

PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

B.E. AERONAUTICAL ENGINEERING

CURRICULUM

CBCS REGULATIONS 2016

SEMESTER I

Course Code	Course Title	L	T	P	C
MA16101	Matrices and Calculus	3	2	0	4
EN16101	Technical English I	3	0	0	3
PH16101	Engineering Physics	3	0	0	3
CH16101	Engineering Chemistry I	3	0	0	3
ME16101	Engineering Graphics	3	2	0	4
EE16101	Basic Electrical and Electronics Engineering	3	0	0	3
PC16101	Physics and Chemistry Laboratory I	0	0	2	1
AE16101	Basic Aero modeling Laboratory	0	0	2	1
GE16101	Engineering Practices Laboratory	0	0	4	2

SEMESTER II

Course Code	Course Title	L	T	P	C
MA16201	Differential Equations and Complex Analysis	3	2	0	4
EN16201	Technical English II	3	0	0	3
PH16202	Applied Physics	3	0	0	3
CH16201	Engineering Chemistry II	3	0	0	3
CS16201	Computer Programming	3	0	0	3
ME16201	Engineering Mechanics	3	2	0	4
PC16201	Physics and Chemistry Laboratory II	0	0	2	1
CS16202	Computer Programming Laboratory	0	0	2	1
EN16202	English Communication Skills Laboratory	0	0	2	1

OBJECTIVES

To enable students to

- understand the concepts of Eigen values and Eigen vectors of real matrices and its applications in the process of diagonalization of real symmetric matrices.
- study applications of Rolle's and Mean Value Theorems and also to understand the concept of maxima and minima using derivatives.
- learn the concept of partial differentiation and its applications to maxima and minima of functions of two or more variables.
- develop a thorough knowledge of definite and indefinite integrals
- learn the concepts of multiple integrals and their applications

15

UNIT I MATRICES

Characteristic equation – Eigenvalues and Eigenvectors of a real matrix – Properties – Cayley-Hamilton theorem (excluding proof) – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT II DIFFERENTIAL CALCULUS

15

Limit – Continuity, properties of limit and classification of discontinuities - Simple problems. Differentiation – Standard forms, Successive differentiation and Leibnitz theorem. Mean value theorem – Rolle's theorem – maxima, minima using first and second derivative tests.

UNIT III FUNCTIONS OF SEVERAL VARIABLES

15

Partial derivatives – Euler's theorem for homogenous functions – Total derivatives – Differentiation of Implicit functions – Jacobians – Taylor's expansion – Maxima and Minima – Method of Lagrangian multipliers.

UNIT IV INTEGRAL CALCULUS

15

Indefinite and definite integrals - Properties of integrals, Integration of simple function. Methods of Integration – Integration by parts – Reduction formulae involving exponential and trigonometric functions, Bernoulli's formula.

UNIT V MULTIPLE INTEGRALS

15

Double integration – Cartesian and polar coordinates – Change of order of integration – Triple integration in Cartesian co-ordinates – Area as double integral – Volume as triple integral.

TOTAL : 75 PERIODS

OUTCOMES

At the end of this course, the students will be able to

- determine eigen values and eigen vectors and diagonalize real symmetric matrices.
- classify various types of functions involved in engineering fields, their differentiation techniques and applications
- find partial derivatives and apply the same to find maxima and minima of two or more variables
- implement different methods of integration used in engineering problems
- execute suitable integration techniques to calculate surface areas and volumes.

TEXT BOOKS

1. Grewal. B.S, “Higher Engineering Mathematics”, 41st Edition, Khanna Publications, Delhi, (2011).
2. P.Jayakumar, and Dr.B.Kishokkumar “Matrices and Calculus”, Global Publishers, Chennai.,(2015).
3. T. Veerarajan., “Engineering Mathematics”, 3rd Edition, Tata McGraw Hill, (2011).

REFERENCES

1. Erwin Kreyszig., “Advanced Engineering Mathematics” 10th Edition, Wiley Publications.
2. Dass, H.K., and Er. Rajnish Verma, “Higher Engineering Mathematics”, S. Chand Private Ltd.,(2011).
3. Glyn James, “Advanced Modern Engineering Mathematics”, 3rd Edition, Pearson Education,(2012).
4. Ramana B.V, “Higher Engineering Mathematics”, Tata McGraw Hill Publishing Company, New Delhi, (2008).

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	-	1	2	3
CO2	3	3	2	3	-	-	-	-	-	-	-	1	2	3
CO3	3	2	2	3	-	-	-	-	-	-	-	1	2	3
CO4	3	2	3	1	-	-	-	-	-	-	-	1	2	3
CO5	3	2	2	2	-	-	-	-	-	-	-	1	2	3



COURSE OBJECTIVES

- To enable the students with various concepts like dimensioning, conventions and standards related to Engineering Drawing
- To impart knowledge on the projection of points, lines and plane surfaces
- To improve the visualization skills for better understanding of projection of solids
- To develop the imaginative skills of the students required to understand Section of solids and Developments of surfaces
- To make the students understand the viewing perception of a solid object in Isometric and Perspective projections

Concepts and Conventions (Not for Examination)

2

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREE HAND SKETCHING

14

Curves Used In Engineering Practices:

Conics – Construction of ellipse, Parabola and hyperbola by eccentricity method – Construction of cycloid, Epicycloid and Hypocycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Construction of spiral curve.

Free Hand Sketching:

Representation of Three Dimensional objects – General principles of orthographic projection – Need for importance of multiple views and their placement – First angle projection – layout views – Developing visualization skills through free hand sketching of multiple views from pictorial views of objects.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACES

14

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes -Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS

12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES

14

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral

surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS

14

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

INTRODUCTION TO INTERSECTION OF SOLIDS (Not for Examination)

5

Introduction to intersection of surfaces – Line of intersection – Intersection of solids

TOTAL: 75 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- perform free hand sketching of basic geometrical constructions and multiple views of objects
- draw the projections of points, straight lines and plane surfaces in given quadrant
- understand the projection of solids in various positions in first quadrant
- draw projections and solids and development of surfaces
- prepare isometric and perspective sections of simple solids

TEXT BOOKS

1. Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2009.
2. S.Prabhakaran, M.Makesh, V. Subburam, “Engineering Graphics”, Sams Publishers, Chennai, 2015.

REFERENCES

1. Gopalakrishnan K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
2. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
3. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 2nd Edition, 2009.
4. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2008.
5. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.

WEBLINKS

1. <http://www.nptel.ac.in/courses/112103019>
2. <http://www.engineeringdrawing.org/>
3. <http://www.mechanical.in/engineering-graphics/>

PUBLICATION OF BUREAU OF INDIAN STANDARDS

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	-	-	-	-	1	1	2	1
CO2	3	3	3	3	3	1	-	-	-	-	1	1	2	1
CO3	3	3	3	3	3	1	-	-	-	-	1	1	2	1
CO4	3	3	3	3	3	1	-	-	-	-	1	1	2	1
CO5	3	3	3	3	3	1	-	-	-	-	1	1	2	1



COURSE OBJECTIVES:

- To impart the knowledge of aeromodelling.
- To study the materials used in aircrafts.
- To gain knowledge of various aircrafts types.
- To learn about basics of design and calculations.
- To learn about glider design

LIST OF EXPERIMENTS

1. Study about historical background of aircrafts
2. Study of components of aircrafts and its functions
3. Construction of glider models using different materials
4. Construction of wings
5. Construction of fuselage
6. Construction of tail plane
7. Assembly of the aircraft models
8. Construction of aircraft
9. Calculation of Endurance, Range, time and CG

COURSE OUTCOMES:

At the end of the course, the students will be able to

- familiarized with the basic principles of aircraft design, building and operations.
- understanding of the basic characteristics involved in the assembly of aircraft models.
- understand the basic calculation of endurance, range and C.G
- develop their creative and innovative ideas
- understand the process involved in aeromodelling.

TOTAL: 30 PERIODS

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	1	-	1	1	1	-	-	-	1	1	1	2	1	1
CO2	1	-	2	1	2	-	-	-	2	1	2	2	2	1
CO3	2	-	2	2	2	-	-	-	2	2	2	2	2	2
CO4	2	-	1	2	1	-	-	-	1	1	1	2	1	1
CO5	1	-	2	1	2	-	-	-	2	2	2	2	2	2



**DIFFERENTIAL EQUATIONS AND COMPLEX
MA 16201 ANALYSIS
(Common to all branches)**

3 2 0 4

OBJECTIVES

To enable students to

- discuss a wide range of basic mathematical methods for solving different types of problems arising in the fields of Science, Mathematics and Engineering.
- acquire sound knowledge in solving ordinary differential equations that model engineering problems.
- understand the concept of vector calculus, which is applied in all engineering disciplines.
- know the standard techniques of complex variable theory.
- learn the purpose of using transforms and to create a new domain

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 15

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

UNIT II VECTOR CALCULUS 15

Gradient, Divergence and Curl – Directional derivative – Irrotational and solenoidal vector fields. – Vector integration – verifications of Green's, Gauss divergence and Stokes' theorem – simple applications.

UNIT III ANALYTIC FUNCTIONS 15

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy – Riemann equation and Sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic

UNIT IV COMPLEX INTEGRATION 15

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor and Laurent expansions – Singular points – Residues – Residue theorem – Contour integration.

UNIT V LAPLACE TRANSFORM 15

Laplace transform – Transform of elementary functions – Basic properties – Definition of Inverse Laplace transform as contour integral – Convolution theorem (excluding proof) – Initial and Final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

TOTAL: 75 PERIODS

OUTCOMES

At the end of this course, the students will be able to

- solve differential equations
- study the basics of vector calculus comprising of gradient, divergence and curl and line, surface and volume integrals and the classical theorems.
- know the concepts of analytic functions and its properties and apply it in conformal mapping.
- gain knowledge in the basics of complex integration and the concept of contour integration which is an important tool for evaluation of certain integrals encountered in practice.
- solve Laplace transform and its properties and give sufficient exposure to the solution of certain linear differential equations.

TEXT BOOKS

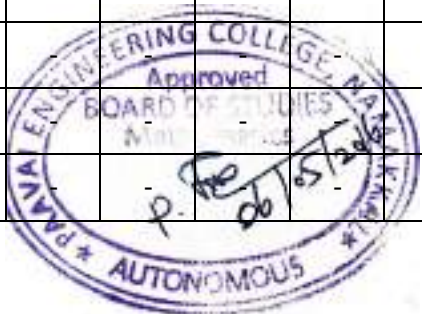
1. Grewal. B.S, “Higher Engineering Mathematics”, 41st Edition, Khanna Publications, Delhi,(2011).
2. P.Jayakumar, and Dr.B.Kishokkumar, “Differential Equations and Complex Analysis”, Global Publishers, Chennai.,(2015).
3. Erwin Kreyszig., “Advanced Engineering Mathematics” 10th Edition, Wiley Publications.

REFERENCES

1. Dass, H.K., and Er. RajnishVerma, “Higher Engineering Mathematics”, S. Chand Private Ltd.,(2011).
2. T. Veerarajan., “Engineering Mathematics”, 3rd Edition, Tata McGraw Hill, 2011.
3. Peter V. O’Neil, “Advanced Engineering Mathematics”, 7th Edition, Cengage learning, (2012).
4. Ramana B.V, “Higher Engineering Mathematics”, Tata McGraw Hill Publishing Company, New Delhi, (2008).

