KUMARAGURU COLLEGE OF TECHNOLOGY,

An autonomous Institution affiliated to Anna University, Chennai

COIMBATORE – 641 049.

B.E., AERONAUTICAL ENGINEERING

REGULATIONS 2017

CURRICULUM AND SYLLABI

III 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 III										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U17MAT3101	Partial Differential Equations and Transforms	Theory	BS	3	1	0	0	4	-------
2	U17AEI3201	Fluid Mechanics	Embedded-Theory & Lab	PC	2	0	2	0	3	-------
3	U17AEI3202	Engineering Thermodynamics	Embedded-Theory & Lab	PC	2	0	2	0	3	-------
4	U17AEI3203	Mechanics of Solids	Embedded-Theory & Lab	PC	2	0	2	0	3	-------
5	U17EEI3202	Aircraft Electrical and Electronics Systems	Embedded-Theory & Lab	ES	2	0	2	0	3	-------
6	U17INI3600	Engineering Clinic 1	Embedded-Practical & Project	ES	0	0	4	2	3	-------
								Total Credits	**19**	
								Total Contact Hours/week	**26**	

Semester IV										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U17MAT4101	Numerical Methods and Probability	Theory	BS	3	1	0	0	4	-------
2	U17AEI4201	Low Speed Aerodynamics	Embedded-Theory & Lab	PC	2	0	2	0	3	U17AEI3201
3	U17AEI4202	Automatic Control Systems	Embedded-Theory & Lab	PC	2	0	2	0	3	-------
4	U17AET4003	Aircraft Structures I	Theory	PC	3	0	0	0	3	U17AEI3203
5	U17AET4004	UAV System Design	Theory	PC	3	0	0	0	3	-------
6	U17AET4005	Aircraft Hardware and Materials	Theory	PC	3	0	0	0	3	-------
7	U17INI4600	Engineering Clinic 2	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	U17AET5101	High speed Aerodynamics	Theory	PC	2	1	0	0	3	U17AEI4201
2	U17AEI5202	Aircraft Structures II	Embedded-Theory & Lab	PC	2	0	2	0	3	U17AET4003
3	U17AET5003	Computational Fluid Dynamics	Theory	PC	3	0	0	0	3	U17AEI4201
4	U17AEI5204	Aircraft Systems and Instruments	Embedded-Theory & Lab	PC	2	0	2	0	3	-------
5	U17AEI5205	Aircraft Propulsion	Embedded-Theory & Lab	PC	2	0	2	0	3	U17AEI3202
6	OE I	Open Elective I	Theory	OE	3	0	0	0	3	-------
7	U17INI5600	Engineering Clinic 3	Embedded-Practical & Project	ES	0	0	4	2	3	-------
Total Credits									**21**	
Total Contact Hours/week									**27**	

Semester VI										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U17AET6001	Flight Dynamics	Theory	PC	3	0	0	0	3	U17AEI4201
2	U17AET6002	Finite Element Method	Theory	PC	3	0	0	0	3	U17AET4003
3	U17AET6003	Vibrations and Aeroelasticity	Theory	PC	3	0	0	0	3	U17AEI5202
4	U17AET6104	Rocket Propulsion	Theory	PC	2	1	0	0	3	U17AEI5205
5	OE II	Open Elective II	Theory	OE	3	0	0	0	3	-------
6	U17AEE00--	Professional Elective I	Theory	PE	3	0	0	0	3	-------
7	U17AEP6505	Design and Simulation Laboratory	Lab	PC	0	0	2	0	1	U17AET5003
8	U17INI6600	Engineering Clinic 4	Embedded-Practical & Project	ES	0	0	4	2	3	-------
Total Credits									**22**	
Total Contact Hours/week									**26**	

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Semester VII										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U17AEI7201	Aircraft Design	Embedded-Theory & Lab	PC	2	0	2	0	3	U17AET6001
2	U17AEI7202	Aircraft Maintenance Practices	Embedded-Theory & Lab	PC	2	0	2	0	3	U17AEI5204
3	U17AEI7203	Avionics	Embedded-Theory & Lab	PC	2	0	2	0	3	U17EEI3202
4	U17AET7004	Aviation Logistics and Supply Chain Management	Theory	PC	3	0	0	0	3	-------
5	U17AEE00--	Professional Elective II	Theory	PE	3	0	0	0	3	-------
6	U17AEE00--	Professional Elective III	Theory	PE	3	0	0	0	3	-------
7	U17INT7000	Professional Communication	Theory	HS	3	0	0	0	3	-------
8	U17AEP7705	Project Work – Phase I	Project	PW	0	0	0	6	3	-------
Total Credits									**24**	
Total Contact Hours/week									**30**	

Semester VIII										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U17AEP8701	Project Work –Phase II	PROJECT	PW	0	0	0	24	12	U17AEP7705
Total Credits									**12**	
Total Contact Hours/week									**24**	

Total Credits 166

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PROFESSIONAL ELECTIVES

Course Code	Course Title	Course category	Course Mode	L	T	P	J	C
U17AEE0001	Experimental Aerodynamics	Elective	Theory	3	0	0	0	3
U17AEE0002	Viscous Flow Theory	Elective	Theory	3	0	0	0	3
U17AEE0003	Hypersonic Aerodynamics	Elective	Theory	3	0	0	0	3
U17AEE0004	Cryogenic Engineering	Elective	Theory	3	0	0	0	3
U17AEE0005	Principles of Combustion	Elective	Theory	3	0	0	0	3
U17AEE0006	Heat and Mass Transfer	Elective	Theory	3	0	0	0	3
U17AEE0007	Composite Materials and Structures	Elective	Theory	3	0	0	0	3
U17AEE0008	Theory of Elasticity	Elective	Theory	3	0	0	0	3
U17AEE0009	Fatigue and Fracture Mechanics	Elective	Theory	3	0	0	0	3
U17AEE0010	Experimental Stress Analysis	Elective	Theory	3	0	0	0	3
U17AEE0011	Space Mechanics	Elective	Theory	3	0	0	0	3
U17AEE0012	Non Destructive Testing	Elective	Theory	3	0	0	0	3

