Radio signals, Modulation, VHF communication, HF communication, SATCOM, ATC communications, SELCAL, Databuses: MIL-STD-1553B, ARINC 429 and 629, Ethernet.

SURVEILLANCE SYSTEMS 3 Hours

Primary Radar, Secondary Radar, Transponder and its modes, TCAS, ADS-B, Weather Radar.

NAVIGATION SYSTEMS 6 Hours

VOR/DME, LORAN, RNAV, Doppler and Inertial Navigation Systems, Satellite Navigation Systems.

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FLIGHT CONTROL AND AUTOPILOT SYSTEMS **6 Hours**
Primary and Secondary Flight controls, Control Systems and Servos, Fly-by-Wire FCS, Autopilot Systems: Height control, Attitude control, Heading control, Airspeed control, Automatic Landing System.

TERRESTRIAL LANDING AIDS **4 Hours**
Instrument Landing System, Microwave Landing System, Radar Altimeter, Ground Proximity Warning Systems.

Lab Component:
List of Experiments/Exercises

1. Design and implementation of 4-bit adder/subtractor circuit.
2. Design and implementation of 4-to-1 multiplexer circuit.
3. Design and implementation of Encoder and Decoder circuits.
4. Design and implementation of 4-bit shift register with D-flip flops using IC 7474.
5. Assembly language program to add two 8-bit and two 16-bit numbers.
6. Assembly language program to arrange an array of data in ascending and descending order.
7. Demonstration of data transfer with MIL-STD-1553B data bus.
8. Demonstration of data transfer with ARINC 429 data bus.
9. Design and analysis of autopilot systems with MATLAB for flight control.

List of Equipment:

1. Bread board trainer kit
2. 8085 Microcomputer
3. 1553B data bus with interface card
4. ARINC 429 data bus with interface card
5. Desktop computer with MATLAB software installed

Theory: 30 Hours	**Tutorial: 0**	**Practical: 30 Hours**	**Project: 0**	**Total: 60 Hours**

REFERENCES

1. Albert Helfrick, ‘Principles of Avionics’, Ninth Edition, Avionics Communications Inc., 2015.
2. Ramesh S. Gaonkar, ‘Microprocessor Architecture, Programming and Applications with the 8085’, Sixth Edition, Penram International Publishers, 2013.
3. R. P. G. Collinson, ‘Introduction to Avionics Systems’, Third Edition, Springer Science, London, 2011.
4. Myron Kayton and Walter R. Fried, ‘Avionics Navigation Systems’, Second Edition, John Wiley and Sons, 1997.
5. Cary R. Spitzer (Ed.), Uma Ferrell (Ed.) and Thomas Ferrell (Ed.), ‘Digital Avionics Handbook’, Third Edition, CRC Press, 2014.
6. Cary R. Spitzer, ‘Digital Avionics Systems: Principles and Practice’, Second Edition, The Blackburn Press, 2001.
7. Ian Moir, Allan Seabridge and Malcolm Jukes, ‘Civil Avionics Systems’, Second Edition, Wiley, 2013.
8. John H. Blakelock, ‘Automatic Control of Aircraft and Missiles’, Second Edition, John Wiley and Sons, 1991.
9. Mike Tooly and David Wyatt, ‘Aircraft Communications and Navigation Systems: Principles, Maintenance and Operation’, Butterworth-Heinemann’s Series, 2007.

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WEBSITE REFERENCES

1. Advanced Avionics Handbook: https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/advanced_avionics_handbook/
2. Programs for 8085 Microprocessor Level 2: http://scanftree.com/microprocessor/Programs-For-8085-Microprocessor-Trainees
3. Digital Circuits Tutorial: https://www.tutorialspoint.com/digital_circuits/digital_arithmetic_circuits.htm

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U18AEP7704	PROJECT WORK – PHASE I	L	T	P	J	C
		0	0	0	6	3

Course Outcomes:

After successful completion of this course, the students will be able to

CO 1: Apply the knowledge of Mathematics, Science, and fundamentals of Aerodynamics, Structures, Propulsion and Avionics to identify, formulate and analyze complex engineering problems in aerospace applications.

CO 2: Develop a project planning strategy.

CO 3: Create aircraft system component models using CATIA, AutoCAD, etc.

CO 4: Conduct experiments, analyze and interpret data by applying appropriate techniques, utilizing available resources and software tools.

CO 5: Work as an individual or as a member on project teams and communicate the results effectively by compiling project reports and presentations.

Pre-requisite(s): Nil

CO-PO and CO-PSO Mapping:

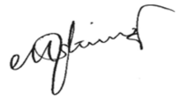
COs	Programme Outcomes(POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M											S	
CO2		S									M			W
CO3			S	S	S									S
CO4				S	S									S
CO5									S	S				W

Course Assessment methods

Direct
1. Review Presentations 2. Project Report 3. Paper Publications 4. Viva voce
Indirect Assessment
NIL

GUIDELINES

1. Selection of a topic or project title in consultation with project guide.
2. Develop a project planning strategy.
3. If it is an industry-sponsored project, a concurrent letter from industry is required.
4. A maximum of 4 students per group will do the project.
5. The project may be done in one of the labs under the supervision of a guide or in the selected industry.



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SEMESTER VIII

U18AEP8701	PROJECT WORK – PHASE II	L	T	P	J	C
		0	0	0	24	12

Course Outcomes:
After successful completion of this course, the students will be able to

CO 1: Apply the knowledge of Mathematics, Science, and fundamentals of Aerodynamics, Structures, Propulsion and Avionics to identify, formulate and analyze complex engineering problems in aerospace applications.
CO 2: Design aircraft system components by considering the constraints such as economics, environment, health and safety, manufacturability.
CO 3: Conduct experiments by applying appropriate techniques, utilizing available resources and understand the impact of project results in environmental and societal context.
CO 4: Simulate, analyze and interpret data using software tools such as MATLAB, ANSYS fluent, CFX, CFD++, ICEM CFD, GAMBIT, etc.
CO 5: Work as an individual or as a member on project teams and communicate the results effectively by compiling project reports and presentations.

Pre-requisite(s): Nil

CO-PO and CO-PSO Mapping:

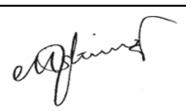
COs	Programme Outcomes(POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S											S	
CO2			S										S	
CO3			M	S									S	
CO4		M			S									S
CO5									S	S				W

Course Assessment methods

Direct
1. Review Presentations 2. Project Report 3. Paper Publications 4. Viva voce
Indirect Assessment
NIL

GUIDELINES

1. Develop a project planning strategy.
2. If it is an industry-sponsored project, a concurrent letter from industry is required.
3. A maximum of 4 students per group will do the project.
4. The project may be done in one of the labs under the supervision of a guide or in the selected industry.
5. At the end of the project, a report will be written and a technical presentation along with demonstration will be made by the students.
6. The report, project demonstration and technical presentation will be evaluated by the internal and external examiners.



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PROFESSIONAL ELECTIVES

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U18AEE0001	EXPERIMENTAL AERODYNAMICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students would be able to

CO1: Apply fluid mechanics measurement techniques to conduct accurate experimental studies and analyze fluid properties.

CO2: Analyze the operation and performance of various wind tunnels to optimize their use in aerodynamics research.

CO3: Evaluate flow visualization methods and analogue techniques to interpret fluid flow characteristics effectively.

CO4: Examine pressure, velocity, and temperature measurement setups for accurate data collection in different flow regimes.

CO5: Assess measurement errors and perform uncertainty analysis to improve the reliability of experimental results in fluid mechanics.

Pre-requisite(s): U18AEI4201 / Low Speed Aerodynamics

CO-PO and CO-PSO Mapping:

CO/PO & PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					M									
CO2	M													M
CO3			S	S									S	
CO4			S	S									S	
CO5				S										

Course Assessment methods

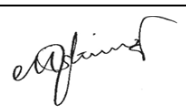
Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Seminar 5. End Semester Exam	Course end survey

BASIC MEASUREMENTS IN FLUID MECHANICS — 7 hours

Objective of experimental studies – Fluid mechanics measurements – Properties of fluids – Measuring instruments – Performance terms associated with measurement systems – Direct measurements – Analogue methods – Flow visualization –Components of measuring systems – Importance of model studies.

CHARACTERISTICS OF MEASUREMENTS — 10 hours

Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels – Power losses in a wind tunnel – Instrumentation of wind tunnels – Turbulence- Wind tunnel balance –principles, types and classifications -Balance calibration.



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FLOW VISUALIZATION AND ANALOGUE METHODS 9 hours

Principles of Flow Visualization – Hele-Shaw apparatus – Interferometer – Fringe-Displacement method – Schlieren system – Shadowgraph – Hydraulic analogy – Hydraulic jumps – Electrolytic tank.

PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS 9 hours

Measurement of static and total pressures in low and high speed flows- Pitot Static tube characteristics – Pressure transducers – principle and operation – Velocity measurements – Hot-wire anemometry – LDV – PIV: Temperature measurements.

SPECIAL FLOWS AND UNCERTAINTY ANALYSIS 10 hours

Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers – Data acquisition and processing – Signal conditioning – Uncertainty analysis – Estimation of measurement errors – External estimate of the error – Internal estimate of the error – Uncertainty calculation – Uses of uncertainty analysis.

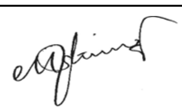
Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Ethirajan Rathakrishnan , "Instrumentation, Measurements, and Experiments in Fluids," CRC Press – Taylor & Francis, Second Edition, 2018.
2. Justin D. Pereira, 'Wind Tunnels: Aerodynamics, Models and Experiments', Nova Science Publishers, 2013.
3. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.
4. Robert B Northrop, "Introduction to Instrumentation and Measurements", Third Edition, CRC Press, Taylor & Francis, 2017.
5. Rae, W.H. and Pope, A., 'Low Speed Wind Tunnel Testing', Third Edition, Wiley India Pvt Ltd, 2010.
6. NAL-UNI Lecture Series 12: Experimental Aerodynamics, NAL SP 98 01 April 1998
7. Lecture course on "Advanced Flow diagnostic techniques" 17-19 September 2008 NAL, Bangalore

WEBSITE REFERENCES

1. http://ocw.metu.edu.tr/course/view.php?id=66
2. https://nptel.ac.in/courses/101106040/Experimental Gas/Aerodynamics
3. https://engineering.purdue.edu/AAE/academics/course-descriptions/AAE520
4. https://ame.nd.edu/undergrad-programs/courses/ame-30333-aerodynamics-laboratory
5. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005/



U18AEE0002	VISCOUS FLOW THEORY	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students would be able to

CO1: Apply the equations of motion for real and ideal fluids to analyze boundary layer behavior and separation on airfoils.