Mapping of Course Outcomes with Programme Outcomes
(1/2/3 indicates strength of correlation) 3-strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	-	-	-	-	-	-	-	2	3	3
CO2	3	2	3	2	-	-	-	-	-	-	-	3	3	3
CO3	3	3	3	2	-	-	-	-	-	-	-	2	3	3
CO4	3	2	3	3	-	-	-	-	-	-	-	3	3	3
CO5	3	3	2	3	-	-	-	-	-	-	-	3	3	3



COURSE OBJECTIVES

- To learn the organization of a digital computer.
- To be exposed to the number systems.
- To think logically and write pseudo code or draw flow charts for problems.
- To be familiar with programming in C.
- To use arrays, strings, functions, pointers, structures and unions in C.

UNIT I INTRODUCTION TO COMPUTERS 9

Introduction – Characteristics of Computers – Evolution of Computers – Computer Generations – Classification of Computers – Basic Computer organization – Number Systems. Computer Software –Types of Software – Software Development Steps – Internet Evolution - Basic Internet Terminology – Getting connected to Internet Applications. Problem Solving Techniques- Planning the Computer Program – Purpose – Algorithm – Flow Charts – Pseudo code. Application Software Packages- Introduction to Office Packages (notdetailed commands for examination).

UNIT II BASICS OF 'C' LANGUAGE 9

Overview of C – Constants, Variables and Data Types – Operators and Expressions – Managing Input and Output operators – Decision Making - Branching and Looping.

UNIT III ARRAYS AND STRINGS 9

Array Concepts- Two Dimensional Array - Passing Arrays to Functions - Multi Dimensional Array. String Operations - Sorting and Searching

UNIT IV FUNCTIONS AND POINTERS 9

Functions – Function Prototypes – Parameter Passing Methods – Recursion – Library Functions. Pointers – Pointers and Functions – Pointers and Strings – Operations on Pointers – Dynamic Memory Allocation

UNIT V STRUCTURE, UNIONS AND FILE HANDLING 9

Structures and Union – Declaring, Accessing, Initialization, Structure assignment, Nested Structure, Array of Structure. File Handling Functions

TOTAL: 45 PERIODS**COURSE OUTCOMES**

At the end of this course, the students will be able to

- gain knowledge about number systems.
- work in office package.
- understand basic concepts of C programs.
- obtain knowledge about user defined function and scope of variables in C.
- acquire knowledge for handling arrays, strings, functions, pointers, structures and unions in C.

TEXT BOOKS

1. Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
2. Pradip Dey, Manas Ghosh, “Fundamentals of Computing and Programming in C”, First Edition, Oxford University Press, 2009.
3. Yashavant P. Kanetkar. “Let Us C”, BPB Publications, 2011.

REFERENCES

1. Byron Gottfried, “Programming with C”, 3rd Edition, (Indian Adapted Edition), TMH publications, 2010.
2. Stephen G.Kochan, “Programming in C”, 5th Edition, Pearson Education India, (2011).
3. Brian W.Kernighan and Dennis M.Ritchie, “The C Programming Language”, Pearson Education Inc., (2009).
4. E.Balagurusamy, “Computing fundamentals and C Programming”, Tata McGraw-Hill Publishing Company Limited, (2011).
5. Dromey R.G., “How to Solve it by Computer”, Pearson Education, Fifth Reprint, 2009.

Mapping of Course Outcomes with Programming Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	1	2	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	1	1	3
CO5	3	1	3	-	-	2	-	-	-	-	-	3	3	2



COURSE OBJECTIVES

To enable the students to

- study about the various metal casting and welding process followed in industries
- introduce the various metallic and non-metallic engineering materials used in aircraft applications and their test methods.
- understand the effect of corrosion in the aircraft materials and its prevention methods.
- learn the heat treatment process of ferrous and non-ferrous materials.
- know the basic concepts of composite materials and its applications.

UNIT I CASTING 8

Casting types, procedure to make sand mould, types of core making, moulding tools, machine moulding, special moulding processes – CO₂ moulding; shell moulding, investment moulding, permanent mould casting, pressure die casting, centrifugal casting, continuous casting, casting defects.

UNIT II WELDING 8

Classification of welding processes. Principles of Oxy-acetylene gas welding. A.C metal arc welding, resistance welding, submerged arc welding, tungsten inert gas welding, metal inert gas welding, plasma arc welding, thermit welding, electron beam welding, laser beam welding, defects in welding, soldering and brazing.

UNIT III MACHINING 10

General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, Universal drilling machine, cylindrical grinding machine, Capstan and Turret lathe. Basics of CNC machines. General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Plasma arc machining, Electron beam machining and Laser beam machining.

UNIT IV AIRCRAFT METAL ALLOYS AND SUPERALLOYS 10

Aluminum alloys, Magnesium alloys, Titanium alloys, Plain carbon and Low carbon Steels, Corrosion and Heat resistant steels, Maraging steels, Copper alloys, Producibility and Surface treatments for each of the above – Super alloys, Nickel based super alloys, Cobalt based super alloys, and Iron based super alloys, manufacturing processes associated with super alloys, Heat treatment and surface treatment of super alloys.

UNIT V AIRCRAFT COMPOSITE MATERIALS AND NON METALLIC 9

Composite materials – GFRP, CFRP, MMC, GLARE – Classification and properties of wood, plywood and applications – Ablation process-ablative materials- super conducting materials matrix materials- their applications – Purpose of Doping – Adhesives – Aircraft paints – Rubber and Rubber materials.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- demonstrate about different manufacturing process and applications in industry for component production
- analyze the properties of different aircraft materials.
- compare the properties of various alloys for aerospace application.

- conduct the heat treatment and surface treatment process for various alloys.
- identify the suitable materials for different parts of the aircraft.

TEXT BOOKS

1. Nagendra Parashar B.S. and Mittal R.K., "Elements of Manufacturing Processes", Prentice-Hall of India Private Limited, 2007
2. Hajra Choudhury, "Elements of Workshop Technology", Vol. I, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2010.

REFERENCES

1. Krishnadas Nair C G, „Handbook of Aircraft Materials“, First Edition, Interline Publishers, Bangalore, 1993.
2. Serope Kalpakjian, Steven R.Schmid, "Manufacturing Processes for Engineering Materials", Fourth Edition, Pearson Education, Inc. 2007.
3. Horst Buhl (Ed.), „Advanced Aerospace Materials“, Springer-Verlag, 1992.
4. George Francis Titterton, „Aircraft Material and Processes“, Fifth Edition, Sterling Book House, Mumbai, 1998
5. Hajra Choudhury, "Elements of Workshop Technology", Vol. II, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2010.

WEB LINKS

1. <http://www.nptelvideos.in/2012/12/advanced-materials-and-processes.html>
2. <http://nptel.ac.in/courses/112107144/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	3	3	2	-	3	-	-	-	-	2	3	3
CO2	-	2	2	3	3	-	2	-	-	-	-	2	3	2
CO3	-	2	3	3	2	-	2	-	-	-	-	2	2	3
CO4	-	3	2	2	3	-	3	-	-	-	-	2	2	2
CO5	-	3	3	2	3	-	3	-	-	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- introduce the basic concepts of and history of aircrafts
- infer the basic principles on which the development of aerodynamics and other principal sub disciplines of aerospace engineering are based.
- learn about the various structures of aircraft
study about the aircraft power plants and its applications
- gather knowledge in basics of space mechanics

UNIT I AIRCRAFT CONFIGURATIONS

9

History of Flight. Different types of flight vehicles, classifications. Components of an airplane and their functions. Conventional control, powered control, basic instruments for flying - typical systems for control actuation.

UNIT II BASICS OF FLIGHT MECHANICS

9

Physical properties and structure of the atmosphere, temperature, pressure and altitude relationships, newton's law of motions applied to aeronautics - evolution of lift, drag and moment. Aerofoil, mach number, maneuvers.

UNIT III AIRPLANE STRUCTURES

9

General types of construction, monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Stresses and strains – Hooke's law – stress - strain diagrams – elastic constants.

UNIT IV POWER PLANTS

9

Basic ideas about piston, turboprop and jet engines - use of propeller and jets for thrust production - comparative merits, principles of operation of rocket, types of rockets and typical applications, exploration into space.

UNIT V BASICS OF SPACE MECHANICS

9

Kepler's laws – Newton's Law of Gravity – Solar System – solar eclipse-celestial sphere. Fundamentals of orbital mechanics- Space environment (atmosphere, radiation & magnetic fields)

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of this course, students will be able to

- classify the components of Aircraft and the basic instruments
- perform basic calculation on Mechanics using Newton law for lift, drag and moment.
- select the suitable materials for Aircraft structure
- identify the types of Power plants and its applications
- carry out and analyze simple calculation about space mechanics

TEXT BOOKS

1. Anderson, J.D., "Introduction to Flight", McGraw-Hill, 2015.
2. Stephen. A. Brandt, "Introduction to Aeronautics: A design perspective" American Institute of Aeronautics & Astronautics, 1997

REFERENCES

1. Wiesel, William E., Spaceflight Dynamics, Tata McGraw Hill Publishing Company Limited New Delhi.
2. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 2012
3. Shevell R.S., „Fundamentals of Flight", Pearson Education, 2012.
4. Vallado, David A., Fundamentals of Astrodynamics and Applications, Kluwer Academic Publishers, London.
5. William J. Astore , Robert B. Giffen , Wiley J. Larson .,Understanding Space: An Introduction to Astronautics, 3rd Edition (SpaceTechnology) , Jerry Jon Sellers.

WEB LINKS

1. <http://aeronautics.hpage.com/>
2. http://technicalsymposium.com/lecturenotes_AERO_3SEM_111305NOL.html

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	-	-	2	3	-	-	-	-	2	3	2
CO2	2	3	3	3	2	2	3	-	-	-	-	2	3	2
CO3	3	2	1	2	2	-	-	-	-	-	2	2	2	2
CO4	-	2	2	2	3	-	-	-	-	-	-	2	3	2
CO5	3	2	2	3	3	-	-	-	-	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- study about the basic fluid properties and flow characteristics
- apply the conservation laws to flow through pipes and hydraulic machines
- know the importance of dimensional analysis.
- study about the various types of pumps and its applications.
- understand the importance of various types of flow in turbines.

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS**6**

Units and dimensions-Properties of fluids. Flow characteristics – concept of control volume - application of continuity equation, energy equation and momentum equation.

UNIT II FLOW THROUGH CIRCULAR CONDUITS**9**

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli-Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation –friction factor- Moody diagram-commercial pipes- minor losses – **Flow through pipes in series and parallel.**

UNIT III DIMENSIONAL ANALYSIS**10**

Need for dimensional analysis – methods of dimensional analysis – Similitude –types of similitude - Dimensionless parameters- application of dimensionless parameters – Model analysis.

UNIT IV PUMPS**10**

Impact of jets - Euler's equation - Theory of roto-dynamic machines – various efficiencies– velocity components at entry and exit of the rotor- velocity triangles - **Centrifugal pumps**– working principle - work done by the impeller - performance curves - Reciprocating pump- working principle – **Rotary pumps** –classification.