LIST OF MANDATORY COURSES

S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Semester
1	U17VEP1501	Personal values	Lab	HS	0	0	2	0	0	I
2	U17VEP2502	Inter-Personal values	Lab	HS	0	0	2	0	0	II
3	U17CHT3000	Environmental Science and Engineering	Theory	MC	2	0	0	0	0	III
4	U17VEP3503	Family Values	Lab	HS	0	0	2	0	0	III
5	U17VEP4504	Professional Values	Lab	HS	0	0	2	0	0	IV
6	U17INT5000	Constitution of India	Theory	MC	2	0	0	0	0	V
7	U17VEP5505	Social Values	Lab	HS	0	0	2	0	0	V
8	U17VEP6506	National Values	Lab	HS	0	0	2	0	0	VI
9	U17VEP7507	Global Values	Lab	HS	0	0	2	0	0	VII

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OPEN ELECTIVES*

S. No.	Course Code	Course Title	Category	Contact Hours	Hours per Week & Credits			
					L	T	P	C
1	U17AEO0001	Basics of Aeronautics	OE	3	3	0	0	3
2	U17AEO0002	Industrial Aerodynamics	OE	3	3	0	0	3
3	U17AEO0003	Non-destructive Testing for Engineering Applications	OE	3	3	0	0	3
4	U17AEO0004	Autonomous Flying Robots	OE	3	3	0	0	3
5	U17AEO0005	Wind Turbine Engineering	OE	3	3	0	0	3
6	U17AEO0006	Theory behind Airplane: From birds to Human Flight	OE	3	3	0	0	3
7	U17AEO0007	Satellite System and Application	OE	3	3	0	0	3
8	U17AEO0008	Basics of Aeroplanes and human life	OE	3	3	0	0	3

INDUSTRY-ORIENTED ONE CREDIT COURSES*

S. No.	Course Code	Course Title	Category	Total Hours
1	U17AEC0201	Wind Turbine Design and Testing	PE	15
2	U17AEC0202	Theory and Practice of Aeronautics with Industrial Applications	PE	15
3	U17AEC0203	Aircraft Design Approach	PE	15
4	U17AEC0204	Introduction to CFD using RotCFD	PE	15
5	U17AEC0205	Satellite System and Application	PE	15

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SEMESTER III

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U17MAT3101	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.

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U17AEI3201	FLUID MECHANICS	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

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

CO 1: Apply the basic equation of fluid statics to determine forces on planar and curved surfaces that are submerged in a static fluid.

CO 2 Apply conservation laws to determine velocities, pressures, and accelerations for incompressible and inviscid fluids.

CO 3: Apply principles of dimensional analysis to identify non dimensional parameters

CO 4: Explain the concepts of viscous boundary layers

CO 5: Apply principles of impacts of jets in fluid machineries.

CO 6: Measure coefficient of discharge of fluid flows

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 **7 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 **7 Hours**

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

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

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DIMENSIONAL ANALYSIS AND SIMILITUDE **6 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 **6 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 **4 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
10. Determination of Reynolds Number

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

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U17AEI3202	ENGINEERING THERMODYNAMICS	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: Analyse open and closed systems using first law of thermodynamics.

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

CO3: **Analyse Otto, Diesel, Dual and Bryton cycle under various operating conditions.**

CO4: Calculate the stoichiometric air fuel ratio required for combustion.

CO5: **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	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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	

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

THEORY COMPONENT CONTENTS

BASIC CONCEPTS AND FIRST LAW 8 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 8 Hours

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

AIRCYCLES 8 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

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cycle, introduction to modified Brayton cycle and Jet Propulsion cycle -Numerical problems.

COMBUSTION THERMODYNAMICS **6 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, enthalpy of combustion.

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/#

LAB COMPONENT CONTENTS

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

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U17AEI3203	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: Solve the problems on structural members subjected to Uni-axial load

CO2: Construct Shear Force, Bending moment and Bending stress distribution in beams subjected to transverse load

CO3: Determine the deflection of statically determinant beam

CO4: Solve the problems on torsion Circular Shafts

CO5: Solve the problems on 2d structural element

CO6: Demonstrate the experiments with UTM and Determinate Beam structures to determinate the predominant parameters

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

THEORY COMPONENT CONTENTS

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.

BEAM DEFLECTION 6 Hours

Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam

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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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U17EEI3202	AIRCRAFT ELECTRICAL AND ELECTRONICS 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: 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

Theory Component:

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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U17CHT3000	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)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		M					S		M			
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.

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Energy resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources, case studies.
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.

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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 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.

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U17VEP3503	FAMILY VALUES (Mandatory)	L	T	P	J	C
		0	0	2	0	0

Course Outcomes

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

CO 1: Develop skills in maintaining the harmony in the family.
CO 2: Create impulsive activities for healthy family
CO 3: Be receptive to troubled Individuals
CO 4: Gain healthy life by practicing Kundalini Yoga & Kayakalpa
CO 5: Possess Empathy among family members.
CO 6: Reason the life and its significance

Pre-requisites :

1. U17VEP1501 / Personal Values
2. U17VEP2502 / Interpersonal Values

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
CO1									S			
CO2							M					
CO3										M		
CO4												S
CO5						S						
CO6								M				

Course Assessment methods

Direct
1.Group Activity / Individual performance and assignment 2.Assessment on Value work sheet / Test
Indirect
1. Mini project on values / Goodwill Recognition

Values Through Practical Activities:

1. Family system: Introduction to Family Values – elements of family values - Adjustment, Tolerance, Sacrifice - Family structure in different society – work life balance.
2. Peace in Family : Family members and their responsibility - Roles of parents, children, grant parents -. Respectable women hood
3. Core value: Empathy: Unconditional love - Respect - Compassion - sacrifice–Care &share - helping – emotional support- hospitality – cleanliness
4. Blessing: Blessing - methods - Vibration effect - Benefits - Reason for misunderstanding in the Family and resolution through blessings.
5. Healthy Family: Good relationship with neighbors - Counseling - Simplified Kundalini Yoga - Kaya Kalpa Yoga

Workshop mode

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REFERENCES:

1. Family - Www.Download.Nos.Org/331coursee/L-13%20family.Pdf
2. Framework For Action On Values Education In Early Childhood – Unesco – Pdf – Www.Unesdoc.Unesco.Org/Images/0012/001287/128712e.Pdf
3. True Family Values Third Edition - Tparents Home Www.Tparents.Org/Library/Unification/Books/Tfv3/_Tfv3.Pdf
4. Family Values In A Historical Perspective - The Tanner Lectures On Www.Tannerlectures.Utah.Edu/_Documents/A-To-Z/S/Stone95.Pdf
5. Problems Of India's Changing Family And State ... - The United Nations - Www.Un.Org/Esa/Socdev/Family/Docs/Egm09/Singh.Pdf

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SEMESTER IV

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U17MAT4101	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.

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INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION **9+3 Hours**

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.

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U17AEI4201	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: Apply conservation laws to solve incompressible flow regime
CO2: Solve the problems on potential flows
CO3: Apply Joukowski transformation to fluid flow problems.
CO4: Explain airfoil and wing characteristics.
CO5: Apply propeller theory to predict blade performance.
CO6: Measure the aerodynamic forces on various aerodynamic bodies

Pre-requisites :

1. U17AEI3201 / 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.

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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.
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

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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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U17AEI4202	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: Determine the transfer function of mechanical and electrical systems.
CO 2: Analyse the time response of various control systems.
CO 3: Design compensators for control systems in MATLAB.
CO 4: Analyse the behaviour of autopilot systems in MATLAB.
CO 5: Explain the processes involved in CNC machines and the purpose of CAD/CAM software for CNC machines.

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	W
CO 3	-	-	M	-	S	-	-	-	-	-	-	-	S	S
CO 4	-	S	-	-	S	-	-	-	-	-	-	-	S	S
CO 5	-	-	-	-	M	-	-	-	-	-	-	-	-	M

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 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.

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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.

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WEBSITE REFERENCES

1. NPTEL Lecture Notes on Control Engineering: https://nptel.ac.in/courses/108102043/
2. Fundamentals of CNC Machining - A Practical Guide for Beginners: https://academy.titansofcnc.com/files/Fundamentals_of_CNC_Machining.pdf

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U17AET4003	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: Identify statically determinate and indeterminate structures.
CO2: Analyze the response of statically indeterminate structures under various loading conditions.
CO3: Determine the reactions of structures using strain energy concept.
CO4: Identify different numerical methods available to solve a single structural problem.
CO5: Examine the structural failures using failure theories.

Pre-requisites :

1. U17AEI3203 / 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.

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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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U17AET4004	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.

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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.

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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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U17AET4005	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: Analyze the properties of different aircraft materials.

CO 2: Identify the various types of composite and non-metallic materials for aircraft construction.

CO 3: Apply suitable hardware materials for different parts of the aircraft.

CO4 : Identify the appropriate cables and connectors for various aircraft applications.

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											M	
CO2		S											M	
CO3	S												M	
CO4		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

Theory Component Contents

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 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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U17VEP4504	PROFESSIONAL VALUES (Mandatory)	L	T	P	J	C
		0	0	2	0	0

Course Outcomes

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

CO 1: Develop the ethical values in both professional and personal life
CO 2: Develop ability to take decision to reinforce professional life
CO 3: Rational in professional skills required for diverse society
CO 4: Excel in ingenious attitude to congregate professional life
CO 5: Research into the professional stand
CO 6: Spruce an Individual with decorum to achieve professional life

Pre-requisites :

1. U17VEP1501 / Personal Values
2. U17VEP2502 / Interpersonal Values
3. U17VEP3503 / Family Values

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
CO1								S				
CO2				M								
CO3			S									
CO4												S
CO5								M				
CO6										M		

Course Assessment methods

Direct
1.Group Activity / Individual performance and assignment 2.Assessment on Value work sheet / Test
Indirect
1. Mini project on values / Goodwill Recognition

Values through Practical activities:

1.Professional skills With Values: Positive Attitude, Adaptability, Responsibility, Honesty and Integrity, Self Esteem, & Self Confidence

2.Building Innovative work cultures: Creative thinking, Critical thinking, Conflict Resolution, Problem Solving, & Decision making

3.Professional Work Ethics: Types of Ethics, Etiquette, personality Grooming, Emotional quotient, Human Dignity, Safety & Role of Professional in Social Responsibility

4.Engineering Ethics: Engineering Council of India - Objectives - Code of Ethics - Social responsibility -Professional Quality - Ethical issues - Effects - Strategy – Corruption, Consequences, Cures

5.Case studies in engineering ethics: Discussion of case studies relating to Public safety, health, welfare, Quality of product, Improper conduct by management, Product responsibility, Intellectual property