CO2: Analyze exact solutions and boundary layer theory to solve laminar incompressible viscous flow problems involving pressure gradients and curvature.

CO3: Evaluate compressible Couette flow and shock-boundary layer interactions to understand hypersonic effects and their impact on flow properties.

CO4: Examine the transition from laminar to turbulent flow using linear and nonlinear theories to predict the effects of various factors on flow stability.

CO5: Analyze experiments and simulations to investigate turbulent flows and validate theoretical predictions for various flow configurations.

Pre-requisite(s): U18AET5001 / High Speed Aerodynamics

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**												**PSOs**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	S	S				W					S		S	
CO 2	S	S				W					S		S	
CO 3	S	S				W					S		S	
CO 4	S	S				W					S		S	
CO 5	S	S		M	S									S

Course Assessment Methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment/Seminar/Project 5. End Semester Exam	Course end survey

INTRODUCTION 10 Hours

Real and ideal fluids, Boundary layer concept, Boundary layer on an airfoil, Boundary layer separation, Derivation of the Equations of Motion: Review of Cartesian tensor notation – Review of thermodynamics – Heat transfer – Derivation of the full compressible viscous Newtonian equations – Conservation of mass, momentum, energy – Vorticity and entropy equations – Kelvin's theorem – Introduction to Non-Newtonian fluids.

LAMINAR INCOMPRESSIBLE VISCOUS FLOW 10 Hours

Exact solutions: stagnation point flow, Jeffrey-Hamel flow, Stokes problems – Low Reynolds number flow – Introduction to perturbation theory – Boundary layer theory – Effects of pressure gradient and curvature – Boundary layer integral equations – Thwaites method – Laminar separation, separation bubbles.

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LAMINAR COMPRESSIBLE VISCOUS FLOW **8 Hours**

Exact solutions: compressible Couette flow, flow through a shock wave – Compressible boundary layers – Introduction to shock-boundary layer interaction and hypersonic effects: dissociation, heating, and non-equilibrium thermodynamics.

TRANSITION TO TURBULENCE **7 Hours**

Linear transition theory – Introduction to nonlinear theory and numerical methods – Introduction to experimental results in bounded and free shear flows, both incompressible and compressible – Effects of roughness, turbulence, vibration, noise, curvature, etc – Transition-separation interactions in boundary layers.

TURBULENT FLOW **10 Hours**

Introduction to Turbulent Flow: Reynolds averaged equations of motion – Introduction to statistics and correlations – Kolmogorov scale – 5/3 law for inertial range self-similarity – Law of the wall in the turbulent boundary layer – Introduction to experimental results for various fundamental turbulent flows – Bluff bodies, internal flows, free shear flows – Introduction to far field self-similarity theories – Introduction to compressible-boundary layer flow.

Theory: 45 Hrs	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hrs**

REFERENCES

1. Frank M. White, 'Viscous Fluid Flow', Third Edition, Tata McGraw Hill Pvt Ltd., New Delhi, 2011.
2. H.Schlichting and K.Gersten, 'Boundary Layer Theory', Ningth Edition, Springer, 2017.
3. Richard Courant and Kurt Otto Friedrichs, 'Supersonic Flow and Shock Waves', Springer Science and Business Media, 1976.
4. Lagerstrom, P.A., 'Laminar Flow Theory', Princeton University Press, 1996.
5. John David Anderson, 'Hypersonic and High Temperature Gas Dynamics', American Institute of Aeronautics and Astronautics, 2006.
6. Carl M. Bender and Steven A. Orszag, 'Advanced Mathematical Methods for Scientists and Engineers I: Asymptotic Methods and Perturbation Theory', Springer-Verlag, New York, 2013.
7. Rutherford Aris, 'Vectors, Tensors and the Basic Equations of Fluid Mechanics', Dover Publications, 2012.

WEBSITES

1. https://ocw.mit.edu/courses/mechanical-engineering/2-25-advanced-fluid-mechanics-fall-2013/equations-of-viscous-flow/
2. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-13-aerodynamics-of-viscous-fluids-fall-2003/
3. https://nptel.ac.in/courses/Webcourse-contents/Iit-Kanpur/Fluid Mechanics/Ui/Course_Home-8.Htm

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U18AEE0003	HYPERSONIC AERODYNAMICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students would be able to

CO1: Analyze the differences between hypersonic and supersonic aerodynamics to understand the concepts of thin shock layers and entropy layers.

CO2: Apply the Newtonian theory and tangent wedge methods to solve problems in hypersonic inviscid flows.

CO3: Evaluate the boundary layer equations for hypersonic flow to understand aerodynamic heating and its effects on airframes.

CO4: Examine the concept of viscous interactions in hypersonic flows to analyze strong and weak interactions and their impact on flow characteristics.

CO5: Analyze models to predict high temperature effects in hypersonic flows, considering chemical reactions in air and boundary layer recombination and dissociation.

Pre-requisite(s): U18AET5001/ High Speed Aerodynamics

CO-PO and CO-PSO Mapping:

CO/PO & PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					M									
CO2	M													M
CO3			S	S									S	
CO4			S	S									S	
CO5				S										

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Seminar 5. End Semester Exam	Course end survey

FUNDAMENTALS OF HYPERSONIC AERODYNAMICS 9 Hours

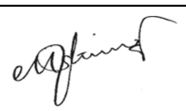
Introduction to hypersonic aerodynamics – differences between hypersonic aerodynamics and supersonic aerodynamics - concept of thin shock layers and entropy layers – hypersonic flight paths – hypersonic similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

SIMPLE SOLUTION METHODS FOR HYPERSONIC INVISCID FLOWS 9 Hours

Local surface inclination methods – Newtonian theory – modified Newtonian law – tangent wedge and tangent cone and shock expansion methods – approximate methods - hypersonic small disturbance theory – thin shock layer theory.

VISCOUS HYPERSONIC FLOW THEORY 9 Hours

Boundary layer equations for hypersonic flow – hypersonic boundary layers – self similar



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and non self-similar boundary layers – solution methods for non self-similar boundary layers – aerodynamic heating and its adverse effects on airframe.

VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9 Hours

Introduction to the concept of viscous interaction in hypersonic flows - Strong and weak viscous interactions - hypersonic viscous interaction similarity parameter – introduction to shock wave boundary layer interactions.

HIGH TEMPERATURE EFFECTS in HYPERSONIC FLOWS 9 Hours

Nature of high temperature flows – chemical effects in air – real and perfect gases – Gibb’s free energy and entropy - chemically reacting boundary layers – recombination and dissociation.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. John D. Anderson, Jr, ‘Hypersonic and High Temperature Gas Dynamics’, Second Edition, AIAA Education Series, 2006.
2. John D. Anderson., ‘Modern Compressible Flow’, Third Edition, Tata McGraw-Hill, New Delhi, 2012.
3. John D Anderson, Jr., ‘Fundamentals of Aerodynamics’, Chapter 14, Sixth Edition, McGraw-Hill Education, 2016.
4. Vinh, N.X, A. Busemann, and R. D Culp, ‘Hypersonic and Planetary Entry Flight Mechanics’, University of Michigan Press, Ann Arbor, 1980.
5. Hayes, W.D, and R.F Probstein, ‘Hypersonic Flow Theory’, Second Edition, Academic Press, New York, 1966.

WEBSITE REFERENCES

1. https://nptel.ac.in/courses/101103003/ hypersonic aerodynamics
2. https://www.grc.nasa.gov/www/BGH/index.html
3. https://www.aem.umn.edu/teaching/curriculum/syllabi/Grad/AEM_5245_syllabus.shtml
4. https://web.stanford.edu/~jurzay/ME356/ Hypersonic Aerothermodynamics
5. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-885j-aircraft-systems-engineering-fall-2005/video-lectures/lecture-7/

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U18AEE0004	CRYOGENIC ENGINEERING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply classical thermodynamics principles to various cryogenics systems.

CO2: Solve unique problems of heat transfer in cryogenic applications.

CO3: Understand the thermo-physical properties variations of materials at cryogenic temperature.

CO4: Analyze the effectiveness of various cryogenic insulation methods to select the most suitable insulation system for specific applications.

CO5: Explain about general safety protocols for cryogenic systems.

Pre-requisites :

1. U18AEI3202 /Engineering Thermodynamics

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													**CO/PSO Mapping**	
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S												M	
CO2		S											M	
CO3		S											W	
CO4		S											M	
CO5	S				M								M	

Course Assessment methods

Direct
1.Continuous Assessment Test I, II 2.Assignment, Group Presentation 3.End Semester Examination
Indirect
1. Course-end survey

BASIC PRINCIPLES **8 Hours**

Introduction to Cryogenics and superconductivity – Applications of Cryogenics – Common Cryogens and their properties – Cryogenic rockets – Thermodynamic analysis of low-temperature systems – Basic principles of low temperature heat transfer, Cryogenic liquefaction process.

CRYOGENIC HEAT TRANSFER **10 Hours**

Basic modes of heat transfer: Conduction, Convection and Radiation in cryogenic systems in steady and unsteady conditions – Temperature dependent thermal conductivity, Boiling and two phase flow, Pool and film boiling of cryogenic fluids – Thermal contact resistance: Unique problems of heat transfer in cryogenic applications.

THERMO-PHYSICAL PROPERTIES OF CRYOGENIC SYSTEM **10 Hours**

PVT behavior of a pure substance – Mechanical properties of materials used in cryogenic systems –Transport properties of solids – thermal properties, emissivity, absorptivity and reflectivity, electrical properties and superconductivity – Prediction of thermodynamic properties, ultra-low temperature refrigerators, Cryocoolers.

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CRYO INSULATION AND DEVICES **10 Hours**

Storage vessel, thermal shields and insulation, effect of size and shape of storage vessel on heat in-leak, vapour shielding, vacuum insulation, evacuated porous insulation, solid foams, multilayer insulation, composite insulation, critical radius of insulation – Micro-sphere insulation, typical insulation systems for space propulsion, aerogel beds, light density Mylar, comparison of insulations.

Cryogenic Instrumentation: Strain, displacement and position, pressure, flow, liquid level, density and temperature for cryogenic applications.

Cryogenic Equipments: Introduction of Compressors, pumps, expansion engines, valves, and heat exchangers for cryogenic applications.