UNIT V TURBINES**10**

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. **Pelton wheel, Francis turbine and Kaplan turbines**- working principles - work done by water on the runner – draft tube. Specific speed - unit quantities – performance curves for turbines – governing of turbines.

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of this course, students will be able to

- apply mathematical knowledge to predict the properties and characteristics of a fluid.
- perform the flow analysis in circular pipes
- identify about the concepts involved in dimensional analysis
- analyze the performance of pumps and its industrial applications.
- execute the performance calculations of turbines.

TEXT BOOKS

1. White F, Fluid „Mechanics“,5th Edition, Tata McGraw-Hill, , New Delhi, 2011.
2. Nodi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2009.

REFERENCES

1. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010
2. Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2010
3. Philip J. Pritchard, „Fox and McDonald's Introduction to Fluid Mechanics", Eighth Edition, Wiley, 2011.
4. Yunus A. Cengel and John M. Cimbala, „Fluid Mechanics: Fundamentals and Applications", Third Edition, McGraw-Hill, 2013.
5. R. K. Bansal, „Fluid Mechanics", Laxmi Publications (P) Ltd, 2008.

WEB LINKS

1. <http://www.nptelvideos.in/2012/11/fluid-mechanics.html>
2. <http://nptel.ac.in/courses/112105182/#>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	3	2	-	-	-	-	-	-	2	3	2
CO2	1	3	2	2	3	-	-	-	-	-	-	2	3	2
CO3	2	2	3	3	2	3	-	-	-	-	-	2	2	2
CO4	3	2	2	2	2	2	-	-	-	-	2	2	3	2
CO5	3	1	3	2	3	3	-	-	-	-	3	2	3	2



COURSE OBJECTIVES

To enable the students to

- study the behavior of materials due to axial, bending, tensional and combined loads.
- infer the knowledge of Stresses in various beams of mechanical, civil and aeronautical engineering
- study about the bending of beams with its various methods.
- know the application of torsion for various material sections.
- understand the basic concepts of bi axial Stresses with pressure for different sections.

UNIT I BASICS AND AXIAL LOADING**9**

Stress and Strain – Hooke's Law – Elastic constants and their relationship – Volumetric strain, Bar with uniform and varying section – composite bar. Thermal Stresses – stresses due to freely falling weight.

UNIT II STRESSES IN BEAMS**9**

Shear force and bending moment diagrams for simply supported and cantilever beams with concentrated load and uniformly distributed – Bending stresses in straight beams – Shear Stresses in bending of beams with various cross sections – beams of uniform strength.

UNIT III DEFLECTION OF BEAMS**9**

Double integration method – McCauley's method – Area moment method – Conjugate beam method.

UNIT IV TORSION**9**

Torsion of circular shafts - shear stresses and twist in solid and hollow circular shafts – closely coiled helical springs.

UNIT V BI AXIAL STRESSES**9**

Stresses in thin circular cylinder and spherical shell under internal pressure. Combined loading – Principal Stresses and maximum Shear Stresses - Analytical and Graphical methods.

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of this course, students will be able to

- understand principles of mathematics, basic sciences and engineering.
- analyze the stress and bending of beams in structures
- apply knowledge of science and engineering principles to solve aeronautical engineering problems.
- perform the torsion analysis process of beam sections
- acquire knowledge about the Bi Axial stress in structures

TEXT BOOKS

1. Stephen Timoshenko, James M. Gere "Mechanics of materials" Van Nostrand Reinhold Co., 1972.
2. Rajput R.K "Strength of Materials" S.Chand and Company Ltd, 2012

REFERENCES

1. Stephen Timoshenko and D. H. Young, Elements of strength Materials, Vol. I and Vol. II, T. Van Nostrand Co-Inc Princeton- N.J
2. Dym C L and I. H. Shames, „Solid Mechanics“, 2013.
3. Nash William, „Strength of Materials“, TMH, 2010.
4. Timoshenko S, „Strength of Materials“, Vol. II, CBS Publishers, 2002.
5. Srinath L.S., „Advanced Mechanics of Solids“, Tata McGraw-Hill Publishing Co., New Delhi, 2003.

WEB LINKS

1. <http://www.nptelvideos.in/2012/11/mechanics-of-solids.html>
2. <http://web.mit.edu/emech/dontindex>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	2	-	-	-	-	-	-	3	2	3	2
CO2	2	3	1	2	-	-	-	-	-	-	2	2	3	2
CO3	2	3	2	3	-	-	-	-	-	-	3	2	2	2
CO4	2	3	2	3	-	-	-	-	-	-	2	2	3	2
CO5	3	2	2	2	-	-	-	-	-	-	2	2	3	2



COURSE OBJECTIVES

To enable the students to

- understand the principles and basics of thermodynamics.
- study about the various air cycles and its applications.
- provide in-depth study of thermodynamic principles, thermodynamics of state, basic thermodynamic relations, properties of pure substances.
- infer the concept of air-conditioning and its concepts
- enlighten the basic concepts of heat transfer and propulsion cycles.

UNIT I BASIC THERMODYNAMICS

9

Systems – Zeroth Law, First Law – Heat and work transfer in flow and non-flow processes – Difference in heat capacities, Ratio of specific heats – Second law, Kelvin Planck statement – Clausius statement – Concept of entropy – Entropy change in non-flow processes – T-S equations for entropy change – Numerical Problems.

UNIT II AIR CYCLES

9

Air standard cycle approximations – Otto, Diesel Cycles – P-v and T-s diagrams –Description – Efficiency, Mean Effective Pressure – Comparison of Otto, Diesel cycles for same compression ratio and heat input – Dual cycles – P-v and T-s diagrams – Brayton cycle for open and closed systems – Efficiency of gas turbine cycle – Numerical problems.

UNIT III THERMODYNAMICS OF ONE DIMENSIONAL FLUID FLOW

9

Application of continuity, momentum and energy equations- Rankine cycle - Isentropic flow of ideal gases through nozzles - Simple jet propulsion system - Thrust rocket motor – Specific impulse.

UNIT IV AIR CONDITIONING

9

Principles of refrigeration, Air conditioning – Vapour compression – Vapour absorption types –Air cycle machine – Humidity control – Coefficient of performance – Properties of refrigerants

UNIT V BASICS OF HEAT TRANSFER

9

Types of heat transfer-free convection-forced convection- specific impulse – ideal and non- ideal cycle analysis - conduction in parallel, radial and composite wall.

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of this course, students will be able to

- apply thermodynamic laws to solve the complex engineering problems.
- explain the principles of continuity, momentum and energy equation to solve the problems in simple jet propulsion systems.
- determine the efficiency and net work of the otto, diesel, and brayton cycles, and to make connections between these cycles and aircraft propulsion systems.
- calculate the design parameters for various air conditioning components.
- apply the basic concepts of heat transfer to solve the various engineering problems

TEXT BOOKS

1. Nag P K, „Engineering Thermodynamics“, Fifth Edition, Tata McGraw-Hill, 2013.
2. Rathakrishnan, E, „Fundamentals of Engineering Thermodynamics“, Prentice Hall, 2005.

REFERENCES

1. Gordon J. Van Wylen and Richard E. Sonntag, „Fundamentals of Classical Thermodynamics“, Sixth Edition, Wiley Publication, 2003.
2. Yunus A. Çengel and Michael A. Boles, „Thermodynamics an Engineering Approach“, Seventh Edition, Tata McGraw-Hill, 2010.
3. Oates, G.C., „Aero Thermodynamics of Aircraft Engine Components“, AIAA Education Series, New York, 1985.
4. Holman.J.P., „Thermodynamics“, 3rd Edition, McGraw-Hill, 1995.
5. Prasanna Kumar: Thermodynamics “Engineering Thermodynamics” Pearson Education, 2013

WEB LINKS

1. http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/Basic_Thermodynamics/ui/TOC.htm
2. <http://nptel.ac.in/courses/112105123/1>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	3	2	-	-	-	-	-	-	2	3	2
CO2	2	3	1	3	3	-	-	-	-	-	-	2	3	2
CO3	-	3	2	2	2	2	3	-	-	-	-	2	2	2
CO4	3	2	2	3	2	3	2	-	-	-	-	2	3	2
CO5	2	3	2	3	3	2	2	-	-	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- study and experiment the flow measurement and the performance of the various fluid machinery
- familiarize the basic flow on the turbines
- impart the knowledge of pumps
- learn about the viscosity

LIST OF EXPERIMENTS

1. Calibration of venturimeter
2. Pressure measurement with pitot static tube
3. Determination of pipe flow losses
4. Verification of Bernoulli's theorem
5. Flow visualization by Heleshaw apparatus
6. Performance test on centrifugal pumps
7. Performance test on reciprocating pumps
8. Performance test on piston wheel turbine
9. Performance test on Francis turbine
10. Determination of Viscosity of a Fluid

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- gain the knowledge measurement equipments for flow measurement
- perform the flow visualization of various apparatus
- analyze the performance thrust on different fluid machinery pumps
- analyze the problems in turbine

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2	3	-	-	-	-	-	-	2	3	2
CO2	1	3	3	2	2	-	-	-	-	-	-	2	3	2
CO3	3	2	2	3	3	2	-	-	-	-	-	2	2	2
CO4	3	2	3	3	2	2	-	-	-	-	3	2	3	2



COURSE OBJECTIVES

- impart the knowledge in testing the materials for hardness, fatigue, impact, tension and torsion.
- familiarize the hardness of materials
- impart the knowledge of strength of materials
- learn about the Fatigue

LIST OF EXPERIMENTS

1. Determine the BHN using Brinell Hardness Test
2. Determine the RHN using Rockwell Hardness test
3. Determine the Tension of various Materials using Tension test
4. Determine the Torsion of Various Materials using Torsion test
5. Determine the Impact Strength value by using Izod Impact test
6. Determine the Impact Strength value by using Charpy Impact test
7. Perform the Reverse plate bending Fatigue test
8. Perform the Rotating Beam Fatigue test
9. Testing of springs
10. Perform the Block Compression Test for various Materials

TOTAL PERIODS 60**COURSE OUTCOMES**

At the end of this course, students will be able to

- perform different destructive testing
- gain knowledge of torsion, Fatigue and Tension
- characterize materials by its strength values
- perform compression test of various materials and springs

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	1	-	-	-	-	-	-	-	2	3	2
CO2	2	3	3	2	-	-	-	-	-	-	-	2	3	2
CO3	2	3	2	3	-	-	-	-	-	-	-	2	2	2
CO4	2	3	2	3	-	-	-	-	-	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- enhance and experiment the basic knowledge in applied thermodynamics and engines
- familiarize the flow of heat exchanger
- impart the knowledge of air-condition
- learn about the thermal conductivity

LIST OF EXPERIMENTS

1. Performance test on a 4-stroke engine
2. Valve timing of a 4 – stroke engine and port timing of a 2 stroke engine
3. Determination of effectiveness of a parallel flow heat exchanger
4. Determination of effectiveness of a counter flow heat exchanger
5. Determination of heating value of a fuel
6. COP test on a vapour compression refrigeration test rig
7. COP test on a vapour compression air-conditioning test rig
8. Determination of specific heat of solid
9. Determination of Thermal Conductivity of solid.
10. Determination of Thermal Resistance of a Composite wall.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- perform test on diesel/petrol engine
- explain the characteristics of the diesel/petrol engine
- compute the properties of the fuels.
- calculate performance coefficients of vapour compression systems

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
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CO1	-	3	-	2	3	2	-	-	2	2	-	2	3	2
CO2	2	3	2	3	-	3	-	-	1	-	2	2	3	2
CO3	2	3	-	3	-	2	3	-	3	-	3	2	2	2
CO4	3	-	1	-	2	2	2	-	2	-	3	2	3	2



COURSE OBJECTIVES

To enable the students to

- introduce the concepts of mass, momentum and energy conservation relating to aerodynamics.
- make the student to understand the concept of vorticity, irrotationality, theory of airfoils and wing sections.
- study the conformal transformation process.
- introduce the basics of airfoil wing theory and its applications.
- learn the boundary layer theory and its problems

UNIT I INTRODUCTION TO AERODYNAMICS**9**

Aerodynamic forces and moments – Pressure distribution on an airfoil – Types of drag – 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.