Workshop mode

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REFERENCES

1. Learning To Do Sourcebook 3 - Unesco-Unevoc -Pdf
   Www.Unevoc.Unesco.Org/Fileadmin/User_Upload/Pubs/Learningtodo.Pdf
2. Declaration Of Professional Values And Ethical Standards
   Www.Garda.Ie/Documents/User/Declarationvalues.Pdf
3. Karma Yoga - Swami Vivekananda
   Www.Vivekananda.Net/Pdfbooks/Karmayoga.Pdf
4. Professional Ethics In Engineering - Sasurie College Of Engineering
   ww.Sasurieengg.Com/.../Ge2025%20professional%20ethics%20in%20engineering.
5. Engineering Ethics Case Study; Challenger
   Www.Ucc.Ie/En/Processeng/Staff/Academic/Ebyrne/.../Pe1006pptnoteslect7.Pdf

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SEMESTER V

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U17AET5101	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: Use Basic Principles of the compressible gas flows.
CO 2: Calculate the parameters of compressible flow through variable area duct.
CO 3: Solve the Problems on one dimensional flow with Normal Shock, Rayleigh and Fanno flows and apply method of characteristics
CO 4: Examine the flow with Oblique shocks and Expansion waves
CO 5: Apply Linearized flow theory for streamlined bodies

Pre-requisite(s):

1. U17AEI4201 / 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**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO1
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.

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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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U17AEI5202	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. U17AET4003/ 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													
COs	Programme Outcomes(POs)													
	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

Theory Component contents

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.

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BUCKLING OF PLATES **5 Hours**

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.

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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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U17AET5003	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: Explain the fluid modeling approaches.
CO2: Develop grids for different fluid flow applications.
CO3: Analyze fluid flow problems using panel methods
CO4: Make use of advanced simulation techniques to solve engineering applications using CFD codes such as Fluent, CFX, ROTCFD etc.,
CO5: Apply appropriate schemes to solve fluid flow problems.
CO6: Examine the CFD simulation results with validation.

Pre-requisites :

1. U17AEI4201 – 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)													
	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							
CO6				W			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)

BOUNDARY LAYER EQUATIONS – STABILITY PROPERTIES **10 Hours**

Introduction to Boundary layer Equations, Implicit time dependent methods, Concept of

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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, PESO – 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

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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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U17AET5004	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: Interpret the construction and working principle of conventional aircraft systems.
CO 2: Illustrate the performance characteristics of various aircraft engine control systems.
CO 3: Explain the functions of various types of aircraft instruments and avionics systems.
CO 4: Demonstrate the operation of aircraft and engine system..
CO 5: Describe the inspection procedure and troubleshooting on aircraft.

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

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, 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).

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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.

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

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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

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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/

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U17AEI5205	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: Analyze overall performance of an aircraft engines.
CO2: Explain the relation between area ratio and external deceleration ratio for diffuser.
CO3: Describe the combustion mechanisms of gas turbine engine.
CO4: Calculate the operating characteristics of compressors, turbines and nozzles.
CO5: Experiment the performance of aircraft engine components.

Pre-requisites :

1. U17AEI3202 / 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	

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

Theory Component contents

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 variation – Mode of inlet operation.

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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.

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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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U17INT5000	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:

CO 1: Gain Knowledge about the Constitutional Law of India
CO 2: Understand the Fundamental Rights and Duties of a citizen
CO 3: Apply the concept of Federal structure of Indian Government
CO 4: Analyze the Amendments and Emergency provisions in the Constitution
CO 5: 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												
COs	Programme Outcomes(POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						M			W			S
CO2						S		S				M
CO3									M	S		W
CO4								W	M			M
CO5						M		M				S
CO6												

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 Constitutic and 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

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

National Emergency, President Rule, Financial Emergency Local Self Government – 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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U17VEP5505	SOCIAL VALUES (Mandatory)	L	T	P	J	C
		0	0	2	0	0

Course Outcomes

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

CO 1: Understand the transformation from self to society
CO 2: Acquire knowledge about disparity among Human Beings
CO 3: Realize the new ethics in creating a more sustainable Society
CO 4: Develop skills to manage challenges in social issues
CO 5: Acquire the skills for Management of Social work & Holistic Society
CO 6: Validate the social liabilities at dissimilar situations

Pre-requisites :

1. U17VEP1501 / Personal Values
2. U17VEP2502 / Interpersonal Values
3. U17VEP3503 / Family Values
4. U17VEP4504 / Professional Values

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
CO1						S						
CO2							S					
CO3								M				
CO4											S	
CO5												S
CO6									M			

Course Assessment methods

Direct
1.Group Activity / Individual performance and assignment 2.Assessment on Value work sheet / Test
Indirect
1. Mini project on values / Goodwill Recognition

Values Through Practical Activities:

1. Self and Society: Relation between self and society – Different forms of society - Elements of Social structures – Realization of Duties and Responsibilities of Individual in the Society

2. Social Values: Tolerance – Responsibility – Sacrifice – Sympathy - Service – peace-nonviolence - right conduct- Unity – forgive – dedication – Honest

3. Social issues : Disparity among Human beings- Poverty-Sanitation -corruption- un employment-superstition – religious intolerance & castes – terrorism.

4. Emerging Ethics for Sustainable Society: Unison of Men in Society - Positive Social Ethics - Cause and Effect - Ensuring an Equitable Society- Effect of Social Media in society - development of Education and Science in the Society

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5. Social Welfare: Social welfare Organization - Programme by Government and NGO's - Benefits of Social Service - Balancing the Family and Social Life – Development of Holistic Society

Workshop mode

REFERENCES

1. Social Problems In India - Forumias.Com – Pdf Discuss.Forumias.Com/Uploads/File Upload/.../711b18f321d406be9c79980b179932.Pd...
2. Investing In Cultural Diversity And Intercultural Dialogue: Unesco ... Www.Un.Org/En/Events/Culturaldiversityday/Pdf/Investing_In_Cultural_Diversity.Pdf
3. Indian Society And Social Change - University Of Calicut Www.Universityofcalicut.Info/Sde/Ba_Sociology_Indian_Society.Pdf
4. Culture, Society And The Media - E- Class Www.Eclass.Uoa.Gr/.../Media164/.../%5btony_Bennett,_James_Curran,_Michael_G
5. Social Welfare Administration - Ignou Www.Ignou.Ac.In/Upload/Bswe-003%20block-2-Unit-6-Small%20size.Pdf