SAFETY WITH CRYOGENIC SYSTEMS **7 Hours**

Introduction – Physiological hazards, explosions and flammability, excessive pressure gas, suitability of materials and construction techniques, safety considerations for liquid hydrogen and liquid oxygen – General safety principles.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

BOOK REFERENCES

1. Thomas M. Flynn, 'Cryogenic Engineering', Second Edition, CRC Press, Taylor and Francis Inc., 2009.
2. Barron, R., 'Cryogenic Systems', Second Edition, Oxford University Press, New York, 1985.
3. Barron, R.F, 'Cryogenic Heat Transfer', Philadelphia, PA: Taylor and Francis Publishers, second edition, 2016.
4. Augustynowicz, S.D. and Fesmire, J.E., "Cryogenic Insulation System for Soft Vacuum", Advances on Cryogenic Engineering, Vol. 45, Kluwer Academic / Plenum Publishers, pp. 1691-1698, 2000.
5. Mamata Mukhopadhyay, 'Fundamentals of Cryogenic Engineering', Prentice Hall India Pvt. Ltd., New Delhi, 2010.

WEBSITE REFERENCE

1. https://trc.nist.gov/cryogenics/
2. https://cryogenicsociety.org/resources/cryogenic_references/
3. https://cryo.gsfc.nasa.gov/Biblio/AdvCryoEnr.html.
4. https://nptel.ac.in/downloads/112101004/
5. https://www.docsity.com/en/cryogenic-engineering-2/4110192/
6. https://web.uvic.ca/calendar2018-09/CDs/MECH/445.html

U18AEE0005	PRINCIPLES OF COMBUSTION	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the principles of combustion to characterize various fuels and combustion modes.

CO2: Analyze the thermodynamics of combustion to determine adiabatic temperature and chemical equilibrium.

CO3: Evaluate the kinetics of combustion reactions to simplify reaction mechanisms and assess global kinetics.

CO4: Analyze the physics of combustion to understand transport phenomena and turbulent flow in combustion processes.

CO5: Explain about Gaseous Jet diffusion flame.

Pre-requisites :

1.U18AEI3202 / Engineering Thermodynamics

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													**CO/PSO Mapping**	
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S											M	
CO2		S											S	
CO3		S											M	
CO4	M												M	
CO5		M											M	

Course Assessment methods

Direct
1.Continuous Assessment Test I, II 2.Assignment 3. End Semester Examination.
Indirect
1. Course-end survey

INTRODUCTION **4 Hours**

Introduction to combustion, Applications of combustion, Types of fuel and oxidizers, Characterization of fuel, Various combustion mode, Scope of combustion.

THERMODYNAMICS OF COMBUSTION **7 Hours**

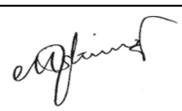
Thermodynamics properties, Laws of thermodynamics, Stoichiometry, Thermochemistry, adiabatic temperature, chemical equilibrium.

CHEMISTRY OF COMBUSTION **7 Hours**

Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics.

PHYSICS OF COMBUSTION **7 Hours**

Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow.



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PREMIXED FLAME **10 Hours**

One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning Velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame.

DIFFUSION FLAME **10 Hours**

Gaseous Jet diffusion flame, Liquid fuel combustion, Atomization, Spray Combustion, Solid fuel combustion.

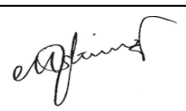
Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45Hours**

BOOK REFERENCES

1. Kenneth Kuan-yun Kuo, ‘Principles of Combustion’, Second Edition revised, ISBN: 978-0-471- 04689-9, January 2005.
2. D. P. Mishra, Fundamentals of Combustion, first edition revised, Prentice Hall of India, New Delhi, 2008.
3. Strehlow R A., “Combustion fundamentals” Krieger Pub Co; Reprint edition (1) 1993.
4. John Heywood “Internal Combustion Engine Fundamentals “McGraw-Hill Education; 1 edition, 1988.

WEBSITE REFERENCES

1. https://nptel.ac.in/courses/101106037/
2. https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/
3. http://www.forbrf.lth.se/english/education/courses/fundamental-combustion/
4. https://www.journals.elsevier.com/combustion-and-flame.
5. http://www.combustioninstitute-indiansection.com/



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U18AEE0006	HEAT AND MASS TRANSFER	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO 1: Apply the principles of conduction to solve problems related to heat transfer in different geometries.

CO 2: Analyze convective heat transfer processes to determine heat transfer coefficients for various flow conditions.

CO 3: Solve problems in natural and forced convection for internal and external flows.

CO 4: Analyze the principles of radiation heat transfer to calculate radiative heat exchange between surfaces.

CO 5: Explain the phenomenon of diffusion and convective mass transfer.

Pre-requisites :

1. U18AEI3202 - Engineering Thermodynamics

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													**CO/PSO Mapping**	
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S												S	M
CO2	M	S												
CO3			M										M	
CO4	S		M											
CO5		M											M	

Course Assessment Methods

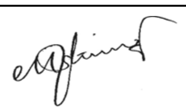
Direct
1. Continuous Assessment Test I, II (Theory component). 2. Assignment (Theory component). 3. End Semester Examination (Theory component).
Indirect
1. Course-end survey

CONDUCTION 9 Hours

Basic Concepts – Mechanism of Heat Transfer – Conduction, Convection and Radiation – Fourier Law of Conduction - General Differential Conduction equation in Cartesian and Cylindrical Coordinate systems – One Dimensional Steady State Heat Conduction through Plane Wall, Cylindrical and Spherical systems – Composite Systems – Critical thickness of insulation - Conduction with Internal Heat Generation – Extended Surfaces – Numerical Methods of One dimensional Heat conduction- Unsteady Heat Conduction – Lumped Analysis, Infinite and semi Infinite solids using Heislers Chart.

CONVECTION 9 Hours

Basic Concepts – Convective Heat Transfer Coefficients – Boundary Layer Concept – Types of Convection – Forced Convection – Dimensional Analysis – External Flow – Flow over Plates, Cylinders and Spheres – Internal Flow – Laminar, Turbulent and Combined flows – Flow over Bank of tubes – Free Convection – Dimensional Analysis – Flow over Vertical, Horizontal and Inclined Plates, Cylinders and Spheres.



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PHASE CHANGE AND HEAT EXCHANGERS **9 Hours**

Nusselts theory of condensation - Regimes in boiling - Correlations in condensation and boiling - Types of Heat Exchangers- compact heat exchanger – Overall Heat Transfer Coefficient – Fouling Factors - LMTD and Effectiveness – NTU methods of Heat Exchanger Analysis.

RADIATION **9 Hours**

Basic Concepts, Laws of Radiation – Black Body Radiation – Grey body radiation – radiation shield - Shape Factor Algebra (Plates, parallel, perpendicular, parallel circular disc) – Gas radiations (qualitative study).

MASS TRANSFER **9 Hours**

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

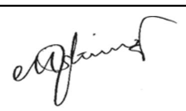
Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45Hours**

REFERENCES

1. Holman J.P, "Heat Transfer" Tata Mc Graw Hill,2007.
2. Yunus Cengal, "Heat and Mass Transfer", Tata McGraw Hill,2008.
3. Ozisik M.N, "Heat Transfer", McGraw-Hill Book Co,2001.
4. Nag P.K, "Heat Transfer", Tata McGraw-Hill, New Delhi, 2002.
5. Eckert, E.R.G, 'Heat and mass transfer " Mc Graw hill, 1959.
6. Frank P. Incropera and David P. DeWitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, March 2006.
7. Sachdeva R C, "Fundamentals of Engineering Heat and Mass Transfer", New Age International,2008.

WEBSITE REFERENCES

1. https://www.edx.org/
2. https://www.coursera.org/
3. https://ocw.mit.edu/courses
4. http://nptel.ac.in/courses/
5. www.mechanicalbooster.com
6. heat transfer.asmedigitalcollection.asme.org
7. hyperphysics.phy-astr.gsu.edu



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U18AEE0007	COMPOSITE MATERIALS AND STRUCTURES	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO1: Analyze stress-strain relations for various types of composite materials.

CO2: Evaluate different methods of material analysis using micromechanics and macro mechanics.

CO3: Apply failure theories to predict failure in laminated plates.

CO4: Generalize design concepts and materials used in sandwich constructions.

CO5: Prepare a plan for composite fabrication processes.

Pre-requisites : -

CO-PO and CO-PSO Mapping:

COs	**CO/PO Mapping** (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													
	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M											M	
CO2		S											M	
CO3			S										M	
CO4	S												M	
CO5			M										M	

Course Assessment methods

Direct
1. Continuous Assessment Test I, II. 2. Journal paper review, Assignment, Group Presentation 3. End Semester Examination.
Indirect
1. Course-end survey

<u>Theory Component contents</u>

STRESS-STRAIN RELATION **6 Hours**

Introduction – Advantages, disadvantages and application of composite materials, reinforcements and matrices – Generalised Hooke's Law – Elastic constants for anisotropic, orthotropic and isotropic materials.

METHODS OF ANALYSIS **12 Hours**

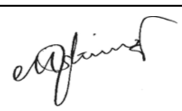
Micromechanics – Mechanics of materials approach, Elasticity approach to determine material properties – Macro mechanics – Stress-Strain relations with respect to natural axis and arbitrary axis – Experimental characterization of lamina.

LAMINATED PLATES **10 Hours**

Governing differential equation for a general laminate, symmetric, balanced, angle ply and cross ply laminates – Failure theory for composites.

SANDWICH CONSTRUCTIONS **10 Hours**

Basic design concepts of sandwich construction – Materials used for sandwich construction – Failure modes of sandwich panels – Flexural rigidity of Sandwich beams and plates.



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FABRICATION PROCESS **7 Hours**

Various open and closed mould processes – Manufacture of fibres – Types of resins and properties and applications – Netting analysis – Environmental effects on composites.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES

1. Autar K. Kaw, 'Mechanics of Composite Materials', Second Edition, First Indian Reprint, CRC Press, 2009.
2. Jones, R.M., 'Mechanics of Composite Materials', McGraw-Hill, Kogakusha Ltd., Tokyo, 1999.
3. Lalit Gupta, 'Advanced Composite Materials', Revised Edition, Fourth Reprint, Himalayan Books, 2007.
4. Alan Baker, Stuart Dutton, and Donald Kelly, 'Composite Materials for Aircraft Structures', Second Edition, AIAA, 2004.
5. Krishan K. Chawla, 'Composite Materials: Science and Engineering', Third Edition, Springer, 2013.
6. Ever J. Barbero, "Introduction to Composite Materials Design", CRC Press, Second Edition 2010.

WEBSITE REFERENCES

1. https://nptel.ac.in/courses/101104010/
2. http://www.ae.iitkgp.ac.in/ebooks/chapter1.html
3. https://www.youtube.com/watch?v=0kB0G6WKhKE&list=PLSGws_74K01-bdEEUElQ9-obrujIKGEhg

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U18AEE0008	THEORY OF ELASTICITY	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO 1: Analyze stress and strain relationships in elastic materials.
CO 2: Evaluate compatibility equations for stresses and strains.
CO 3: Apply Airy's stress function to solve plane stress and plane strain problems.
CO 4: Generalize the use of polar coordinates in solving elasticity problems.
CO 5: Demonstrate different theories of torsion and their applications to various cross-sectional geometries.