UNIT II TWO DIMENSIONAL FLOWS**9**

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, D'Alembert Paradox, Magnus effect-Numerical Problems

UNIT III CONFORMAL TRANSFORMATION**8**

Joukowski transformation and its application to fluid flow problems, Joukowski, and Karman-Trefftz Profiles-Numerical Problems.

UNIT IV AIRFOIL AND WING THEORY**10**

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

UNIT V INTRODUCTION TO BOUNDARY LAYER THEORY**9**

Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, energy thickness, shape parameter, boundary layer equations for a steady, two dimensional incompressible flow, boundary layer growth over a flat plate, critical Reynolds number, Blasius solution, basics of turbulent flow

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of this course, students will be able to

- apply airfoil theory to predict airfoil performance and behavior of airflow over bodies
- analyze and optimize the aircraft wing performance.
- perform the dimensional analysis in two dimensions
- analyze the problems of incompressible flow for airfoils
- explain the properties of boundary layer

TEXT BOOKS

1. Anderson, J.D., „Fundamentals of Aerodynamics”, Fifth Edition, McGraw-Hill Book Co., New York, 2012.
2. Houghton E L, P. W. Carpenter, Steven H. Collicott, and Daniel T. Valentine, „Aerodynamics for Engineering Students”, Sixth Edition, Butterworth-Heinemann, 2012.

REFERENCES

1. Clancy, L.J., „Aerodynamics”, Pitman, 1986.
2. Kuethe A M and C-Y Chow, „Foundations of Aerodynamics: Bases of Aerodynamic Design”, Fifth Edition, Wiley, 1997.
3. John J. Bertin and Russell M. Cummings, „Aerodynamics for Engineers”, Sixth Edition, Pearson, 2013.

WEB LINKS

1. <http://nptel.ac.in/courses/101105059/>
2. <http://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005/lecture-notes/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	3	2	-	-	-	-	-	-	2	3	2
CO2	2	3	1	3	2	-	2	-	-	-	-	2	3	2
CO3	2	3	2	2	3	2	-	-	-	-	-	2	2	2
CO4	-	2	2	3	2	2	-	-	-	-	-	2	3	2
CO5	2	3	2	3	3	3	2	-	-	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- introduce basic concepts and salient features of engine components of jet propelled engines which are operated in atmosphere to students.
- familiarize with jet propulsion components and its methods.
- understand the performance and types of combustion chambers and nozzles.
- study about the details of compressor of jet propulsion and hypersonic propulsion
- infer about the working of turbines and its applications

UNIT I FUNDAMENTALS OF AIR BREATHING ENGINES 9

Classification of gas turbines – open cycle and closed cycle turbines, efficiencies - illustration of working of gas turbine engine – the thrust equation – factors affecting thrust – effect of pressure, velocity and temperature changes of air entering compressor – methods of thrust augmentation – characteristics of turboprop, turbofan and turbojet – performance characteristics.

UNIT II INLETS FOR JET ENGINES 9

Internal flow and Stall in subsonic inlets – relation between minimum area ratio and external deceleration ratio – diffuser performance – supersonic inlets – starting problem on supersonic inlets – shock swallowing by area variation – Numerical problems

UNIT III COMBUSTION CHAMBERS AND NOZZLES 10

Classification of combustion chambers – combustion chamber performance – effect of operating variables on performance – flame stabilization real flow in nozzles and nozzle efficiency – losses in nozzles – equilibrium flow and frozen flow in nozzles- two phase flow in nozzles – ejector and variable area nozzles - interaction of nozzle flow with adjacent surfaces – thrust reversal- Numerical Problems

UNIT IV COMPRESSORS FOR JET ENGINES 8

Principle of operation of centrifugal compressor and axial flow compressor– Work done and pressure rise – velocity diagrams – degree of reaction – free vortex and constant reaction designs of axial flow compressor – performance characteristics of centrifugal and axial flow compressors

UNIT V TURBINES FOR JET ENGINES 9

Impulse and reaction blading of gas turbines – velocity triangles and power output – elementary theory – vortex theory – choice of blade profile, pitch and chord – estimation of stage performance – limiting factors in gas turbine design- overall turbine performance – methods of blade cooling – matching of turbine and compressor – numerical problems.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- identify the engine components of jet propelled engines analyze thermodynamics of an aircraft jet engine
- estimate the best possible engine performance
- assess the internal mechanisms of gas turbine engine components
- evaluate the operating characteristics of compressors and Turbines
- examine the working of turbine

TEXT BOOKS

1. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 2009.
2. James Award, "Aerospace Propulsion System", Wiley, 2010

REFERENCES

1. Cohen, H. Rogers, G.F.C. and Saravanan, H.I.H. "Gas Turbine Theory", Longman, 2006.
2. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.
3. Rolls Royce, "Jet Engine", 5th Edition, Rolls Royce Technical Publications, 2015.
4. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 2010.
5. Ganesan, V., "Gas Turbines", Third Edition, Tata McGraw-Hill, 2010.

WEB LINKS

1. <http://nptel.ac.in/courses/101101001/>
2. <http://www.nptelvideos.in/2012/11/jet-aircraft-propulsion.html>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
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CO3	-	3	2	2	3	3	-	-	-	-	3	3	2	2
CO4	-	2	2	3	2	3	2	-	2	-	3	2	3	2
CO5	-	3	2	3	3	3	2	-	2	-	2	2	3	2



COURSE OBJECTIVES

To enable the students to

- provide the students an understanding on the aircraft basic structures
- infer about the indeterminate and determinate aircraft structural components.
- learn about various energy methods and its applications
- study about the column and loading functions
- offer the design process using different failure theories

UNIT I INTRODUCTION TO AIRCRAFT STRUCTURES 15

Aircraft construction methods – Components of Semi-monocoque structure – Component loads – Stress types - Stress-strain relation – Strain-displacement relations – Equations of equilibrium – Strain tensor – Lamé's constant - cubical dilation

UNIT II STATICALLY DETERMINATE AND INDETERMINATE STRUCTURE 15

Truss analysis – Method of joints – Method of sections – Clapeyron's three moment equation – **Moment distribution method.**

UNIT III ENERGY METHODS 15

Strain energy due to axial, bending and torsional loads – Castigliano's theorem – Maxwell's reciprocal theorem, unit load method – Application to beams, trusses, frames, rings, etc.

UNIT IV COLUMNS 15

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

UNIT V FAILURE THEORY 15

Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory - Maximum Strain energy theory – Application to aircraft Structural problems.

TOTAL PERIODS 75

COURSE OUTCOMES

At the end of this course, students will be able to

- understand different aircraft structures.
- calculate the response of statically indeterminate structures under various loading conditions.
- apply the reaction forces of structures using strain energy concept.
- create a structure to carry the given load.
- examine the structural failures using failure theories

TEXT BOOKS

1. Donaldson B.K, "Analysis of Aircraft Structures – An Introduction", 2nd Edition, Cambridge University Press.
2. Megson T.H.G, "Aircraft Structures for Engineering Students" 4th Edition, Elsevier AerospaceEngineering Series, 2007.

REFERENCES

1. Prof S K Maiti, "Advanced Strength of Materials", NPTEL, Web course, Department of Mechanical Engineering, Indian Institute of Technology, Bombay
2. John Cutler, Jeremy Liber, "Understanding Aircraft Structures", 4th Edition, Wiley Balckwell publishing.
3. Lakshmi Narasaiah G, "Aircraft Structures", BSP Books Pvt.Ltd-Hyderabad.
4. Peery D.J, "Aircraft Structures", 2nd Edition, McGraw Hill.

WEB LINKS

1. <http://www.nptelvideos.in/2012/11/structural-analysis-ii.html>
2. <http://www.nptel.ac.in/courses/112107146/34>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO4	3	2	2	3	2	-	3	-	-	-	2	2	3	2
CO5	2	3	2	1	3	3	2	-	-	-	3	2	3	2



COURSE OBJECTIVES

To enable the students to

- impart the knowledge of hydraulic and pneumatic systems components.
- study the engines and its various control systems
- gain knowledge of advance control systems and its applications
- learn about the types of instruments and its operation including navigational instruments
- understand about the cockpit layout of a aircraft

UNIT I CONVENTIONAL AIRCRAFT SYSTEMS**9**

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.

UNIT II CONVENTIONAL ENGINE CONTROL SYSTEMS**9**

Fuel systems of Piston engine and Jet engine – Main engine components and functions of jet engines – Engine lubrication systems – Accessory gear box and accessories driven – Engine starting system – Main and After burner fuel control systems – Thrust reversing and Thrust vector control.

UNIT III ADVANCED TECHNOLOGY SYSTEMS**9**

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

UNIT IV AIRCRAFT INSTRUMENTS**9**

Flight instruments, Navigation and Communication instruments, Gyroscope, Accelerometers, Airspeed indicator, Mach meter, Electronic horizontal situation indicator, Horizontal situation 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).

UNIT V COCKPIT LAYOUT**9**

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.

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of this course, students will be able to

- compare the features of various flight control systems.
- describe the principle and working of different aircraft systems.
- analyze the performance of various aircraft engine systems.
- acquire and interpret data from various aircraft instruments.
- identify the various cockpit controls.

TEXT BOOKS

1. Pallett E H J, „Aircraft Instruments – Principles and Applications”, Second Edition, Longman House, 1981.
2. Pallett E H J and S. Coyle, „Automatic Flight Control”, Fourth Edition, Blackwell Science Ltd, 1993.
3. Irwin Treager, „Aircraft Gas Turbine Engine Technology”, Third Edition, McGraw- Hill, 2013.

REFERENCES

1. James Powell, „Aircraft Radio Systems”, Shroff Publishers, 2006.
2. Ian Moir and Allan Seabridge, „Aircraft Systems – Mechanical, electrical and avionics subsystems integration”, Second Edition, Professional Engineering Publishing Limited, 2001.
3. Ian Moir, Allan Seabridge and Malcolm Jukes, „Civil Avionics Systems”, Second Edition, Wiley, 2013.
4. “General Hand Book of Airframe and Powerplant Mechanics”, U.S.Dept. of Transportation, Federal Aviation Administration, English Book Store, New Delhi, 1995.
5. Mike Tooley and David Wyatt, „Aircraft Communications and Navigation Systems: Principles, Maintenance and Operation”, Butterworth-Heinemann’s Series, 2007.