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SEMESTER VI

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U17AET6001	FLIGHT 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: Calculate atmospheric properties at various altitudes.
CO2: Calculate the performance of an airplane for non-accelerating flight conditions.
CO3: Solve accelerated performance equations to get Take-off and landing distances.
CO4: Estimate Longitudinal static stability and trim requirements for an aircraft.
CO5: Assess lateral and directional stability requirements for an aircraft

Pre-requisites :

1. U17AEI4201 / 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 **6 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 **10 Hours**

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

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ACCELERATING FLIGHT **7 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 **12 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 **10 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: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 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.

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4. http://www.princeton.edu/~stengel/MAE331Lectures.html

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U17AET6002	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.

CO4: 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. U17AET4003/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.

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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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U17AET6003	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: Explain the concept and types of vibration.
CO 2: Determine the natural frequencies and mode shapes of the vibrating system.
CO 3: Solve the equations of motion for multidegree-of-freedom systems.
CO 4: Determine the natural frequency of continuous systems of free-vibration.
CO 5: Identify the effects of vibrations on aircraft structures and the static and dynamic aeroelastic effects.

Pre-requisites :

1. U17AEI5202/ 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		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

Theory Component contents

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.

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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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U17AET6104	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

CO1: Illustrate the Basic principles and parameters of rockets.

CO2: Differentiate and interpret the ignition systems of rocket

CO3: Analyze the performance of solid-core nuclear thermal rockets, arc jets, and ion thrusters.

CO4: Analyze the performance of Liquid Propellant Rockets

CO5: Interpret the advanced propulsion techniques of a rocket

Pre-requisite(s):

1. U17AEI5205 / 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 problems.

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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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U17AEP6505	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): U17AET5003 / 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	Course end survey
2.	Lab Observation / Record	
3.	Viva-voce / Model Practical Exams	
4.	End Semester Exam	

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

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U17VEP6506	NATIONAL VALUES (Mandatory)	L	T	P	J	C
		0	0	2	0	0

Course Outcomes

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

CO 1: Acquire knowledge on the Essence of Indian Knowledge Tradition
CO 2: Know the great Indian personalities and follow their trail
CO 3: Understand the specialty of democracy
CO 4: Disseminate our Nation and its values to propagate peace
CO 5: Contribute with their energy and effort for a prosperous India
CO 6: Propagate the youth and the contribution for development of our Nation

Pre-requisites :

1. U17VEP1501 / Personal Values
2. U17VEP2502 / Interpersonal Values
3. U17VEP3503 / Family Values
4. U17VEP4504 / Professional Values
5. U17VEP5505 / Social Values

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
CO1						S						
CO2									M			
CO3							M					
CO4								S				
CO5											S	
CO6												M

Course Assessment methods

Direct
1.Group Activity / Individual performance and assignment 2.Assessment on Value work sheet / Test
Indirect
1. Mini project on values / Goodwill Recognition

Values Through Practical Activities:

1. Essence of Indian Knowledge Tradition:
Basic structure of Indian Knowledge System - Modern Science and Indian Knowledge System - Yoga and Holistic Health care - Case studies - Philosophical Tradition - Indian Linguistic Tradition - Indian Artistic Tradition.
2. Great Indian Leaders : Ancient rulers - Freedom fighters - Social reformers -Religious and Spiritual leaders - Noble laureates -Scientists – Statesman.
3. Largest Democracy : Socialist -Secular - Democratic and Republic – special features of Indian constitution – Three pillar of Indian democracy - Fundamental rights – Duties of a citizen – centre state relationship.
4. India's Contribution to World peace : Nonaligned Nation – Principle of Pancha Sheela – Mutual respect, non-aggression, non-interference, Equality and cooperation –

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Role of India in UNO -Yoga India's gift to the world.

5. Emerging India : World's largest young work force - Stable Economic development - Labor market & Achievement in space technology – Value based Social structure. Emerging economic superpower.

Workshop mode

REFERENCES

1. Knowledge Traditions And Practices Of India, *Cbse Publication Cbseacademic.Nic.In/Web_Material/Circulars/2012/68_Ktpi/Module_6_2.Pdf*
2. Cultural Heritage Of India - Scert Kerala Www.Scert.Kerala.Gov.In/Images/2014/Hsc.../35_Gandhian_Studies_Unit-01.Pdf
3. Learning To Do: Values For Learning And Working Together - Unesco Www.Unesdoc.Unesco.Org/Images/0014/001480/148021e.Pdf
4. India After Gandhi.Pdf - Ramachandra Guha - University Of Warwick Www2.Warwick.Ac.Uk/Fac/Arts/History/Students/Modules/Hi297/.../Week1.Pdf
5. India's Contribution To The Rest Of The World - Yousigma Www.Yousigma.Com/Interesting Facts/Indiasgifttotheworld.Pdf
6. India As An Emerging Power - International Studies Association Web.Isanet.Org/Web/Conferences/.../11353cac-9e9b-434f-A25bA2b51dc4af78.Pdf

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SEMESTER VII

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U17AEI7201	AIRCRAFT DESIGN	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: Conduct trade-off between the conflicting demands of different disciplines by performing a detailed preliminary design of a complete aircraft

CO2: Decide mission specific wing loading for the aircraft.

CO3: Select appropriate design and dimensional parameters for wing, fuselage and Empennage.

CO4: Identify the constraints in a mission and select the power plant for the aircraft.

CO5: Estimate the performance parameters and size the control surfaces

CO6: Estimate loads on different aircraft components.