Pre-requisites :

1.U18AEI5202/ Aircraft Structures-II

CO-PO and CO-PSO Mapping:

COs	**CO/PO Mapping** (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													
	Programme Outcomes(POs) and PSOs													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M											M	
CO2	S	M											M	
CO3	S	S											M	
CO4	S	S											M	
CO5	S	M											M	

Course Assessment methods

Direct
1. Continuous Assessment Test I, II. 2. Assignment, Group Presentation 3. End Semester Examination.
Indirect
1. Course-end survey

<u>Theory Component contents</u>

ASSUMPTIONS IN ELASTICITY **7 Hours**

Definitions – Notations and sign conventions for stress and strain Strain-displacement relations – Stress-strain relations – Lame's constant – cubical dilation – Compressibility of material – Bulk modulus – Shear modulus- Equations of equilibrium.

BASIC EQUATIONS OF ELASTICITY **10 Hours**

Compatibility equations for stresses and strains - Principal stresses and principal strains – Mohr's circle – Saint Venant's principle.

PLANE STRESS AND PLANE STRAIN PROBLEMS **10 Hours**

Airy's stress function – Bi-harmonic equations – Polynomial solutions – Simple two-dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams.

POLAR COORDINATES **10 Hours**

Equations of equilibrium – Strain displacement relations – Stress-strain relations – Airy's stress function – Axisymmetric problems – Kirsch-Michell's and Boussinasque problems.

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TORSION **8 Hours**

Navier's theory – St. Venant's theory – Prandtl's theory on torsion – Semi-inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Timoshenko, S. P., and Goodier, J. N., 'Theory of Elasticity', Third Edition, McGraw-Hill Ltd., Tokyo, 1970.
2. Enrico Volterra and J.H. Caines, 'Advanced Strength of Materials', Prentice Hall New Jersey, 1991.
3. Wang, C.T., 'Applied Elasticity', McGraw-Hill Co., New York, 1993.
4. Sokolnikoff, I.S., 'Mathematical Theory of Elasticity', McGraw-Hill, New York, 1978.
5. P.N Chandramouli., 'Theory of Elasticity', Yes Dee Publishing, 2017.

WEBSITE REFERENCES

1 https://onlinecourses.nptel.ac.in/noc18_ce18/unit?unit=5&lesson=19

2 http://micro.stanford.edu/~caiwei/me340/

3. https://www.youtube.com/watch?v=eICv1p8WjgI&list=PLbRMhDVUMngcbhsZgRWuYCi2kKQwQ0Av1

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U18AEE0009	FATIGUE AND FRACTURE MECHANICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students would be able to

CO1: Analyze S-N curves and the effects of mean stress to determine endurance limits and fatigue life modifying factors.

CO2: Evaluate cyclic stress-strain behavior to interpret strain-life curves and mean stress effects.

CO3: Analyze the phases in fatigue life including crack initiation, growth, and final fracture to understand the physical aspects of fatigue.

CO4: Evaluate Linear Elastic Fracture Mechanics (LEFM) and Elastic Plastic Fracture Mechanics (EPFM) to apply Griffith's theory to ductile materials.

CO5: Analyze fatigue design methodologies incorporating variable amplitude loading theories and fracture mechanics principles for aerospace structures.

Pre-requisite(s):

U18AEI3203 - Mechanics of Solids

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**												**PSOs**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1		M											S	
CO 2		S											M	
CO 3		M											M	
CO 4	S												S	
CO 5		M											S	

Course Assessment Methods:

Direct
1. Continuous Assessment Test I, II 2. Assignment; Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

FATIGUE OF STRUCTURES – STRESS LIFE **7 Hours**

S.N. curves – Endurance limits – Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams –Modifying Factors of Fatigue life.

FATIGUE OF STRUCTURES – STRAIN LIFE **7 Hours**

Monotonic Stress-Strain Behavior – Cyclic Stress-strain Behavior – Transient Behavior – Strain-Life Curve – Mean stress effects.

PHYSICAL ASPECTS OF FATIGUE **6 Hours**

Phases in fatigue life – Crack initiation – Crack growth – Final Fracture – Dislocations – Fatigue fracture surfaces.

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FRACTURE MECHANICS **10 Hours**

Introduction – LEFM (Linear Elastic Fracture Mechanics) & EPFM (Elastic Plastic Fracture Mechanics) – Potential energy and surface energy – Griffith's theory – Irwin-Orwin extension of Griffith's theory to ductile materials.

VARIABLE AMPLITUDE LOADING **7 Hours**

Linear and Nonlinear damage theories – Cycle counting Techniques-Level crossing Counting, Peak Counting, Rain flow Counting.

FATIGUE DESIGN AND TESTING **8 Hours**

Fatigue Design philosophies –Importance of Fracture Mechanics in aerospace structures.

Theory: 45	Tutorial: 15	Practical: 0	Project: 0	Total: 60 Periods

REFERENCES

1. Julie A. Bannantine, "Fundamentals of Metal Fatigue Analysis" 1st Edition, Pearson Education (US), 1990.
2. R. W. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials", John Wiley and Sons, 1996.
3. C. R. Brooks and A. Choudhury, "Failure Analysis of Engineering Materials", McGraw-Hill, 2002.
4. Barrois W and Ripely, E.L., "Fatigue of Aircraft Structure", Pergamon Press, 1983.
5. R. J. Sanford., "Principles of Fracture Mechanics", Pearson Education (US),2003.

WEBSITE REFERENCES

1. https://ocw.mit.edu/courses/materials-science-and-engineering/3-35-fracture-and-fatigue-fall-2003/lecture-notes/
2. https://www.cranfield.ac.uk/courses/short/aerospace/introduction-to-fatigue-and-fracture-analysis
3. https://online-learning.tudelft.nl/courses/fatigue-of-structures-and-materials/
4. https://nptel.ac.in/courses/112106065/

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U18AEE0010	EXPERIMENTAL STRESS ANALYSIS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Analyze principles of measurements and their application.

CO2: Evaluate different types of extensometers and their advantages and disadvantages.

CO3: Apply knowledge of strain gauges to measure strain and analyze strain gauge data.

CO4: Generalize the principles of photoelasticity and its application in stress analysis.

CO5: Evaluate the effectiveness of various non-destructive testing techniques and their applications.

Pre-requisites :

1.U18AEI5202/ Aircraft Structures-II

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													**CO/PSO Mapping**	
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		S											M	
CO2		S		M									S	
CO3		S		M									S	
CO4		S		M									M	
CO5		S		M	M								M	

Course Assessment Methods:

Direct
1.Continuous Assessment Test I, II 2. Assignment, Group Presentation, 3.End Semester Examination
Indirect
1. Course-end survey

MEASUREMENTS **5 Hours**

Principles of measurements – Accuracy – Sensitivity and range of measurements.

EXTENSOMETERS **10 Hours**

Mechanical – Optical – Acoustical – Electrical extensometers and their uses –Advantages and disadvantages.

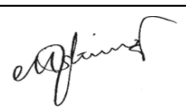
STRAIN GAUGES **12 Hours**

Strain Measurements: Introduction – Properties of Strain gauge Systems – Types of Strain gauges.

Electrical Resistance Strain Gauge: Introduction – Strain Sensitivity in Alloys – Strain gauge Adhesives – Gauge sensitivity and gauge factor.

Strain Gauge Circuit: Potentiometer and its Application – Wheatstone bridge – Bridge Sensitivity – Null Balance Bridges.

Analysis of Strain Gauge Data: Two gauge rosette – Rectangular rosette – Delta Rosette, Stress Gage – Plane Shear gage.



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PHOTOELASTICITY **10 Hours**

Optics related to photo elasticity – Ordinary light – Monochromatic light – Polarized light – Natural and artificial Birefringence – Stress optic law in two dimensions at normal incidence – Material fringe value interms of stress function – Polariscope – Plane polariscope – Circular polariscope – Effect of stressed model in plane polariscope – Effect of stressed model in circular polariscope.

NON-DESTRUCTIVE TESTING (NDT) **8 Hours**

Fundamentals of NDT – Radiography – Ultrasonic testing – Magnetic Particle Inspection – Dye Penetrant Technique – Eddy Current Testing – Acoustic Emission Technique – Fundamentals of brittle coating methods – Introduction to Moire Fringe technique – Holography – Thermography – Fibre optic sensors.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

BOOK REFERENCES

1. Dr. Sadhu Singh, ‘Experimental Stress Analysis’, Khanna Publications, 2009.
2. Dally, J.W., and Riley, W.F., ‘Experimental Stress Analysis’, College House Enterprises, New York, Fourth Edition, 2005.
3. Srinath, L.S., Raghava, M.R., Lingaiah,K., Garagesha,G. Pant B. and Ramachandra,K., ‘Experimental Stress Analysis’, Tata McGraw-Hill, New Delhi, 1984.
4. J. Srinivas, ‘Stress Analysis and Experimental Techniques: An Introduction’, Alpha Science International Ltd, 2012.

WEBSITE REFERENCES

1. http://www.nptelvideos.in/2012/12/experimental-stress-analysis.html
2. https://www.sanfoundry.com/best-reference-books-stress-analysis/
3. https://nptel.ac.in/courses/112106068/
4. https://nptel.ac.in/courses/112106198/

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U18AEE0011	SPACE MECHANICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO1: Apply the concepts of orbital mechanics to find the trajectory/orbit of a space vehicle or a satellite.
CO2: Develop the mathematical model of satellite's orbital motion with perturbations.
CO3: Calculate the delta-v required for transferring a spacecraft from one orbit to another.
CO4: Design an approximate trajectory for interplanetary and lunar spacecraft.
CO5: Apply the concepts of orbital mechanics to free flight phase of ballistic missiles.

Pre-requisite(s): -

CO-PO and CO-PSO Mapping:

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes (POs)											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO 1	S	-	-	-	-	-	-	-	-	-	-	-	S	-
CO 2	-	M	-	-	-	-	-	-	-	-	-	-	M	-
CO 3	S	-	-	-	-	-	-	-	-	-	-	-	M	-
CO 4	S	M	-	-	-	-	-	-	-	-	-	-	S	-
CO 5	S	-	-	-	-	-	-	-	-	-	-	-	W	-

Course Assessment methods

Direct Assessment
1. Internal Tests 2. Assignments 3. End Semester Exam
Indirect Assessment
Course exit survey

INTRODUCTION **6 Hours**

Celestial sphere, Ecliptic, Right ascension and Declination, Vernal equinox, Solar time and Sidereal time, Kepler's laws of planetary motion, Keplerian Orbital elements.