WEB LINKS

1. http://www.faa.gov/regulations_policies
2. <http://www.niuniv.com>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	-	3	-	-	-	-	-	2	3	2
CO2	2	2	2	2	-	2	-	-	-	-	-	2	3	2
CO3	3	1	2	2	3	2	-	-	-	-	-	2	2	2
CO4	2	2	3	2	2	2	-	-	-	-	-	2	3	2
CO5	2	2	2	2	3	3	-	-	-	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- familiarize the students in basic aerodynamics and use of wind tunnels.
- familiarize the calibration of wind tunnel
- impart the knowledge of wind tunnel balance
- learn about the different airfoil lift and drag

LIST OF EXPERIMENTS

1. Flow visualization in water flow channel
2. Flow visualization in smoke tunnel
3. Plot of RPM VS test section velocity in a subsonic wind tunnel.
4. Pressure distribution over circular cylinder.
5. Pressure distribution over airfoil and estimation of C_L and C_D .
6. Force measurement using wind tunnel balance.
7. Determination of lift and drag for the given airfoil section
8. Pressure distribution over a smooth and rough circular cylinder.
9. Pressure distribution over a symmetric and cambered aerofoil.
10. Flow visualization studies in subsonic flows
11. Surface and Flow Pattern Visualization

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- operate the wind tunnel for various models
- gain knowledge of lift, drag and pressure relation
- analyze the pressure distribution around various models
- measure pressure distribution over different surfaces.

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	3	-	-	-	2	2	-	2	3	2
CO2	-	3	2	-	2	3	3	-	2	-	2	2	3	2
CO3	-	-	-	3	3	3	3	-	3	3	-	2	2	2
CO4	1	3	-	-	2	-	-	-	-	3	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- experiment the load deflection characteristics of structural materials under different types of loads.
- familiarize with reciprocal theorem
- acquaint with mechanical properties of thin cylinder internal pressure
- practically understand the principle of superposition

LIST OF EXPERIMENTS

1. Determination of Young's modulus of a material.
2. Determination of deflection of a simply supported beam.
3. Determination of deflection of a cantilever beam.
4. Determination of forces in statically indeterminate force system.
5. Verification of Principle of superposition
6. Verification of Maxwell's Reciprocal theorem
7. Column – Testing using various materials
8. South – well's plot.
9. Testing of Riveted Joints.
10. Determination of membrane stresses in a thin cylinder under internal pressure.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- know the strength of rivet and thin cylinder
- find the properties of different materials
- gain knowledge of stress variation in the deflected materials
- analyze the strengths of different structures and joints

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO2	2	3	2	-	3	-	3	-	3	-	3	-	3	2
CO3	2	3	3	-	2	-	-	-	3	-	3	-	2	2
CO4	2	3	3	-	2	-	3	-	2	-	3	-	3	2



COURSE OBJECTIVES

To enable the students to

- develop the reading skills of the students and make them familiarized in skimming and scanning.
- instill the communication concepts to enhance the students' conversational skills through various practice sessions.
- familiarize them with a variety of business correspondence.
- inculcate the receptive skills i.e. Listening and Reading and to make the students well versed in the Productive skills.

UNIT I READING & VOCABULARY

Understanding short, real notices, messages - detailed comprehension of factual material- skimming & scanning skills - interpreting visual information - reading for detailed factual information - reading for gist and specific information - reading for grammatical accuracy and understanding of text structure - reading and information transfer.

UNIT II WRITING

Re-arranging appointments - asking for permission - giving instructions - apologizing and offering compensation - making or altering reservations - dealing with requests - giving information about a product.

UNIT III LISTENING

Listening to short telephonic conversation - Listening to short conversation or monologue - Listening to specific information - Listening to conversation- interview, discussion.

UNIT IV SPEAKING

Conversation between the interlocutor and the candidate - general interaction and social language - A mini presentation by each candidate on a business theme - organizing a larger unit of discourse - giving information and expressing opinions - two way conversation between candidates followed by further prompting from the interlocutor- Expressing opinions- agreeing and disagreeing.

TOTAL: 30 PERIODS

COURSE OUTCOMES

At the end of the course, the student will be able

- enrich the vocabulary through reading and to develop their pronunciation skills.
- prepare flawless reports and proposals.
- listen to speeches and conversations and answer the questions.
- communicate fluently and effectively on any given topic and appear with confidence for on-line tests.

TEXT BOOKS

1. Cambridge BEC Preliminary, Self-Study Edition, Cambridge University Press, New York, 2012.
2. Whitby, Norman. Business Benchmark, Pre-intermediate to intermediate, Business Preliminary, ShreeMaitrey Printech Pvt. Ltd., Noida, 2014.

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO2	-	-	-	1	-	-	1	-		3	-	-	-	-
CO3	-	-	-	-	2	-	-	-		2	2	-	-	-
CO4	-	-	-	-	-	1	2	2	3	3	3	-	-	-



PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

B.E. AERONAUTICAL ENGINEERING

REGULATIONS - 2016

(CHOICE BASED CREDIT SYSTEM)

CURRICULUM

SEMESTER – V

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	AE16501	Gas Dynamics	3	0	0	3
2	PC	AE16502	Aircraft General Engineering and Maintenance Practices	3	0	0	3
3	PC	AE16503	Aircraft Structures II	3	2	0	4
4	PC	AE16504	Aircraft Performance	3	0	0	3
5	PC	AE16505	Rocket Propulsion	3	0	0	3
6	PE	AE1615*	Programme Elective – I*	3	0	0	3
Practical							
7	PC	AE16506	Aircraft Structures II Laboratory	0	0	4	2
8	PC	AE16507	Propulsion laboratory	0	0	4	2
9	EE	EN16501	Career Development Laboratory I	0	0	2	1
TOTAL				18	2	10	24

SEMESTER – VI

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	BA16254	Principles of Management	3	0	0	3
2	PC	AE16601	Computational Fluid Dynamics	3	2	0	4
3	PC	AE16602	Aircraft Stability and Control	3	0	0	3
4	PC	AE16603	Theory of Vibrations	3	0	0	3
5	PE	AE1625*	Programme Elective – II*	3	0	0	3
6	OE	AE169**	Open Elective – I*	3	0	0	3
Practical							
7	PC	AE16604	Aero CAD and CAM Laboratory	0	0	4	2
8	PC	AE16605	Aircraft Engine and Structures Repair Laboratory	0	0	4	2
9	EE	EN16601	Career Development Laboratory II	0	0	2	1
TOTAL				18	2	10	24

PROGRAMME ELECTIVE (PE)

ELECTIVE – I

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	AE16151	Principles of UAV and MAV	3	0	0	3
2	PE	AE16152	Experimental Stress Analysis	3	0	0	3
3	PE	AE16153	Aircraft Communication and Navigation System	3	0	0	3
4	PE	AE16154	Air Traffic control and Planning	3	0	0	3

ELECTIVE – II

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	AE16251	Industrial Aerodynamics	3	0	0	3
2	PE	AE16252	Experimental Aerodynamics	3	0	0	3
3	PE	AE16253	Hypersonic Aerodynamics	3	0	0	3
4	PE	AE16254	Wind Tunnel Techniques	3	0	0	3

OPEN ELECTIVE (OE)

ELECTIVE – I

S.No.	Category	Course Code	Course Title	L	T	P	C
1	OE	AE16901	Aircraft Rules and Regulations	3	0	0	3
2	OE	AE16902	Wind Power Engineering	3	0	0	3
3	OE	AE16903	Aircraft Safety	3	0	0	3
4	OE	AE16904	Active Control Technology	3	0	0	3

SEMESTER V

AE16501

GAS DYNAMICS

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- acquire the basic concepts of compressible flow
- understand the behavior of airflow both internal and external in compressible flow regime with particular emphasis on supersonic flows.
- know the theory behind the formation of shocks and expansion fans in Supersonic flows.
- obtain the potential flow in two dimensional compressible flow.
- introduce the methodology of measurements in Supersonic flows.

UNIT I FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW 10

Aerodynamics variables and flow physics - Aerodynamic forces and moments, Definition of Compressible flow, Adiabatic steady state flow equations. Compressibility, continuity, momentum and energy equations for steady one dimensional flow, compressible Bernoulli's equation, area – mach number – velocity relation, mach Cone, mach angle, Choked flow, Numerical Problems

UNIT II INVISCID, COMPRESSIBLE FLOWS 8

One dimensional flow equations. Quasi-one dimensional flow - one dimensional isentropic flow through variable area duct, critical conditions - characteristic mach number, area-mach number relation - maximum discharge velocity - operating characteristics of nozzles - Isentropic flow through supersonic nozzle.

UNIT III SHOCK AND EXPANSION WAVES 10

Normal shock relations, Prandtl's relation, Hugoniot equation, Rayleigh Supersonic Pitot tube equation, Oblique shocks, θ - β -M relation, Shock Polar, Reflection of oblique shock - Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Attached and detached shocks, Introduction to viscous flow - Introduction to boundary-layers, shock wave boundary-layer interaction.

UNIT IV TWO DIMENSIONAL COMPRESSIBLE FLOW 10

Potential equation for 2-dimensional compressible flow, Linearisation of potential equation, perturbation potential, Linearised Pressure Coefficient, Linearised subsonic flow - Prandtl-Glauert rule, Linearised supersonic flow, Method of characteristics

UNIT V HIGH SPEED FLOWS 7

Critical Mach number, Drag divergence Mach number - Shock Stall, Supercritical Airfoil Sections, Transonic area rule - Swept wing, wave drag - Wind tunnels for transonic - Supersonic and hypersonic flows - shock tube - Gun tunnels - Supersonic flow visualization methods

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- understand and apply the fundamental aspects of compressible flow
- understand and apply the fundamental aspects of compressible flow
- compute the calculations related to shock and expansion waves

- compute the equations for various parameters in two dimensional compressible flow
- elaborate the visualization methods of flow properties

TEXT BOOKS

1. Anderson. J. D, "Modern Compressible Flow", McGraw-Hill and Co., 2002.
2. Rathakrishnan. E, "Gas Dynamics", Prentice Hall of India, 2004.

REFERENCES

1. Shapiro. A. H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronald Press, 1982.
2. Zucrow. M. J. and Anderson, J. D., "Elements of Gas Dynamics", McGraw- Hill and Co., 1989.
3. Oosthuizen. P.H., and Carscallen, W.E., "Compressible Fluid Flow", McGraw- Hill and Co., 1997.

WEB LINKS

1. <http://nptel.ac.in/courses/101105059/>
2. <https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005/lecture-notes/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO2	3	2	3	3	2	2	2	-	-	-	3	2	3	2
CO3	-	2	1	3	2	2	3	-	-	-	3	2	2	3
CO4	2	2	3	3	2	2	3	-	-	-	3	2	2	2
CO5	2	2	2	2	3	3	2	-	-	-	2	2	3	2



COURSE OBJECTIVES

To enable the students to

- study about the various ground handling procedures of an aircraft
- know about the ground servicing of Aircraft Subsystems,
- learn the safety procedures and precautions requirements
- understand the inspection procedures
- introduce the basic hardware, materials, system processes involved in aircraft

UNIT I AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT 9

Mooring, jacking, leveling and towing operations – Preparation – Equipment – precautions – Engine starting procedures – Piston engine, turboprops and turbojets – Engine fire extinguishing – Ground power unit.