Pre-requisites :

1. U17AET6001/ 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 **5 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 **5 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.

DESIGN OF WING, FUSELAGE AND TAIL **6 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 –

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Airfoil selection type – Tail placement – Spread sheets for tail design

DESIGN OF PROPULSION SYSTEM **5 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 **5 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 **4 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.
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: 30	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 60 Hours**

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U17AEI7202	AIRCRAFT MAINTENANCE PRACTICES	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: Describe various ground support system for aircraft operations
CO 2: Operate the appropriate precision measuring tools and special tools during the maintenance process of an aircraft.
CO 3: Apply the inspection and maintenance procedures for various aircraft systems.
CO 4: Demonstrate the ground servicing of critical aircraft systems
CO 5: Illustrate the various manual specifications used in airframe and engine manual.

Pre-requisite(s): U17AEI5204 - Aircraft Systems and Instruments

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; Written & Group Presentation. 3. End Semester Examination	1. Lab Exercises 2. Lab Observation / Record 3. Viva-voce 4. Model Practical Exams
Indirect Assessment	
Course exit survey	

Theory Component:

AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT **7 Hours**

Safety and fire precautions- Mooring, Jacking, Leveling, symmetry check, Rigging and Towing Operations- Equipment's- Engine Starting Procedures – Piston Engine and jet engine.

WORKSHOP PRACTICE AND AIRCRAFT HARDWARE **6 Hours**

Hand tools- machine tools and precision measuring instruments, gears and bearings, correct use and inspection of aircraft bolts, nuts, rivets, screws and locking devices of British and American systems- Swaging Procedures, Tests, Advantages of Swaging Over Splicing

INSPECTION **5 Hours**

Process – Purpose – Types – Inspection Intervals – Techniques – Checklist – Special Inspection – Publications

GROUND SERVICING OF VARIOUS SUB SYSTEMS **7 Hours**

Oxygen And Oil Systems- Engine Fire Extinguishing – Ground Power Unit- Water And Waste System- Rain Removal System – Position And Warning System

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AIRCRAFT MANUALS **5 Hours**

FAR Air Worthiness Directives – Type Certificate Data Sheets – ATA Specifications- Airframe Manuals- Engine Manuals.

LAB COMPONENT:

List of Experiments/Exercises

1. Perform the Aircraft Procedure for 'Jacking Up'
2. Perform the Aircraft Procedure for 'Leveling'
3. Perform the Aircraft Procedure for 'Rigging check'
4. Perform the Aircraft Procedure for 'Symmetry Check'.
5. Riveted patch repairs- Butt Joint
6. Riveted patch repairs- Lap Joint.
7. Sheet metal forming for the given shape.
8. Ground Running procedure for cessna 172 aircraft.

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

List of Equipment

1. Fuselage support stand.
2. Tripod jacks
3. Wing support stand.
4. Engine removal sling.
5. Engine hoist and stand.
6. Engine removal and fitment tools.

REFERENCES

1. Kroes, Watkins, Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1992
2. Larry Reithmeir, "Aircraft Repair Manual", Palamar Books, Marquette, 1992.
3. Brimm D.J. Bogges H.E., "Aircraft Maintenance", Pitman Publishing Corp., New York, 1940.
4. Delp. Bent and Mckinely "Aircraft Maintenance Repair", McGraw Hill, New York, 1987.
5. Kroes Watkins Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1993
6. A&P Mechanics, "Aircraft Hand Book", F A A Himalayan Book House, New Delhi, 1996
7. A&P MECHANICS, 'General Hand Book', FAA Himalayan Book House, New Delhi, 1996.

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1. https://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/
2. nptel.ac.in
3. http://dgca.nic.in/licencing/syl-ind.htm

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U17AEI7203	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: Demonstrate the working of simple digital circuits using logic gates.

CO 2: Create assembly language programs with microprocessor for simple applications.

CO 3: Demonstrate the integration of avionic systems with data buses.

CO 4: Explain the working of aircraft communication and navigation systems.

CO 5: Discuss the autopilot systems in aircraft.

CO 6: Describe the components and working of aircraft landing systems.

Pre-requisite(s): U17EEI3202 / 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**

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

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.

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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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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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U17AET7004	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

CO1: Describe the role of logistics in a market-oriented society

CO2: Use an opportunity for comprehensive analysis and discussion of key contemporary issues in logistics management

CO3: Demonstrate Supply Chain Management and its relevance to today's business decision making.

CO4: Recognize the general concepts of aviation logistics and its trends.

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						W							W	
CO2							M						W	
CO3											S		M	
CO4												W	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.

CARGO HANDLING AGENTS AND COOL LOGISTICS 9 Hours

History- change factor- Role of general handling agent- Cool chain business- Case study-


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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.

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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

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U17INT7000	PROFESSIONAL COMMUNICATION & ANALYTICAL REASONING	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: Prepare resumes, and face GDs & Interviews.
CO 2: Crack Questions on Quantitative Ability.
CO 3: Crack Problems and Puzzles on Analytical and Logical Reasoning.
CO 4: Crack Questions on Verbal Ability.
CO 5: Develop a holistic approach to face Campus Placements and Competitive Examinations.