TWO-BODY PROBLEM AND ORBIT PERTURBATIONS **12 Hours**

Two-body problem, Orbit equation, Orbital velocity and Orbital energy, Kepler's equation and Time of flight, Orbit perturbations, Special and General Perturbation methods.

ORBITAL MANEUVERS **9 Hours**

Orbit transfer, In-plane orbit changes, Hohmann transfer, Bi-elliptic transfer, Out-of-plane orbit changes, Delta-v requirement and propellant mass for maneuvers.

INTERPLANETARY AND LUNAR TRAJECTORIES **9 Hours**

Sphere of Influence, Patched conic approximation with simplified example, Realistic interplanetary mission, Locating the planets, Design of departure and arrival trajectories, Gravity-assist maneuvers, Design of departure and arrival lunar trajectories.

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APPLICATION OF ORBITAL MECHANICS TO BALLISTIC MISSILES **9 Hours**

General ballistic missile problem, Geometry of ballistic missile trajectory, Free flight range, Flight-path angle, Maximum range trajectory, Time of free flight, Effect of launching errors, Influence coefficients, Effect of earth rotation.

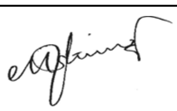
Theory: 45 Hours	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES

1. Charles D. Brown, 'Elements of Spacecraft Design', First Edition, AIAA Education Series, 2002.
2. Roger R.Bate, Donald D.Mueller, and Jerry E.White, 'Fundamentals of Astrodynamics', Dover Publications Inc., 1971.
3. Vladimir A. Chobotov, 'Orbital Mechanics', Third Edition, AIAA Education Series, 2002.
4. Howard D. Curtis, 'Orbital Mechanics for Engineering Students', Third Edition (Revised), Butterworth-Heinemann, 2013.
5. David A. Vallado and James Wertz (Ed.), 'Fundamentals of Astrodynamics and Applications', Fourth Edition, Microcosm Press, 2013.

WEBSITE

1. Online Lecture notes on An Introduction to Solar System Astronomy - Unit 4: The Physics of Astronomy: http://www.astronomy.ohio-state.edu/~pogge/Ast161/Unit4/index.html
2. Hohmann transfer: http://web.mit.edu/12.000/www/finalpresentation/traj/hohman.html
3. Orbital Mechanics with Example problems: http://www.braeunig.us/space/orbmech.htm



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U18AEE0012	NON-DESTRUCTIVE TESTING	L	T	J	P	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students would be able to

CO 1: Analyze various NDT techniques to determine their importance in quality assurance and defect detection.

CO 2: Evaluate the principles and applications of radiographic inspection to interpret radiographs and detect welding defects.

CO 3: Apply ultrasonic testing methods to measure material properties and detect internal flaws.

CO 4: Compare liquid penetrant, magnetic particle, and eddy current testing methods to determine their effectiveness in different scenarios.

CO 5: Explore advanced NDT methods like thermal inspection, optical holography, and acoustic emission to recommend appropriate techniques for specific applications.

Pre-requisite(s): U18AEI3203/ Mechanics of Solids

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1		S											S	
CO 2	M			S	M								M	
CO 3					S								S	
CO 4		S											S	
CO 5				M	M									M

Course Assessment Methods:

Direct
1. Continuous Assessment Test I, II 2. Assignment; Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

INTRODUCTION TO NDT 6 Hours

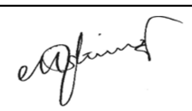
Importance of NDT in quality assurance – Different types of nondestructive techniques to obtain information regarding size, location and orientation of damage or cracks – Visual inspection techniques and coin tapping technique for composite structures and adhesive bonds.

RADIOGRAPHIC INSPECTION 9 Hours

X–ray radiography: Principles of X-ray radiography, equipment – Production of X-rays, Absorption, scattering, X-ray film processing – Industrial radiographic practice, micro-radiography, Gamma ray radiography: Radioactivity, gamma ray sources, film radiography, application, examples – General radiographic procedures – Reading and Interpretation of Radiographs – Defects in welding.

ULTRASONICS 8 Hours

Principle of wave propagation – Ultrasonic equipment – Variables affecting an ultrasound test



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– Pulse echo technique, pitch-catch technique, through transmission technique, A-scan, B-Scan, C-scan – Determination of elastic constants using Ultrasonic velocity.

LIQUID PENETRANT TEST **12 Hours**

Basic concept – Test equipment – Test Parameters and Procedure – Safety precautions.

MAGNETIC PARTICLE TEST: Methods of generating magnetic field – Demagnetization of materials – Magnetic particle test: Principles, Test Equipment and Procedure – Interpretation and evaluation.

EDDY CURRENT TEST: Principles of eddy current – Factors affecting eddy currents – Test system and test arrangement – Standardization and calibration – Application and effectiveness.

OTHER METHODS **10 Hours**

Thermal Inspection: Principles, equipment, inspection methods, applications – Optical Holography: Principles and Applications, Holographic recording interferometer techniques of inspection – Acoustic Emission Inspection: Sources of acoustic emission in composites, Peak amplitude, Rise time during events, Ring-down counts duration of events.

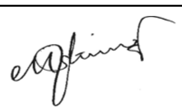
Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. J Prasad and C G Krishnadas Nair, "Non-Destructive Test and Evaluation of Materials", Tata McGraw-Hill Publishing Co. Ltd., 2008.
2. P. E. Mix, "Introduction to Non-Destructive Testing", John Wiley and Sons, 2005.
3. Bray, Don E. and Don McBride, "Nondestructive Testing Techniques", Chapter 11 (Ultrasonic Testing of Aerospace Materials), John Wiley and Sons, New York, 1992.
4. Baldev Raj, T. Jayakumar, and M. Thavasimuthu, "Nondestructive Testing", Narosa Publishing House, 1997.
5. C. Hellier, "Handbook of Nondestructive Evaluation", McGraw-Hill, 1994.

WEBSITE

1. https://nptel.ac.in/courses/113106070/
2. https://www.ndt.net/article/ecndt98/aero/031/031.htm
3. https://inspectioneering.com/tag/nondestructive+testing
4. http://www.modalshop.com/ndt/Comparison-of-Non-Destructive-Methods%3FID%3D256
5. https://www.sgs.com/en/industrial-manufacturing/services-related-to-production-and-products/materials-testing/non-destructive-testing-ndt



U18AEE0013	AIRCRAFT MAINTENANCE PRACTICES	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students will be able to

CO 1: Apply welding techniques and equipment maintenance practices to ensure the quality and reliability of welds in aircraft structural components.

CO 2: Analyze damage in sheet metal components, classify the severity, and decide on appropriate repair or replacement methods.

CO 3: Evaluate the maintenance and repair techniques for plastic and composite components to recommend effective repair schemes and safety precautions.

CO 4: Apply the procedures for aircraft jacking, assembly, and rigging, including balancing and inspection of control surfaces and helicopter flight controls.

CO 5: Design a comprehensive inspection and maintenance plan for hydraulic and pneumatic systems, ensuring proper functionality and safety in aircraft systems.

Pre-requisite(s):

CO-PO and CO-PSO Mapping:

COs	Programme Outcomes(POs)											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M												W	
CO2	M												W	
CO3		S											W	
CO4		M											M	
CO5	S												S	

Course Assessment methods

Direct
1. Continuous Assessment Test I, II 2. Assignment; Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

WELDING IN AIRCRAFT STRUCTURAL COMPONENTS **4 Hours**

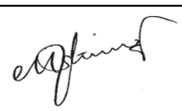
Equipment used in welding shop and their maintenance – Ensuring quality welds – Welding jigs and fixtures – Soldering and brazing.

SHEET METAL REPAIR AND MAINTENANCE **5 Hours**

Inspection of damage – Classification – Repair or replacement – Sheet metal inspection – Nondestructive Testing – Riveted repair design, Damage investigation – Reverse technology.

PLASTICS AND COMPOSITES IN AIRCRAFT **9 Hours**

Review of types of plastics used in airplanes – Maintenance and repair of plastic components – Repair of cracks, holes etc., and various repair schemes – Scopes – Inspection and Repair of composite components – Special precautions – Autoclaves.



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AIRCRAFT JACKING, ASSEMBLY AND RIGGING **9 Hours**

Airplane jacking and weighing and Center of Gravity location – Balancing of control surfaces – Inspection and maintenance – Helicopter flight controls – Tracking and balancing of main rotor.

REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM **9 Hours**

Inspection and maintenance of landing gear systems – Inspection and maintenance of air-conditioning and pressurization system, water and waste system – Installation and maintenance of Instruments – Handling – Testing – Inspection.

INSPECTION AND MAINTENANCE OF AUXILIARY SYSTEMS **9 Hours**

Inspection and maintenance of auxiliary systems – Fire protection systems – Ice protection system – Rain removal system – Position and warning system – Auxiliary Power Units (APUs). **SAFETY PRACTICES:** Hazardous materials storage and handling – Aircraft furnishing practices – Equipment – Troubleshooting – Theory and practices.

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**

REFERENCES

1. Kroes, Watkins and Delp, ‘Aircraft Maintenance and Repair’, McGraw-Hill, New York, 1992.
2. Larry Reithmeir, ‘Aircraft Repair Manual’, Palamar Books, Marquette, 1992.
3. Brimm D.J. and Bogges H.E., ‘Aircraft Maintenance’, Pitman Publishing corp., New York, 1940.
4. A&P MECHANICS, ‘Aircraft Hand Book’, FAA Himalayan Book House, New Delhi, 1996.
5. A&P MECHANICS, ‘General Hand Book’, FAA Himalayan Book House, New Delhi, 1996.

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U18AEE0014	HELICOPTER AERODYNAMICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students would be able to

CO 1: Analyze the configurations and control methods of helicopters to understand torque reaction and control mechanisms.

CO 2: Evaluate the hovering performance using momentum and blade element theories to estimate profile and induced power.

CO 3: Calculate the power requirements for forward flight to generate performance curves and assess helicopter stability.

CO 4: Compare various configurations of V/STOL aircraft to evaluate their performance in different flight modes.

CO 5: Evaluate lift augmentation systems for ground effect machines to optimize hover height and power efficiency.

Pre-requisite(s): U18AEI4201 / Low Speed Aerodynamics

CO-PO and CO-PSO Mapping:

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Program Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO 1	-	W	-	-	-	-	-	-	-	-	-	-	S	-
CO 2	-		-	-	-	-	-	-	-	-	-	-	S	-
CO 3	-	S	-	-	-	-	-	-	-	-	-	-	S	-
CO 4	-	M	-	-	-	-	-	-	-	-	-	-	S	-
CO 5	-	M	-	-	-	-	-	-	-	-	-	-	S	-

Course Assessment Methods:

Direct Assessment
1. Internal Tests 2. Assignments 3. End Semester Exam
Indirect Assessment
Course exit survey

ELEMENTS OF HELICOPTER AERODYNAMICS **10 Hours**

Configurations based on torque reaction – Jet rotors and compound helicopters – Methods of control – Collective and cyclic pitch changes – Lead-Lag and flapping hinges.