UNIT II GROUND SERVICING OF VARIOUS SUB SYSTEMS 8

Air conditioning and pressurization system and their maintenance – Oxygen and oil systems and their maintenance – Ground units and their maintenance.

UNIT III MAINTENANCE OF SAFETY 8

Shop safety – Electrical Safety – Fire Protection and Fire Safety – Safety Around: Compressed Gases, Hazardous Materials, Machine Tools –Flight Line Safety–Safety Around Airplanes and Helicopters–Environmental cleanliness – Precautions

UNIT IV INSPECTION 10

Process – Purpose – Types – Inspection intervals – Techniques – Checklist – Special inspection –Publications, bulletins, various manuals – FAR Air worthiness directives – Type certificate Data sheets– ATA Specifications

UNIT V AIRCRAFT HARDWARE, MATERIALS, SYSTEM PROCESSES 10

Hand tools – Precision instruments – Special tools and equipments in airplane maintenance shop– Identification terminology – Specification and correct use of various aircraft hardware (i.e. nuts, bolts, rivets, screws etc) American and British systems of specifications – Threads, gears, bearings, etc –Drills, tapes and reamers – Identification of all types of fluid line fittings Materials. Metallic and nonmetallic Plumbing connectors – Cables – Swaging procedures, tests, Advantages of swaging over splicing.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- elaborate the ground handling operations of an aircraft
- carry out ground servicing of critical aircraft systems
- identify the safety requirements in the maintenance bay
- compute the effective inspection required for various parts of an aircraft
- compare the specifications standards of aircraft hardware systems

TEXT BOOKS

1. A and P Mechanics, "Aircraft Hand Book", F A A Himalayan Book House, New Delhi, 1996
2. A and P Mechanics, " General Hand Book", F A A Himalayan Bok House, New Delhi, 1996

REFERENCES

1. Kroes Watkins Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1993
2. Brimm D.J. and Hogges H.E., "Aircraft Maintenance", Pitman Publishing corp., New York, 1940
3. Larry Reithmeir, "Aircraft Repair Manual", Palamar Books, Marquette, 1992.
4. Dale Crane, Aviation Maintenance Technician: Power plants, 2nd edition, Aviation Supplies and Academics Inc, 2005
5. Jeppesen Sanderson, Standard Aviation Maintenance Handbook, Jeppesen and Company, 2003

WEB LINKS

1. https://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/amt_handbook/
2. https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/pilot_handbook.pdf

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO1	3	2	2	2	3	3	2	-	-	-	-	2	3	3
CO2	2	2	1	2	2	3	3	-	-	-	-	2	3	2
CO3	2	3	2	2	3	2	2	-	-	-	-	2	2	3
CO4	3	3	2	2	3	2	2	-	-	-	-	2	2	2
CO5	2	2	2	2	3	1	2	-	-	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- introduce the various structural components of aircrafts
- familiarize with different section of beams subjected to various types of loading.
- know the theoretical and methodological approaches to design aircraft structures.
- provide the knowledge on the importance of structural analysis of aircraft.
- study the behavior of various aircraft structural components under different types of loads.

UNIT I UNSYMMETRICAL BENDING**9+4**

Bending stresses in beams of unsymmetrical sections -K-method-Neutral axis method and Principle axis Method-
Bending of symmetric sections with skew loads.

UNIT II SHEAR FLOW IN OPEN SECTIONS**9+7**

Thin walled beams – Concept of shear flow – shear centre – Elastic axis – one axis of symmetry – wall effective and ineffective in bending – unsymmetrical beam sections

UNIT III SHEAR FLOW IN CLOSED SECTIONS**9+7**

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

UNIT IV BUCKLING OF PLATES**9+7**

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

UNIT V STRESS ANALYSIS IN WING AND FUSELAGE**9+5**

Shear resistant web beams – Tension field web beams (Wagner Beam) – Shear and bending moment distribution for cantilever and semi-cantilever types of beams – loads on aircrafts – lift distribution – V-n diagram – Gust loads.

TOTAL PERIODS**75****COURSE OUTCOMES**

At the end of this course, students will be able to

- analyze the response of structures due to unsymmetrical bending.
- identify and analyze structural problems commonly encountered in aircrafts.
- find the shear flow over the section
- determine the effect of a variety of loading and support conditions on the small deflection of beams
- identify various types of structural components and their loading pattern.

TEXT BOOKS

1. Megson T.H.G., "Aircraft Structures for Engineering Students", 4th edition Butterworth Heinemann,
2. Bruhn, E.H. "Analysis and Design of Flight vehicles Structures", Tri – state off set company, USA, (1985).

REFERENCES

1. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw-Hill, N.Y., (1993).
2. Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw-Hill, (1993).
3. Michael Chun-Yung Niu, "Airframe Structural Design: Practical Design Information and Data on Aircraft Structures", 2nd edition, Adaso/Adastra Engineering Center, (2006).
4. Howard D Curtis, "Fundamentals of Aircraft Structural Analysis", WCB-McGraw Hill, (1997)
5. Lakshmi Narasaiah G, "Aircraft Structures", BSP Books Pvt.Ltd-Hyderabad.

WEB LINKS

1. <http://nptel.ac.in/courses/105106049/65>
2. <https://pritamashutosh.wordpress.com>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO4	3	3	3	2	2	-	2	-	-	-	3	2	2	2
CO5	3	3	3	3	3	2	3	-	-	-	3	2	3	2



COURSE OBJECTIVES

To enable the students to

- study in detail about fundamentals of flight performance.
- acquire the knowledge of power required and available for steady flight performance.
- impart the students with necessary background for understanding the physical behavior of flight during maneuvers.
- study and understand the various special performance of an aircraft.
- familiarize the students with performance of various pitch propeller.

UNIT I LIFT AND DRAG ON FLIGHT PERFORMANCE 12

Streamlined and bluff bodies, aerofoil classification - Aerofoil characteristics, Pressure distribution around aerofoil. Types of drag, Effects of Reynold's number on skin friction and pressure drag, Drag reduction of airplanes. Induced drag, Chord wise and span wise pressure distribution - Aspect ratio, Camber and plan form characteristics - drag polar.

UNIT II STEADY FLIGHT 8

Steady level flight - Thrust/power - available and required with altitude Estimation of maximum level flight speed - conditions for minimum drag and minimum power required

UNIT III GLIDING, CLIMBING AND TURNING PERFORMANCE 12

Maximum range - Minimum rate of skin a glide, Shallow angle of climb, Rate of climb, time to climb and ceilings, Glide hodograph. Bank angle and load factor, Limitations on turn - Pull up and push over - the v-n diagram.

UNIT IV SPECIAL PERFORMANCE 6

Range and endurance of jet and propeller type of airplanes, estimation of take-off and landing distance. High lift devices, Use of thrust augmentation and reverse thrust.

UNIT V PROPELLERS 7

Froude momentum and blade element theories, Propeller coefficients, Use of propeller charts, performance of fixed and variable pitch propeller.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the aerodynamics forces and performance of an aircraft.
- evaluate the power required and available for steady flight performance.
- compute the various load factor performance.
- compare the various performance of an aircraft.
- identify the various performance of pitch propeller and its charts.

TEXT BOOKS

1. John D. Anderson, Jr Aircraft performance and design
2. Houghton, E.L, Carruthers, N.B, "Aerodynamics for engineering students", Edward Arnold Publishers, 1988.

REFERENCES

1. L.J.Clancy, Aerodynamics, Pitman, 1986.
2. Kuethe, A.M., and Chow, C.Y., Foundations of Aerodynamics, John Wiley and Sons, 1982
3. J.J. Bertin, Aerodynamics for engineers, Prentice-hall, 1988.
4. Schlichting, E., Aerodynamics of the Airplane, McGraw-Hill, 1979.
5. A.C.Kermode., "Mechanics of Flight"

WEB LINKS

1. <http://nptel.ac.in/downloads/101104007/>
2. <http://nptel.ac.in/courses/101106041/>

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CO4	2	3	2	2	3	2	-	-	-	-	3	2	2	2
CO5	1	2	2	2	3	2	-	-	-	-	3	2	3	2



COURSE OBJECTIVES

To enable the students to

- study in detail about fundamentals of chemical rockets, rocket propulsion and advanced propulsion techniques
- acquire an overview of various rocket technologies and applications.
- impart students with a sound fundamental in gas dynamics, thermo chemistry, heat transfer, and vehicle dynamics as related to rocket motor/vehicle analysis.
- familiarize students with a sound fundamental in analyzing /designing various rocket propulsion systems such as liquid propellant rocket motors, solid propellant rocket motors.
- understand about the multi-stage launch vehicles, arc jets, solid core nuclear thermal rocket motors, and ion thrusters.

UNIT I DEFINITIONS AND FUNDAMENTALS**9**

Operating principle of chemical rockets. Definitions: Rocket thrust, Exhaust velocity, Specific Impulse, Vehicle acceleration - Effective exhaust velocity, Characteristic velocity, Mass ratio, Propellant mass fraction, Burning time - Total impulse - Thrust coefficient, Isentropic flow through nozzles, Rocket nozzle classifications. Under and over expanded nozzles - Optimum expansion - Numerical Problems.

UNIT II IGNITION SYSTEMS IN ROCKETS**9**

Types of solid propellant rocket igniters – Pyrotechnic igniters and pyrogen igniters. Igniter Design spreading, Considerations: Igniter mass and chamber volume, Ignition Chain: Ignition delay, mode of heat transfer, flame Deflagration and Detonation. Hypergolic ignition. Ignition systems in liquid rockets.

UNIT III SOLID PROPELLANT ROCKETS**9**

Selection criteria of solid propellants – Important hardware components of solid rockets. Propellant grain design considerations. Burn rate. Internal ballistics - Pressure-time curve. Starting transient, erosive burning, Rocket performance considerations – Staging of rockets. Thrust vector control. Thrust termination techniques, Numerical problems.

UNIT IV LIQUID PROPELLANT ROCKETS**9**

Liquid propellant rocket engine fundamentals. Liquid propellants. Propellant feed systems. Selection of liquid propellants. Valves and pipe lines. Thrust chambers. Injectors, combustion chamber and nozzle, Combustion Instability. Secondary injection thrust vector control in liquid rockets – Cooling in liquid rockets. Numerical Problems. Introduction to hybrid rockets – Relative advantages of liquid rockets over solid rockets. Types of Rocket tests. Rocket exhaust plumes.

UNIT V ADVANCED PROPULSION TECHNIQUES**9**

Cryogenic rockets - Satellite thrusters - Electric rockets - Ion propulsion techniques - Nuclear rockets – Types, Sail, Anti-matter propulsion - Preliminary Concepts in nozzle less propulsion.

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of this course, students will be able to

- analyze the fluid flow in a rocket nozzle

- compute the preliminary heat transfer calculations in a rocket nozzle
- design various rocket motor systems to satisfy a wide range of applications
- elaborate about the solid-core nuclear thermal rockets, arc jets, and ion thrusters
- analyze a rocket engine system to determine its specific impulse and performance.