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)												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	Indirect
1.Internal test I 2.Internal test II 3.Assignment/ Seminar/ Tutorial 4.End Semester Examination	1.Course end survey

RESUME PREPARATION, GROUP DISCUSSION & INTERVIEW **9 Hours**

Importance of resume, essentials of a good resume, do's and don'ts of resume, sample resume, importance of group discussion, practice GD, interviews, types of interviews, how to prepare for interview, interview etiquettes, Mock GD & Interview

QUANTITATIVE ABILITY 1 **9 Hours**

Number theory, Average, Mixture & Allegation, Ages, Ratio, Percentage, Partnership, Profit & Loss, SI, CI, Clocks, Calendar

QUANTITATIVE ABILITY 2 **9 Hours**

Speed Distance Time, Boats & Stream, Train, Time and Work, Pipes and Cistern, Probability, Permutation & Combinations, Linear and Quadratics Equations

LOGICAL REASONING **9 Hours**

Based Problems on Cubes and Dices, Blood relations, Analytical reasoning, Syllogism, Series completion

VERBAL REASONING **9 Hours**


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Basic Grammar / Types of Sentence/ Selecting Words / Spotting Errors/ Sentence Formation / Sentence Improvement/ Sentence Completion / Sentence Correction / Idioms &Phrases

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

REFERENCES

1) Campus Placements – A Comprehensive Guide By Mr. Ankur Malhotra - Tata Mcgraw Hill's Publications.
2) Resumes And Interviews – The Art Of Winning By Mr. Ashraf Rizvi - Tata Mcgraw Hill's Publications.
3) How To Prepare For Group Discussion & Interviews By Mr. Hari Mohan Prasad And Mr. Rajnish Mohan - Tata Mcgraw Hill's Winning Edge Series.
4) Quantitative Ability – Quantitative Aptitude For Competitive Examinations (Revised Edition – 2017) By Dr. R.S Aggarwal – S. Chand Publications.
5) Quantitative Ability – Quantitative Aptitude – Quantum Cat By Mr. Sarvesh K Varma – Arihant Publications.
6) Logical Reasoning – A Modern Approach To Verbal And Non Verbal Reasoning (Revised Edition) By Dr. R.S Aggarwal – S. Chand Publications.
7) Logical Reasoning – A New Approach To Reasoning By Mr. Bs Sijawali And Ms. Indu Sijwali – Arihant Publications.
8) Verbal Reasoning – General English For Competitions By Mr. A.N. Kapoor – S. Chand Publications.
9) Verbal Reasoning – Objective English For Competitive Examinations By Mr. Hari Mohan Prasad And Ms. Uma Rani Sinha – Tata Mcgraw Hill's Winning Edge Series.

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U17VEP7507	GLOBAL VALUES (Mandatory)	L	T	P	J	C
		0	0	2	0	0

Course Outcomes

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

CO1: Aware of the concept of Universal Brotherhood and support the organizations which are working for it

CO2: Follow the path of Ahimsa in every aspect of their life

CO3: Uphold the Universal declaration of Human Rights

CO4: Understand the unequal distribution of wealth in the World and bestow their effort towards inclusive growth

CO5: Sensitize the environmental degradation and work for the sustainable development

CO6: Amalgamate harmony through Non-violence and edify the nation headed for upholding development

Pre-requisites :

1. U17VEP1501 / Personal Values
2. U17VEP2502 / Interpersonal Values
3. U17VEP3503 / Family Values
4. U17VEP4504 / Professional Values
5. U17VEP5505 / Social Values
6. U17VEP6506 / National Values

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
CO1							M					
CO2								S				
CO3									M			
CO4						S						
CO5											M	
CO6												S

Course Assessment methods

Direct
1.Group Activity / Individual performance and assignment 2.Assessment on Value work sheet / Test
Indirect
1. Mini project on values / Goodwill Recognition

Values Through Practical Activities:

1. Universal Brotherhood : Meaning of Universal Brotherhood- Functioning of Various organization for Universal human beings -Red Cross, UN Office for Humanitarian Affairs – Case study on humanitarian problems and intervention - Active role of Students/Individual on Universal Brotherhood.

2. Global Peace, Harmony and Unity : Functions of UNO - Principal Organizations - Special organization – Case study relating to disturbance of world peace and role of UNO – Participatory role of Students/Individual in attaining the Global peace and Unity.

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3. Non-Violence : Philosophy of nonviolence- Nonviolence practiced by Mahatma Gandhi – Global recognition for nonviolence - Forms of nonviolence - Case study on the success story of nonviolence– Practicing nonviolence in everyday life.

4. Humanity and Justice: Universal declaration of Human Rights - Broad classification - Relevant Constitutional Provisions– Judicial activism on human rights violation - Case study on Human rights violation– Adherence to human rights by Students/Individuals.

5. Inclusive growth and sustainable development : Goals to transform our World: No Poverty - Good Health - Education – Equality - Economic Growth - Reduced Inequality –Protection of environment – Case study on inequality and environmental degradation and remedial measures.

Workshop mode

REFERENCES

1. Teaching Asia-Pacific Core Values Of Peace And Harmony – Unicef
   Www.Unicef.Org/.../Pdf/Teaching%20asia-Pacific%20core%20values.Pdf
2. Three-Dimensional Action For World Prosperity And Peace- Iim Indore -
   Www.Iimidr.Ac.In/.../Three-Dimensional-Action-For-World-Prosperity-And-Peace-Glo...
3. My Non-Violence - Mahatma Gandhi
   Www.Mkgandhi.Org/Ebks/My_Nonviolence.Pdf
4. Human Rights And The Constitution Of India 8th ... - India Juris
   Www.Indiajuris.Com/Uploads/.../Pdf/L1410776927qhuman%20rights%20080914.Pdf
5. The Ethics Of Sustainability – Research Gate
   Www.Researchgate.Net/File.Postfileloader.Html?Id...Assetkey..

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PROFESSIONAL ELECTIVES

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U17AEE0001	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: Explain the measurement systems in fluids
CO2: Utilize wind tunnel balance for aerodynamic measurements.
CO3: Demonstrate flow visualization techniques
CO4: Measure pressure, velocity and temperature of fluid flows.
CO5: Analyze the data using data acquisition system

Pre-requisite(s): U17AEI4201 / 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										
CO6					M									M

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.

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.