IDEAL ROTOR THEORY **12 Hours**

Hovering performance – Momentum and simple blade element theories – Figure of merit – Profile and induced power estimation – Constant chord and ideal twist rotors.

POWER ESTIMATION **8 Hours**

Induced, profile and parasite power requirements in forward flight – Performance curves with effects of altitude – Preliminary ideas on helicopter stability.

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LIFT, PROPULSION AND CONTROL OF V/STOL AIRCRAFT **8 Hours**

Various configuration – Propeller, rotor, ducted fan and jet lift – Tilt wing and vectored thrust – Performance of VTOL and STOL aircraft in hover, transition and forward motion.

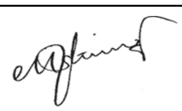
GROUND EFFECT MACHINES **7 Hours**

Types – Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machine – Drag of hovercraft on land and water – Applications of hovercraft.

Theory: 45 Hours	**Tutorial: 0**	**Practical: 0 Hours**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Gessow A and Myers G.C., ‘Aerodynamics of the Helicopter’, Continuum International Publishing Group Ltd., 1997.
2. Gupta. L, ‘Helicopter Engineering’, Himalayan Books, 1996.
3. Simon Newman, ‘The Foundations of Helicopter Flight’, Halsted Press, 1994.
4. John M. Seddon and Simon Newman, ‘Basic Helicopter Aerodynamics’, Third Edition, AIAA Education Series, 2011.
5. J. Gordon Leishman, ‘Principles of Helicopter Aerodynamics’, Second Edition, Cambridge University Press, 2006.
6. Philip Terpstra, ‘V/STOL Aircraft Design’, Third Edition, Spirit Publications, 2005.
7. Barnes W. McCormick, ‘Aerodynamics of V/STOL Flight’, Academic Press Inc., 1967.
8. Barnes W. McCormick, ‘Aerodynamics, Aeronautics and Flight Mechanics’, Second Edition, Wiley India Pvt. Ltd., 2009.



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U18AEE0015	HIGH ENERGETIC FUELS AND PROPELLANTS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students would be able to

CO 1: Apply the principles of aviation fuels to evaluate the impact of fuel properties on combustion temperature and flame propagation.

CO 2: Analyze solid propellant formulations to determine the influence of additives and binders on mechanical and ballistic properties.

CO 3: Evaluate combustion characteristics of solid propellants to assess the impact of grain geometry on ignition, flame spread, and combustion instability.

CO 4: Analyze the essential characteristics of liquid propellants to identify performance criteria, hazards, and desirable physical properties.

CO 5: Analyze the combustion characteristics of liquid propellant.

Pre-requisite(s): U18AET6104 / Rocket Propulsion

CO-PO and CO-PSO Mapping:

CO/PO &PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs) and Programme Specific Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1		S											S	
CO 2			S										M	
CO 3				M									S	
CO 4			S										M	
CO 5		S		M									S	

Course Assessment Methods

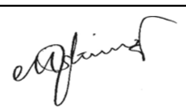
Direct
1. Internal Test I 2. Internal Test II 3. Assignment 4. Tutorial 5. End Semester Exam
Indirect
Course end survey

INTRODUCTION **7 Hours**

Aviation Fuels: Types of jet engine fuels, Properties of fuels commonly used in gas turbine combustors, combustion temperature and fuel-air ratio, Flame propagation, flame speed on fuel air ratio, estimate of TSFC, supersonic combustion – Introduction to biofuels, Green aviation.

SOLID PROPELLANTS **10 Hours**

Classification – Double Base, Composite, Composite Modified Double Base, Fuel- rich and Metalized Propellants; Propellant formulations, Mechanical and Ballistic Properties; The



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Mechanism of Deflagration-to-Detonation Transition (DDT) in high-performance combustors, Factors influencing ignition delay, Binders, burning-rate modifiers, curing agents, energetic and binders plasticizers, additives, Viscoelastic properties of propellants.

COMBUSTION OF SOLID PROPELLANTS **10 Hours**

Physical and chemical process, ignition process, extinction or thrust termination, combustion instability, vortex-shedding instability, Ignition and flame spread characteristic: Influence of Solid Propellant Grains geometry on ignition and flame spread characteristics. Different types of grains: End Burning, Radial Burning and Non-cylindrical Burning Grains; Segmented Grains; Grain Clustering; Burning Surface Area Evaluation; Design Criteria; Combustion characteristics of radial burning Dual Thrust Motor Grains.

LIQUID PROPELLANTS **10 Hours**

Essential Characteristics of Liquid Propellants, Propellant properties: performance of propellants, Common physical hazards: corrosion, explosion hazards, fire hazards, accidental spills, health hazards, material compatibility, Desirable physical properties: low freezing point, high specific gravity, stability, heat transfer properties, pumping properties, temperature variations, ignition, combustion and flame properties, additive,

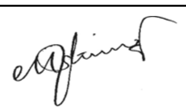
COMBUSTION OF LIQUID PROPELLANTS **8 Hours**

Physical and chemical processes in the combustion of liquid propellants: injection, atomization, vaporization, mixing and reaction, Rapid combustion zone, injection/atomization zone, stream tube combustion zone, analysis and simulation, combustion instability: chugging, buzzing or entropy waves, screeching or screaming, pogo instability, Rating techniques and control of instabilities.

Theory: 45 Hours	Tutorial: 0 Hours	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES

1. George P. Sutton and Oscar Biblarz, ‘Rocket Propulsion Elements’, ngth Edition, John Wiley and Sons Inc., New York, 2017.
2. Philip G. Hill and Carl R. Peterson, ‘Mechanics and Thermodynamics of Propulsion’, Addison-Wesley Publishing Company, New York,2009.
3. Kenneth Kuan-yun Kuo, ‘Principles of Combustion’, Second Edition, Wiley-Interscience, 2012.
4. Gordon Oates, ‘Aero Thermodynamics of Gas Turbine and Rocket Propulsion’, AIAA Education Series, New York, 1997.
5. Kenneth Kuan-yun Kuo, ‘Fundamentals of Solid Propellant Rockets’ AIAA Education Series, 1980.
6. F. A. Williams, M. Barrere, and N. C. Huang, ‘Fundamental Aspects of Solid Propellant Rocket’, 1978.



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U18AEE0016	AIRCRAFT STRUCTURAL ANALYSIS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Analyze stress and strain relationships to determine principal stresses and strains in aircraft structures.

CO2: Apply energy methods including strain energy and virtual work to solve deflection problems in structures.

CO3: Evaluate stiffness matrices to perform matrix analysis of pin-jointed frameworks and uniform beams.

CO4: Analyze the behavior of thin plates under various loading conditions including bending, twisting, and in-plane loading.

CO5: Evaluate the structural integrity of aircraft components such as wing spars, box beams, and fuselages under bending, shear, and torsion loads.

Pre-requisites : U18AEI5202/ Aircraft Structures II

CO-PO and CO-PSO Mapping:

	CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S			S								M	
CO2	M	S		M									S	
CO3	S				S								S	
CO4		S		M									M	
CO5		S											S	

Course Assessment Methods

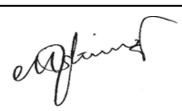
Direct
1. Internal Tests 2. Assignments 3. End Semester Exam
Indirect
Course end survey

BASIC ELASTICITY **9 Hours**

Stress – Notation for forces and stresses – Equations of equilibrium – Plane stress – Boundary conditions – Determination of stresses on inclined planes – Principal Stresses – Strain – Compatibility equations – Plane strain – Determination of strains on inclined planes – Principal strains – Stress-strain relationships.

ENERGY METHODS **10 Hours**

Strain energy and complementary energy – Principle of the stationary value of the total complementary energy – Application to deflection problems – Virtual work Method – Applications of the principle of virtual work.



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MATRIX METHODS **9 Hours**

Stiffness matrix for an elastic spring – Matrix analysis of pin-jointed frameworks – Stiffness matrix for a uniform beam.

ANALYSIS OF THIN PLATE **8 Hours**

Pure bending of thin plates – Plates subjected to bending and twisting – Plates subjected to a distributed transverse load – Combined bending and in-plane loading of a thin rectangular plate.

ANALYSIS OF AIRCRAFT COMPONENTS **9 Hours**

Analysis of Wing spars and box beams – Tapered wing spar – Open and closed section beams – Beams having variable stringer areas – Analysis of Fuselages – Bending – Shear – Torsion.

Theory: 45 Hours	**Tutorial: 0 Hours**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Megson, T.H.G., 'An Introduction to Aircraft Structural Analysis', Second Edition Butterworth-Heinemann, 2013.
2. Chajes, A., 'Principles of Structural Stability Theory', Prentice Hall, 1987.
3. Auchert, T.R., 'Energy Principles in Structural Mechanics', McGraw Hill, 1989.
4. Howard D.Curtis, 'Fundamentals of Aircraft Structural Analysis', Irwin Publications, 1997.
5. Megson, T.H.G., 'Aircraft Structures for Engineering Students', Fifth Edition (Rev.), Butterworth-Heinemann, 2012.

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U18AEE0017	AUTONOMOUS NAVIGATION	L	T	P	J	C
		3	0	0	0	3

Course Outcomes:

After successful completion of this course, the students will be able to

CO 1: Explain the relation between navigation, guidance and control for autonomous vehicles.
CO 2: Select suitable sensors for autonomous vehicle navigation.
CO 3: Describe the working principle of various navigation sensors.
CO 4: Estimate the states of autonomous vehicles using Kalman filter for navigation.
CO 5: Construct navigation algorithm for autonomous vehicles.

Pre-requisite(s): Nil.

CO-PO and CO-PSO Mapping:

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Program Outcomes (POs)**												**PSOs**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	M	-	-	-	-	-	-	-	-	-	-	S	-
CO 2	S	S	-	-	-	-	-	-	-	-	-	-	S	-
CO 3	S	M	-	-	-	-	-	-	-	-	-	-	S	-
CO 4	S	S	-	-	-	-	-	-	-	-	-	-	S	-
CO 5	S	S	-	-	-	-	-	-	-	-	-	-	S	-

Course Assessment Methods:

Direct Assessment
1. Internal Tests 2. Assignments 3. End Semester Exam
Indirect Assessment
Course exit survey

INTRODUCTION **9 Hours**

Definition of autonomous navigation, Coordinate systems, Guidance, Navigation and Control loops, Data fusion.