TEXT BOOKS

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley and Sons Inc., New York, 7th edition.
2. Kou K.K and Summerfield.M., Fundamental Aspects of Solid Propellant Rockets, Progress in and Aeronautics, AIAA, Vol.90, 1982.

REFERENCES

1. Barrere.M, "Rocket Propulsion", Elsevier Publishing Company, New York, 1960.
2. Hill, P.G. and Peterson, C.R. "Mechanics and Thermodynamics of Propulsion" 2nd Edition Pearson Education, 1999.
3. Gordon Oates, "Aero thermodynamics of Gas Turbine and Rocket Propulsion", AIAA Education Series, York, 1989.
4. J.W.Cornelisse, H.F.R.Schoyer, K.F.Wakker, "Rocket Propulsion and Spaceflight Dynamics," Pitman, London. (1979)

WEB LINKS

1. <http://npTELac.in/courses/112106073/>
2. <http://npTELac.in/courses/101104019/>
3. <http://www.nptelvideos.in/2012/12/rocket-propulsion.html>
4. <http://npTELac.in/syllabus/112106073/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	2	2	-	-	-	3	2	3	3
CO2	2	3	3	2	3	2	2	-	-	-	3	2	3	2
CO3	-	1	3	2	3	2	2	-	-	-	2	-	2	3
CO4	-	3	2	3	2	-	3	-	-	-	3	2	2	2
CO5	-	2	3	3	3	3	-	-	-	3	2	2	3	2



COURSE OBJECTIVES

To enable the students to

- understand the behavior of structural components with different loading conditions.
- know the shear center location of open and closed section
- find the fringe value of the material
- gain knowledge of tensioned specimen

LIST OF EXPERIMENTS

1. Determination of principle plane of unsymmetrical section
2. Determination of Shear centre location for Z sections
3. Determination of Shear centre location for open channel sections
4. Determination of Shear centre location for angle sections
5. Calibration of Photo-elastic materials using plane polariscope
6. Calibration of Photo-elastic materials using circular disc under compression
7. Calibration of Photo-elastic material using beam subjected to pure tension
8. Determination of forces in wire of hinged bar experiment
9. Wagner beam – Tension field beam with gauge mounting practices
10. Determine the acceleration and velocity by vibration test
11. Determination of elastic constant for composite tensile specimen
12. Fabrication of composite laminate

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- evaluate the numerical analysis of structural components.
- estimate the shear center of various section
- identify the fringe value of the materials
- fabricate the different composite laminates

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	3	-	-	-	2	-	2	-	3	3
CO2	3	2	1	-	2	-	3	-	3	-	3	-	3	2
CO3	3	2	2	-	3	-	2	-	2	-	2	-	2	3
CO4	3	2	2	-	2	-	2	-	3	-	2	-	2	2



COURSE OBJECTIVES

To enable the students to

- understand the basic concepts in aerospace propulsion.
- gain the knowledge about piston engine and jet engine components.
- familiarize student with a calibration test.
- learn the testing of different jets and velocity profile.

LIST OF EXPERIMENTS

1. Velocity profiles of free jets.
2. Velocity profiles of wall jets.
3. Free convective heat transfer over a cylinder.
4. Forced convective heat transfer over a cylinder.
5. Determination of Thermal Resistance of a Composite wall.
6. Calibration of Fuel Test rig
7. Study of an aircraft piston engine.
8. Study of an aircraft jet engine compressor.
9. Study of jet engine combustion chamber.
10. Study of jet engine turbine.
11. Determination of calorific value of Aviation Fuel

COURSE OUTCOMES**TOTAL PERIODS 60**

At the end of this course, students will be able to

- analyze the performance of various aircraft piston and gas turbine engines components.
- compute the flow behavior of jets
- identify various testing methods of variable area ducts, jet engine components
- estimate the calorific value of various types of fuels.

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	-	-	3	2	-	3	-	3	2	3	3
CO2	2	3	3	3	2	2	2	-	3	-	2	2	3	2
CO3	3	2	2	3	3	3	2	-	2	-	3	-	2	3
CO4	2	2	-	-	2	3	2	-	3	-	3	-	2	2



SEMESTER VI

BA16254

PRINCIPLES OF MANAGEMENT

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand history and development of management thought.
- know the planning activities in management.
- understand organizing, dimensions of organization structure, and choosing the right structural form.
- know how to manage human resources.
- understand various methods and techniques of control

UNIT I INTRODUCTION TO MANAGEMENT 9

Management: Meaning, Scope, Managerial Roles. Management: Science, Art or Profession; Universality of Management, Ancient roots of management theory; Classical schools of management thought; Behavioral School, Quantitative School; Systems Approach, Contingency Approach; Contemporary Management thinkers and their contribution.

UNIT II PLANNING 9

Characteristics of planning, Planning Process; Types of plans; Decision making, Decision making tools, Group decision making, Forecasting and MBO.

UNIT III ORGANIZING 9

Organizational structure and design; types of organizational structures; authority, delegation, decentralization and reengineering; Organization Size, Technology, Environment, Power-control; choosing the right structural form

UNIT IV MANAGING HUMAN RESOURCES 9

Human resource planning, Recruitment, selection, training and development, performance appraisal, managing change, compensation and employee welfare, leadership theory, motivation theory, communication

UNIT V CONTROLLING 9

Nature of organizational control; control process; Methods and techniques of control; Designing control systems.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able

- To demonstrate history and development of management thought.
- To exhibit the planning activities in management.
- To know organizing, dimensions of organization structure, and choosing the right structural form.
- To gain knowledge how to manage human resources.
- To develop various methods and techniques of control.

TEXT BOOKS

1. Management a Global and Entrepreneurial Perspective, Heinz Wehrich, Mark V. Cannice, Tata McGraw-Hill Education, 2010.
2. Management, James A.F. Stoner and R. Edward Freeman, Prentice-Hall of India Private Limited, New Delhi, 5/e, 2010.

REFERENCES

1. Management, John R. Schermerhorn, Jr., Daniel G. Bachrach, Wiley India, 13/e, 2015.
2. Essentials of Management, Joseph L. Massie, Prentice-Hall India, New York, 4/e, 2013.
3. Management, S.A. Sherdekar, Himalaya Publications, Mumbai, 1/e, 2012.
4. Principles of Management, L.M. Prasad, Sultan Chand and Sons, New Delhi, 9/e, 2015.

WEB LINKS

1. <https://www.slideshare.net/ersmbalu/principles-of-management-lecture-notes>
2. mboexamnotes.com/principles-of-management.html
3. <https://www.cliffsnotes.com/study-guides/principles-of-management>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	-	3	2	2	3	3	2	3	-	-
CO2	-	-	2	-	-	3	3	3	2	2	3	2	-	-
CO3	-	-	3	-	-	2	3	2	3	3	2	2	-	-
CO4	-	-	3	-	-	3	2	3	3	3	2	3	-	-
CO5	-	-	2	-	-	2	2	3	2	2	3	3	-	-



COURSE OBJECTIVES

To enable the students to

- gain the basic flow equations, characteristics of mathematical model for a given flow.
- know the importance and significance of grid generation methods.
- understand the concepts of discretization, upwind differencing and implicit, explicit solutions
- familiarize with finite element techniques in computational fluid dynamics.
- learn with aerospace application in computational fluid analysis.

UNIT I FUNDAMENTAL CONCEPTS**9+6**

Introduction - Basic Equations of Fluid Dynamics - Review of Source sink Panel methods- lifting flows over arbitrary bodies. Mathematical properties of Fluid Dynamics Equations - Elliptic, Parabolic and Hyperbolic equations - Well posed problems - discretization of partial Differential Equations. **Introduction to Finite**

Difference method

UNIT II GRID GENERATION**9+6**

Structured grids. Types and transformations. Generation of structured grids. Unstructured grids. Delany triangulation.

UNIT III DISCRETIZATION**9+6**

Boundary layer Equations and methods of solution -Implicit time dependent methods for inviscid and viscous compressible flows - Concept of numerical dissipation --Stability properties of explicit and implicit methods - Conservative upwind discretization for Hyperbolic systems - **Further advantages of upwind differencing.**

UNIT IV FINITE VOLUME TECHNIQUES**9+6**

Finite Volume Techniques - Cell Centered Formulation - Lax - Vendoroff Time Stepping - Runge - Kutta Time - Stepping - Multi - stage Time Stepping - Accuracy - Cell Vertex Formulation - Multistage Time Stepping - FDM like Finite Volume Techniques - Central and Up-wind Type Discretizations - Treatment of Derivatives. Flux splitting schemes. Pressure correction solvers - SIMPLE, PISO, Vorticity transport formulation. Implicit/semi-implicit schemes

UNIT V APPLICATION OF CFD**9+6**

Numerical solution of flow over a cylinder using 2-D panel methods using both vertex and source panel methods for lifting and non lifting cases respectively. Numerical solution of 1-D conduction- convection energy equation using time dependent methods using both implicit and explicit schemes - application of time split method for the above equation and comparison of the results

TOTAL PERIODS 75**COURSE OUTCOMES**

At the end of the course, the students will be able to

- elaborate the flow phenomena in a flow field with correspondence with elliptic, parabolic and hyperbolic equations.
- identify the steps involved in source and panel methods.
- discretize a flow model for analysis.
- compute the values using weighted, variational and Galerkin method of finite volume technique.

- analyze the numerical methods of aerospace application in computational

TEXT BOOKS

1. John F. Wendt (Editor), "Computational Fluid Dynamics - An Introduction", Springer – Verlag, Berlin, 1992
2. Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics", Vols. I and II, Springer - Verlag, Berlin, 1988

REFERENCES

1. Charles Hirsch, "Numerical Computation of Internal and External Flows", Vols. I and II. John Wiley and Sons, New York, 1988.
2. Anderson, Jr.D., "Fundamentals of Aerodynamics", McGraw-Hill, 2000.
3. Klaus A. Hoffmann and Steve T. Chiang. "Computational Fluid Dynamics for Engineers", Vols. I and II
4. Engineering Education System, P.O. Box 20078, W. Wichita, K.S., 67208 - 1078 USA, 1993.
5. Versteeg.H and Malalasekera W "An Introduction to Computational Fluid Dynamics: The Finite Volume Method" Prentice Hall, 2008

WEB LINKS

1. <http://npTEL.ac.in/courses/112107080/>
2. <http://npTEL.ac.in/courses/103106073/>
3. <http://npTEL.ac.in/courses/112105045/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	3	3	3	-	-	-	-	3	1	3	2
CO2	3	2	2	2	-	1	-	-	-	-	2	2	3	2
CO3	2	3	3	-	-	1	-	-	-	-	3	2	2	2
CO4	2	1	2	-	-	2	-	-	-	-	2	2	3	2
CO5	3	2	3	-	2	2	-	-	-	-	2	1	3	2



COURSE OBJECTIVES

To enable the students to

- acquire the necessary background for understanding the stability and control of an aircraft.
- study and understand the various longitudinal stability characters.
- familiarize the applications of various aircraft components towards the lateral stability and control.
- impart the knowledge of directional stability.
- understand the basic concepts of special maneuvers like spin, dutch roll, autorotation and spiral.