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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/

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U17AEE0002	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: Interpret ideal and Real fluid flows on boundary layer perspective.

CO2: Examine laminar incompressible and compressible viscous flows.

CO3: Summarize transition phenomenon in incompressible and compressible flows

CO4: Apply the statistical mechanics to predict the turbulent flow behavior

Pre-requisite(s): U17AET5001 / 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)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	S	S				W					S	
CO 2	S	S				W					S	
CO 3	S	S				W					S	
CO 4	S	S				W					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.

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 –

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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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U17AEE0003	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

CO 1: Explain shock wave and expansion wave relations of inviscid hypersonic flows
CO 2: Explain the solution methods for hypersonic inviscid flows
CO 3: Analyze the hypersonic boundary layers
CO 4: Explain the viscous interaction in hypersonic flows
CO 5: Analyze chemical and temperature effects in hypersonic flow

Pre-requisite(s): U17AET5001/ 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										
CO6					M									M

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 and non self-similar boundary layers – solution methods for non self-similar boundary layers – aerodynamic heating and its adverse effects on airframe.

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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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U17AEE0004	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: Explain about thermo-physical properties of cryogenic system.
CO4: Identify typical cryogenic insulation system for space propulsion.
CO5: Illustrate general safety principles to various cryogenics systems.

Pre-requisites :

1. U17AEI3202 /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

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U17AEE0005	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 basic thermodynamics concepts to various engineering systems.
CO2: Calculate adiabatic flame temperatures of multi-component gas mixtures.
CO3: Identify the types of chemical reaction takes place during combustion process.
CO4: Estimate the flame speed and flame structure using classical laminar flame theories.
CO5: Describe about Gaseous Jet diffusion flame.

Pre-requisites :

1.U17AEI3202 / 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.

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.

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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.

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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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U17AEE0006	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 steady state heat conduction problems for composite systems and fins.
CO 2: Solve transient heat conduction problems.
CO 3: Solve problems in natural and forced convection for internal and external flows.
CO 4: Calculate the effectiveness of heat exchanger using LMTD and NTU methods.
CO 5: Illustrate radiation shape factors for various geometries.
CO 6: Explain the phenomenon of diffusion and convective mass transfer.

Pre-requisites :

1. U17AEI3202 - 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.
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3. https://ocw.mit.edu/courses
4. http://nptel.ac.in/courses/
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7. hyperphysics.phy-astr.gsu.edu

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U17AEE007	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: Identify the properties of fiber and matrix materials used in commercial composite materials.

CO2: Determine the material properties of composites.

CO3: Apply the conventional failure theories to composite materials.

CO4: Design a laminate for a given load condition.

CO5: Identify the most appropriate manufacturing process for fabricating composite components based on its requirement.

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

Theory Component contents

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.

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2. http://www.ae.iitkgp.ac.in/ebooks/chapter1.html
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U17AEE008	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: Apply the equations compatibility conditions and equations of equilibrium for stress and strain.

CO 2: Solve the elasticity problems using Airy stress function expressed as biharmonic function.

CO 3: Solve plane strain and plane stress problems in Cartesian and polar coordinates.

CO 4: Analyze the torsional problems in non-circular cross sections.

Pre-requisites :

1.U17AEI5202/ 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		M											M	
CO2		M											M	
CO3		S											M	
CO4		S											M	

Course Assessment methods

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

Theory Component contents

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.

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2 http://micro.stanford.edu/~caiwei/me340/
3. https://www.youtube.com/watch?v=eICv1p8WjgI&list=PLbRMhDVUMngcbhsZgRWuYCi2kKQwQ0Av1

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U17AEE0009	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

CO 1: Interpret the results from stress – strain behavior of the materials under fatigue load.

CO 2: Explain the physical phases in a fatigue life of a component.

CO3: Identify different Fracture Mechanics involved in the propagation of cracks during fracture in a material.

CO4: Infer the details from variable amplitude fatigue loadings using simple counting techniques.

CO5: Explain the fatigue based design philosophies and classify the materials based on their fatigue life.

Pre-requisite(s):

1. U17AEI3203 - 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.

FRACTURE MECHANICS **10 Hours**

Introduction – LEFM (Linear Elastic Fracture Mechanics) & EPFM (Elastic Plastic Fracture


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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.

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3. https://online-learning.tudelft.nl/courses/fatigue-of-structures-and-materials/
4. https://nptel.ac.in/courses/112106065/

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U17AEE0010	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: Identify the parameters that control the behavior and response of a measurement system.

CO2: Measure the change in length of the solid materials using suitable extensometers.

CO3: Analyze the strain gauge data under various loading condition by using gauge rosette method.

CO4: Apply experimental techniques of stress analysis using photo elasticity and strain gauges.

CO5: Identify the location and size of defect in structural materials using NDT

Pre-requisites :

1.U17AEI5202/ 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.

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Analysis of Strain Gauge Data: Two gauge rosette – Rectangular rosette – Delta Rosette, Stress Gage – Plane Shear gage.

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.

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2. https://www.sanfoundry.com/best-reference-books-stress-analysis/
3. https://nptel.ac.in/courses/112106068/
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U17AEE0011	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: Discuss the perturbation of satellite orbits and its mathematical background.

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.

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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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U17AEE0012	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: Identify various methods of Non-destructive testing (NDT) to test the material integrity used in engineering application.

CO 2: Apply different NDT processes in aerospace industry.

CO 3: Utilize Thermal inspection, Optical holography NDT methods for aerospace applications.

CO 4: Distinguish various defect types and select the appropriate NDT methods for better evaluation.

Pre-requisite(s): U17AEI3203/ 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	

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 – Pulse echo technique, pitch-catch technique, through transmission technique, A-scan, B-Scan, C-scan – Determination of elastic constants using Ultrasonic velocity.

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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 hrs	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.

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