SENSOR SYSTEMS **12 Hours**

Accelerometer, Rate gyros, Pressure sensors, Magnetometers, Inertial measurement units (IMUs), Global positioning systems (GPS), LIDAR, Laser range finder, Ultrasonic sensors, Infrared sensors, Vision sensors.

STATE ESTIMATION **12 Hours**

Introduction to probability and Gaussian distribution, Mean and standard deviation, Kalman filter, State estimation with Kalman filter, Examples.

NAVIGATION METHODS **12 Hours**

GPS aided navigation, Way-point navigation, Path planning and path following algorithms, Mapping, Obstacles detection, Vision guided navigation.

Theory: 45 Hours	**Tutorial: 0**	**Practical: 0 Hours**	**Project: 0**	**Total: 45 Hours**

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REFERENCES

1. K. Nonami, F. Kendoul, S. Suzuki, W. Wang, and D. Nakazawa, ‘Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Aerial Vehicles’, Springer Science, 2010.
2. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, ‘Probabilistic Robotics’, MIT Press, 2005.
3. Peter S. Maybeck, ‘Stochastic Models, Estimation, and Control: Volume 1’, Academic Press, 1979.
4. Paul Gerin Fahlstrom and Thomas James Gleason, ‘Introduction to UAV Systems’, John Wiley and Sons, 2012.
5. Mohinder S. Grewal, Lawrence R. Weill, and Angus P. Andrews, ‘Global Positioning Systems, Inertial Navigation, and Integration’, John Wiley and Sons, 2007.
6. Steven M. LaValle, ‘Planning Algorithms’, Cambridge University Press, 2006.

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U18AEE0018	ADDITIVE MANUFACTURING AND TOOLING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Classify the concepts and terminologies of additive manufacturing
CO2: Apply the reverse engineering concepts for design development
CO3: Identify the variety of additive manufacturing techniques based on end product applications
CO4: Design and develop newer tooling models
CO5: Familiarise with cutting edge technologies in rapid tooling and manufacturing
CO6: Analyse the cases relevant to Additive manufacturing

Pre-requisite: NIL

CO-PO and CO-PSO Mapping:

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Program Outcomes (POs)**												**PSOs**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	M				W	M					M		M
CO 2	S	S	S	M	W		S	M				M		S
CO 3	S	M					M							M
CO 4	S	S	S	M	W		S	M	M					S
CO 5	S	M			W		M					M		S
CO 6	S	S	S	M			M	M						S

Course Assessment methods:

Direct Assessment
1. Internal Tests 2. Assignments 3. End Semester Exam
Indirect Assessment
Course exit survey

INTRODUCTION **9 Hours**

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits Applications.

REVERSE ENGINEERING & CAD MODELING **9 Hours**

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

ADDITIVE MANUFACTURING SYSTEMS **9 Hours**

Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

SINTERING BASED ADDITIVE MANUFACTURING SYSTEMS **9 Hours**
Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies

TOOLING **9 Hours**
Classification, Soft tooling, Production tooling, Bridge tooling, direct and indirect tooling, Fabrication processes, Applications, Case studies- aerospace industries.

Theory: 45 Hours	**Tutorial: 0**	**Practical: 0 Hours**	**Project: 0**	**Total: 45 Hours**

References:

1. “Rapid prototyping: Principles and applications”, Chua, C.K., Leong K.F. and Lim C.S., second edition, World Scientific Publishers, 2010.
2. Rapid Tooling: Technologies and Industrial Applications, Hilton, P.D. and Jacobs, P.F., CRC press, 2005.
3. “Rapid prototyping”, Gebhardt, A., Hanser Gardener Publications, 2003.
4. Gibson, I., Rosen, D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
5. Kamrani, A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.

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U18AEE0019	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	J	C
		3	0	0	0	3

Course outcomes:

CO1: Analyze the development processes and organizations to identify challenges and opportunities in product development.

CO2: Evaluate customer needs and product specifications to prioritize and establish final specifications.

CO3: Analyze and evaluate product concepts based on customer feedback and concept scoring.

CO4: Examine product architecture and industrial design to optimize manufacturing processes and product quality.

CO5: Plan and manage prototyping and economic analysis to ensure project success and effective execution.

Pre-requisite: Nil

CO-PO and CO-PSO Mapping:

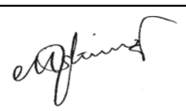
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Program Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	M		M		M					W			M	
CO 2			M										M	
CO 3	M		M										S	
CO 4			S			W				M	M		M	
CO 5			S		M	M								S

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation 5. End semester exam	Course end survey

INTRODUCTION - DEVELOPMENT PROCESSES AND ORGANIZATIONS – PRODUCT PLANNING **9 Hours**

Characteristics of successful product development to Design and develop products, duration and cost of product development, the challenges of product development. A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization. The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.



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IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATIONS 9 Hours

Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into a hierarchy, establishing the relative importance of the needs and reflecting on the results and the process. Specifications, establish specifications, establishing target specifications setting the final specifications.

CONCEPT GENERATION - CONCEPT SELECTION - CONCEPT TESTING 9 Hours

The activity of concept generation clarify the problem search externally, search internally, explore systematically, reflect on the results and the process, Overview of methodology, concept screening, concept scoring, caveats. Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.

PRODUCT ARCHITECTURE - INDUSTRIAL DESIGN - DESIGNFOR MANUFACTURING 9 Hours

Meaning of product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, is assessing the quality of industrial design. Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

PROTOTYPING PRODUCT DEVELOPMENT ECONOMICS MANAGING PROJECTS 9 Hours

Prototyping basics, principles of prototyping, technologies, planning for prototypes, Elements of economic analysis, base case financial mode, Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis. Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Karl Ulrich,T, Steven Eppinger, D, “Product Design and Development”, McGrawHill, 2015.
2. Chitale, AK, Gupta, RC, “Product Design and Manufacturing” PHI, 2013.
3. Timjones, “New Product Development:An Introduction to a multifunctional process”, Butterworth-Heinemann, 1997.
4. Geoffery Boothroyd, Peter Dewhurst and Winston Knight,A, “Product Design for Manufacture and Assembly”, CRC Press, 2011.

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U18AEE0220	PRODUCT LIFECYCLE MANAGEMENT	L	T	P	J	C
		2	0	2	0	3

Course outcomes:

CO1: Analyze the PLM lifecycle model and its components to understand the opportunities and benefits of PLM.

CO2: Evaluate PLM concepts, processes, and workflow to determine the drivers and elements that influence PLM.

CO3: Examine collaborative product development techniques to enhance product reuse, change management, and virtual testing.

CO4: Assess the features and system architecture of PLM systems to identify their functionalities and product information models.

CO5: Develop a PLM strategy and assess its impact to implement initiatives supporting corporate objectives.

CO6: Design and manage collaborative tasks and change management processes to streamline CAD data simulation models and documentations.

Pre-requisite: Nil

CO-PO and CO-PSO Mapping:

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Program Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	M		M		M					W			M	
CO 2			M										M	
CO 3	M		M										M	
CO 4			S			W				M	M		M	
CO 5			S		M	M								S
CO 6						M							M	

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation 5. End semester exam	Course end survey

INTRODUCTION TO PRODUCT LIFE CYCLE MANAGEMENT 6 Hours

Definition, PLM Lifecycle Model, Threads of Product Lifecycle Management, Need for Product Lifecycle Management, Opportunities and Benefits of Product Lifecycle Management, Views, Components and Phases of Product Lifecycle Management, Product Lifecycle Management feasibility study, Product Lifecycle Management Visioning.

PLM CONCEPTS, PROCESSES AND WORKFLOW 6 Hours

Characteristics of Product Lifecycle Management, Environment Driving Product Lifecycle Management, Product Lifecycle Management Elements, Drivers of Product Lifecycle

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Management, Conceptualization, Design, Development, Validation, Production, Support of Product Lifecycle Management.

COLLABORATIVE PRODUCT DEVELOPMENT **6 Hours**

Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management, Bill of Materials and Process Consistency, Digital Mock-Up and Prototype Development, Design for Environment, Virtual Testing and Validation, Marketing Collateral.

SYSTEM ARCHITECTURE **6 Hours**

Introduction, Types of Product Data, Product Lifecycle Management systems, Features of Product Lifecycle Management System, System architecture, Product information models, Functionality of the Product Lifecycle Management Systems

DEVELOPING A PLM STRATEGY AND ASSESSMENT **6 Hours**

Strategy, Impact of strategy, implementing a PLM strategy, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment, Assessment of Current Systems and Applications.

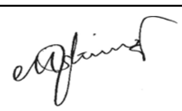
PRACTICAL: **30 Hours**

1. Streamline collaboration to capture and manage the creation, revision, release of CAD data simulation models and documentations
2. Create, assign and mange task, setting priorities of task to the teams on track,
3. Resolving issues (issue management)
4. View and markup complex 3D product design
5. Change management capabilities
6. Customization and implementation of various industrial practices
7. Conceptualization for Product Lifecycle Management
8. Validation for Product Lifecycle Management
9. Building Product information models

Theory: 30	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 60 Hours**

REFERENCES:

1. Michael Grieves, Product Lifecycle Management: Driving the Next Generation of Lean Thinking, Mc Graw Hill, 2015.
2. Martin Eigner, System Lifecycle Management – Engineering Digitalization (Engineering 4.0), Springer Vieweg 2021.
3. Karl Ulrich,T, Steven Eppinger, D, “Product Design and Development”, McGrawHill, 2015.
4. Chitale, AK, Gupta, RC, “Product Design and Manufacturing” PHI, 2013.
5. Geoffery Boothroyd, Peter Dewhurst and Winston Knight,A, “Product Design for Manufacture and Assembly”, CRC Press, 2011.



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U18AEE0021	COMPUTATIONAL METHODS FOR AERONAUTICAL ENGINEERING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Use the numerical techniques to find the solution algebraic equations and system of equations.
CO2: Understanding of computational engineering process.
CO3: Use to finite element analysis, interpretation of analysis results.
CO4: Use to finite volume analysis, interpretation of analysis results.
CO5: Understanding of advanced computational approaches involved in aeronautical engineering problems.

Pre-requisites: U18AET5003 / Computational Fluid Dynamics;
U18AET6002 / Finite Element Methods

CO-PO and CO-PSO Mapping:

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Program Outcomes (POs)**												**PSOs**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	S											S	M
CO 2		S		M									S	M
CO 3		S				M							S	M
CO 4		S			S	S	S							S
CO 5		S	S	W			S		S					S

Course Assessment methods:

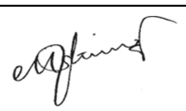
Direct Assessment
1. Internal Tests 2. Assignments 3. Group presentation 4. End Semester Exam
Indirect Assessment
Course exit survey

COMPUTATIONAL METHODS **9 Hours**

Introduction and unique characteristics of numerical solution methods in engineering analysis; Solution of Nonlinear Equations; Polynomial Approximation; Numerical Integration Methods; Numerical Methods for Solving Differential Equations; Direct and Iterative based Elimination Methods; Initial and boundary value problems – Heat Transfer – Structural – Fluid Dynamics; Implicit and Explicit approaches based solution techniques; Differential Equations for Solid Mechanics and Fluid Dynamics; Mathematical Properties of Solid Mechanic and Fluid Dynamic and Equations; Approximation techniques involved in Solid Mechanics and Fluid Dynamics; Von Neumann stability analysis.

PROBLEM FORMULATIONS OF COMPUTATIONAL METHODS **9 Hours**

Computational Engineering Process; Computational Models – Discretizations – Boundary Conditions – Governing Equations – Solver Descriptions – Computational Refinement Studies: Domain Refinement Studies - Grid Independence Studies; Validational Studies: Experimental Validations and Literature survey-based correlation studies; Application of these procedures in simulation tool using suitable examples.



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FINITE ELEMENT METHODS FOR AERONAUTICAL ENGINEERING **9 Hours**

Finite element methods (FEM) in Structural integrity and failure – Finite Element Techniques in Computational Fluid Dynamics; FEM in various vibrational problems; FEM in 2-D heat transfer problems under different loading conditions; FEM in different Plate Elements; Introduction to Finite Element Analysis (FEA) simulation software; Pre- and Post-Processing: Free mesh, Blocking mesh and Mapped mesh techniques, Quality checks on nodes, elements, and boundary conditions; Application of these schemes in simulation tool using suitable examples.

FINITE VOLUME METHODS FOR AERONAUTICAL ENGINEERING **9 Hours**

Finite Volume Methods (FVM) in Computational Fluid Mechanics; Formulation of Finite Volume Methods: Comparison of Cell Centered and Vertex Centered Formulations; Description the need of interpolation schemes and flux limiters in FVM; Introduction to FVM based simulation software; Comparison of FVM based CFD solvers and their compositions for real-time applications; Comparative study of smooth and rough flows in same object; Comparison of Pressure Correction Techniques; Case Study on CFD solver tool and its facilities; Moving Reference Frame Approaches for FVM based CFD problems.

ADVANCED COMPUTATIONAL APPROACHES **9 Hours**

Introduction to Fluid–Structure Interaction (FSI); Types and Problem Formulations involved in FSI Problems; FSI computations under different loading conditions; Computational Aeroacoustic Analyses; Crash Investigation through Explicit Dynamics; Transient Structural and Thermal Analyses; Computational Vibrational Analyses under different loading conditions; Topology Optimization based Simulations; Application of these problems in simulation tool using suitable examples.

Theory: 45 Hours	**Tutorial: 0**	**Practical: 0 Hours**	**Project: 0**	**Total: 45 Hours**

References:

1 “Applied Engineering Analysis”, Tai-Ran Hsu, published by John Wiley & Sons, 2018 (ISBN 97811119071204).

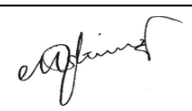
2 “Numerical Methods for Scientific and Engineering Computation”, by M. K. Jain and S.R.K. Iyengar. Publisher: New Age International Publishers.

3 “Applied Numerical Analysis”, by Gerald & Wheatley. Publisher Addison – Wesley.

4 “Introductory Methods of Numerical Analysis”, by, S.S. Sastry. Publisher: PHI Pvt. Ltd., 5th Edition, New Delhi, 2009.

5 “Applied Numerical Methods Using MATLAB”, by W.Y. Yang, W. Cao, T.S. Chung and J. Morris. Publisher: Wiley India Edn., 2007.

6 “Numerical Methods for Engineers with Programming and Software Applications”, by Steven C. Chapra and Ra P. Canale. Publisher: Tata McGraw Hill, 2014 7th Edition.



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U18AEE0022	GRID GENERATION TECHNIQUES	L	T	P	J	C
		3	0	0	0	3

Course outcomes:

CO1: Acquire knowledge on the importance of grid generation and be able to apply predominant grid selection tasks in aerospace applications.

CO2: Understand the multi-block grid generation procedures and be able to evaluate multi-block grid designs of computational domain in aerospace related problems.

CO3: Evaluate structured, unstructured grid designs and be able to take decisions on selection of suitable grid blocks for the computational domains in aerospace applications.

CO4: Apply adaptive meshing methods for better management of computer resources and cost-effective solutions in aerospace engineering

CO5: Apply skills in ensuring the good quality of grid that is essential to get reasonably accurate numerical solutions for complex aerospace engineering problems.

Pre-requisite: U18AET5003-Computational Fluid Dynamics; U18AET6002-Finite Element Methods

CO-PO and CO-PSO Mapping:

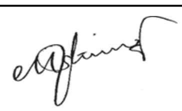
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Program Outcomes (POs)**												**PSOs**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	S	S											S	M
CO 2		S		M									S	M
CO 3		S				M							S	M
CO 4		S			S	S	S							S
CO 5		S	S	W			S		S					S

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation 5. End semester exam	Course end survey

BASIC ASPECTS IN GRID GENERATION **9 Hours**

Importance and unique characteristics of Discretization - Methodology of grid generation-classification of grid generation techniques – Structured, Unstructured and Hybrid grids and their characteristic features – Areas of application – Geometry related issues for grid generation – linear and quadratic based element orders – Grid or mesh topology checking – Pinch Tolerance – Conformal Mapping-Domain decomposition with multi-blocking – Grid Independence Study.



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GRID QUALITY AND QUALITY CONTROL **9 Hours**

Importance of metrics for grid quality – Aspect ratio – Skewness – Warpage factor – Jacobian Ratio – Parallel Deviation – Orthogonal Quality - Best practices for grid quality and grid control – mesh/grid quality aspects in surface meshing – Volume meshing and quality check – Grid quality aspects in boundary layer flows – Prismatic layers – Quality control in hybrid mesh transition – Comprehensive studies of grid qualities for various computational solvers.

STRUCTURED GRID GENERATION **9 Hours**

Blocking mesh and Mapped mesh techniques, Quality checks on nodes, elements, and boundary conditions - Structured Mono-Block Grid - Structured Multi-Block Grid - Algebraic methods for structured grid generation – Use of blending functions for grid generation - Use of partial differential equations for structured grid generation – Implementation of boundary conditions for smooth grid generation – Variational methods – A brief introduction to Elliptic, Hyperbolic, and Parabolic schemes for grid generation.

UNSTRUCTURED GRID GENERATION **9 Hours**

Use of triangular, quadrilateral, hexahedral, and tetrahedral grids/meshes – Concept of free mesh and dual mesh – Connectivity Information and data structure in unstructured grid generation – Hierarchy in unstructured grid Generation – Composite grid schemes in unstructured grid generation – Moving front technique – unstructured hexa mesh method – layered tetrahedron method – patch conforming and patch independent based tetrahedrons methods.

ADVANCED GRID GENERATION **9 Hours**

Description of adaptive mesh refinement – Adaption control – Strategies for mesh adaption – Solution gradient, discretization error and recovery-based adaption - r adaption, h adaption and p adaption methods – Role of adaptive meshing in solution accuracy and convergence – Elementary concepts in dynamic meshing, mesh motion and moving reference frame approaches– Coupled field harmonic-based mesh concepts – Turbomachinery grid concepts – Fluid-structure interaction-based coupling mesh concepts.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Fletcher C.A.J., “Computational Techniques for Fluid Dynamics 1” Springer Verlag, 1996.
2. Liseikin V. D., “Grid Generation Methods: Springer-Verlag Berlin and Heidelberg GmbH & Co. KG 1st edition 1999
3. Chung T. J., “Computational Fluid Dynamics”, Cambridge University Press; 2nd edition, 2010.
4. Patrick Knupp & Stanly Steinberg, “Fundamentals of Grid Generation” CRC Press 1st edition 1993
5. Versteeg H.K. and Malalsekera W. “An Introduction to Computational Fluid Dynamics, The Finite Volume Method”, PHI; 2nd edition 2007.
6. John F Wendt, “Computational Fluid Dynamics – An Introduction”, 3rd Edition, Springer Verlag, Berlin Heidelberg, 2009.

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MANDATORY COURSES

U18AER0001	INTRODUCTION TO AERONAUTICS	L	T	J	P	C
		2	0	0	0	0

Course Outcomes

After successful completion of this course, the students would be able to

CO 1: Explain various configurations of the aircraft

CO 2: Explain the functions of all the basic components in the aircraft

CO 3: Explain the process of aerodynamic forces and moments generation in the aircraft

CO 4: Differentiate various aircraft power plants based on its operation and thrust production

CO 5: Identify the various structural elements and understand its functions

Pre-requisite(s):

CO-PO and CO-PSO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	M												S	
CO 2	M												S	
CO 3	M												S	
CO 4	M												S	
CO 5	M												S	

Course Assessment Methods:

Direct
1. Continuous Assessment Test I, II 2. Assignment; Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

HISTORY OF FLIGHT **5 Hours**

Balloon flight, Ornithopter, Heavier-than-air Flight, Wright Brothers' airplane, Evolution of aircraft design, Developments in aerodynamics, materials, structures and propulsion over the years.

AIRCRAFT CONFIGURATIONS **7 Hours**

Atmosphere and its properties - Different types of flight vehicles - classifications- Basic Components of aircraft- principle of operation and their functions - Different types of Wing and Tail configurations.

INTRODUCTION TO AERODYNAMICS **6 Hours**

Newton's law of motions applied to Aeronautics- Generation of lift, drag and pitching moment, Airfoil lift and drag curve, stall, types of drag, factors affecting lift and drag, Centre of pressure and its significance; aerodynamic center, aspect ratio, Mach number and supersonic flight effects.

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INTRODUCTION TO AIRCRAFT PROPULSION **6 Hours**

Aircraft power plants, classification based on the principle of operation. Piston-Propeller Turboprop, Turbojet, Turbofan, Ramjet engines– use of propeller and jets for thrust production- Comparative merits, performance characteristics.

INTRODUCTION TO AIRCRAFT STRUCTURES **6 Hours**

General types of construction, Monocoque, semi-monocoque constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials.

Theory: 30	Tutorial: 0	Practical: 0	Project: 0	Total: 30 Hours

REFERENCES

1. Anderson, J.D., “Introduction to Flight”, Seventh Edition, McGraw-Hill, 2013.
2. Kermode, A.C. "Mechanics of Flight ", Pearson Education; Eleventh edition, 2006.
3. Federal Aviation Administration “The pilot's handbook of aeronautical knowledge”, 2016.
4. Dava Newman “Interactive Aerospace Engineering and Design”, McGraw-Hill, 2002.

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