UNIT I INTRODUCTION 4

Degrees of freedom of a system - Static and dynamic stability, Need for stability in an airplane, purpose of controls, Inherently and marginally stable airplanes.

UNIT II STATIC LONGITUDINAL STABILITY: 14

Stick fixed: Basic equations of equilibrium, Stability criterion - Wing and tail moments, Effect of fuselage and nacelles, Effect of c.g. location, Power effects, Stabiliser setting and c.g. location, Elevator effects, stick fixed neutral point. Stick free: Hinge moment coefficients, Stick free neutral point symmetric maneuvers, stick force gradients and stick force per cg. Aerodynamic balancing of control surfaces.

UNIT III STATIC LATERAL STABILITY 6

Dihedral effect - coupling between rolling moment and yawing moment, Adverse yaw, Aileron power, Aileron reversal

UNIT IV STATIC DIRECTIONAL STABILITY 6

Weather cocking effect, rudder requirements. One engine inoperative conditions, rudder lock.

UNIT V DYNAMIC STABILITY 15

Equation of motion, Stability derivatives - Routh's discriminant, solving the stability quadratic - Phugoid motion, factors affecting the period and damping, Dutch roll and spiral instability Auto rotation and spin, Two control airplane

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- elaborate about the degrees of freedom and stability of an aircraft.
- analyze the stability of an aircraft under various operating conditions.
- identify the concepts behind the lateral stability.
- compute the problems in control systems of an aircraft.
- elaborate the static and dynamic response of aircraft for both voluntary and involuntary changes in flight conditions.

TEXT BOOKS

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley and Son: Inc, New York, 1988.

REFERENCES

1. Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New York, 1982

2. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co.,1998.
3. Clancy, L.J., "Aerodynamics", Pitman, 1986
4. Bandu N. Pamadi., "Performance, Stability, Dynamics, and Control

WEB LINKS

1. <http://nptel.ac.in/courses/101106043/>
2. <https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall-2004/lecture-notes/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	3	3	3	-	-	-	-	3	1	3	2
CO2	3	2	2	2	-	1	-	-	-	-	2	2	3	2
CO3	2	3	3	-	-	1	-	-	-	-	3	2	2	2
CO4	2	1	2	-	-	2	-	-	-	-	2	2	3	2
CO5	3	2	3	-	2	2	-	-	-	-	2	1	3	2



COURSE OBJECTIVES

To enable the students to

- know about the Basic terminologies
- understand the vibration measuring instrument
- study the vibration absorber
- learn the vibration of elastic bodies
- gain the knowledge of different methods of finding natural frequency

UNIT I BASIC NOTIONS 6

Simple harmonic motion-addition-Terminologies - Newton's Law - D'Alembert's principle-Energy Methods for free vibration

UNIT II SINGLE DEGREE OF FREEDOM SYSTEMS 9

Free vibrations – Damped vibrations – Forced Vibrations, with and without damping –support excitation – Vibration measuring instruments

UNIT III MULTI DEGREES OF FREEDOM SYSTEMS 12

Two degrees of freedom systems – Static and Dynamic couplings vibration absorber-Principal co- ordinates, and Principal modes and orthogonal condition – Eigen value problems. Hamilton's principle- Lagrangean equation application.

UNIT IV CONTINUOUS SYSTEMS 9

Vibration of elastic bodies-Vibration of strings- Longitudinal, Lateral and Torsional vibrations.

UNIT V APPROXIMATE METHODS AND ELEMENTS OF AEROELASTICITY 9

Rayleigh's method- Holzer Method- Vibration due to coupling of bending and torsion – aeroelastic problems – collars triangle wing divergence – aileron control reversal – flutter – buffeting. – elements of servo elasticity

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- perform basic concept of vibration
- describe the working principles of Dampers and vibration measuring instruments
- identify the different parameters of a vibrating system
- compute the vibration on elastic bodies
- estimate the natural frequency for different kinds of methods

TEXT BOOKS

1. Timoshenko S., "Vibration Problems in Engineering"– John Wiley and Sons, New
2. Tse. F.S., Morse, I.F., Hinkle, R.T., "Mechanical Vibrations", – Prentice Hall, New York, 1984
3. Tongue. B. H., "Principles of Vibration", Oxford University Press, 2000.

REFERENCES

1. T. Gowda, D.V.Girish, T.Jagadeesha, "Mechanical vibrations", McGraw Hill Edu, 2012.
2. Singiresu S. Rao "Mechanical Vibrations" 5th edition, Prentice Hall, 2010
3. Rao S S "Mechanical Vibrations" Prentice Hall,Fifth edition, 2010.

WEB LINKS

1. <http://nptel.ac.in/courses/112103111/>
2. <http://nptel.ac.in/courses/112103112/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	-	2	-	-	-	2	2	3	3
CO2	3	3	2	3	2	-	2	-	-	-	3	2	3	2
CO3	2	2	3	2	3	-	3	-	-	-	3	2	2	3
CO4	3	2	3	2	3	-	3	-	-	-	3	2	2	2
CO5	3	1	3	2	3	-	3	-	-	-	2	2	3	2



COURSE OBJECTIVES

To enable the students to

- develop skill to use software to create 2D and 3D models.
- train the students about the different types of operation by using CNC.
- teach the student to design the layout of control system and engine components
- design the different welding joints by using software.

LIST OF EXPERIMENTS

1. Design of piston engine components (radial Engine)
2. Design of Jet Engine components
3. Design of welded and riveted joints
4. Computer aided modeling of typical aircraft wing.
5. Computer aided modeling of typical fuselage structure.
6. Computer aided modeling of landing gear
7. Three view diagram of a typical aircraft
8. Facing and Turning (Taper, Step) operations.
9. Drilling operations
10. Layout of control systems

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- operate the CAM
- prepare the layout of aircraft component
- develop the model aircraft component using software
- perform structural analysis using software packages.

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	-	3	-	-	-	-	-	-	2	3	3
CO2	1	2	2	-	1	-	-	-	-	-	-	2	3	2
CO3	1	2	2	-	3	-	-	-	-	-	-	2	2	3
CO4	1	2	2	1	3	-	-	-	-	-	-	2	2	2



COURSE OBJECTIVES

To enable the students to

- give training on riveting, patchwork, welding and carpentry
- learn the dismantling procedure for a piston engine.
- practice the different patch repairs and wood gluing joint
- know the composite materials with different resins.

LIST OF EXPERIMENTS

1. Dismantling of a piston engine
2. Engine (Piston Engine) - cleaning, visual inspection, NDT checks.
3. Piston Engine Components - dimensional checks.
4. Piston – Engine reassembly.
5. Engine starting procedures.
6. Aircraft wood gluing-single and double scarf joints
7. Welded single and double V-joints.
8. Fabrication of Composite Materials
9. Riveted Patch repairs
10. Tube bending and flaring
11. Study on MIG, TIG and PLASMA welding of aircraft components

TOTAL PERIODS**60****COURSE OUTCOMES**

At the end of this course, students will be able to

- identify the engine components
- obtain the repair work of airframe
- analyze riveted joints
- inspect the piston engine defects.

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	1	-	-	-	-	-	2	2	3	3
CO2	2	2	3	3	1	2	-	-	-	-	3	2	3	2
CO3	1	2	3	1	1	-	-	-	-	-	2	2	2	3
CO4	3	2	2	1	3	2	-	-	-	-	3	2	2	2



PROGRAMME ELECTIVE I

AE16151

PRINCIPLES OF UAV AND MAV

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- know the importance of unmanned aerial vehicle
- understand the application of UAV system
- learn the basic hardware of UAV
- interpret the basic concepts of controlling of forces and moments on models during the payload
- perform the flight analysis

UNIT I INTRODUCTION TO UAV AND MAV 9

Historical Background of UAVs and MAVs -classifications based on range and Endurance -basic terminology- models and prototypes - Preliminary, Conceptual and Detailed design stages.

UNIT II DESIGN OF UAV SYSTEM 9

Fixed wing -Rotor -VTOL-STOL- Blimb wing Airframe - flapping wing - dynamics -modeling fuselage structures - Airfoil selection - Propeller selection - Empennage design -Flight control surfaces specifications - Airframe maintenance.

UNIT III HARDWARE SUPPORT 9

Autopilot sensors, servos, accelerometer, gyros, actuators-, power supply processor, integration, installation, Configuration.

UNIT IV PAYLOADS AND CONTROLS 9

Payloads, Telemetry, tracking - Aerial photography, controls, PID feedback, radio control frequency range, modems, Memory system, simulation, ground test-analysis, trouble shooting.

UNIT V PATH PLANNING 9

Path planning ,Trajectory generations, Obstacles avoidance ,Endurance ,Way points navigation ground control Software, Flight Endurance and Range ,analysis of existing UAVs and MAVs.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the classification of UAV
- identify and analyze UAV system and structures
- identify the theory behind the hardware
- determine the effect of payload
- identify various types of planning and trajectory

TEXT BOOKS

1. Fahlstrom, P. and Gleason, T. 2012. Introduction to UAV Systems. 4th edition. United Kingdom. John Wiley and Sons Ltd.
2. Wolf, P., DeWitt, B., and Wilkinson, B. 2014. Elements of Photogrammetry with Applications in GIS, 4th Edition. McGraw-Hill.

3. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010

REFERENCES

1. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems" Lockheed Martin Aeronautics Company, 2001
2. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998
3. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
4. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

WEB LINKS

1. <http://nptel.ac.in/courses/101106035/>
2. <https://www.uavsystemsinternational.com/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	-	2	-	-	-	2	-	2	2	3	3
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CO3	2	2	3	3	2	3	-	-	3	-	2	2	2	3
CO4	-	1	3	2	2	2	-	-	3	-	3	2	2	2
CO5	-	3	-	3	2	2	-	-	3	-	3	2	3	2



COURSE OBJECTIVES

To enable the students to

- understand the relation between the mechanics theory and experimental stress analysis.
- bring consciousness on experimental method of finding the response of the structure to different types of load.
- learn the fundamental concepts and newly experimental techniques.
- use the experimental techniques on the practical problems
- know the fundamental aspects of different non destructive testing techniques

UNIT I EXTENSOMETERS AND DISPLACEMENT SENSORS 8

Principles of measurements - Accuracy, Sensitivity and range of measurements, Mechanical, Optical, Acoustical and Electrical extensometers and their uses - Advantages and disadvantages, Capacitance gauges, Laser displacement sensors

UNIT II ELECTRICAL RESISTANCE STRAIN GAUGES 12

Principle of operation and requirements, Types and their uses, Materials for strain gauges, Calibration and temperature compensation, cross sensitivity - Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators, Rosette analysis, stress gauges, load cells

UNIT III PHOTOELASTICITY 11

Two dimensional photo elasticity, Photo elastic materials, Concept of light - photoelastic effects, stress optic law, Transmission photoelasticity, plane and circular polariscope, Interpretation of fringe pattern, Calibration of photoelastic materials, Compensation and separation techniques, Introduction to three dimensional photo elasticity.

UNIT IV BRITTLE COATING AND MOIRE TECHNIQUES 7

Relation between stresses in coating and specimen - use of failure theories in brittle coating, Moire method of strain analysis.

UNIT V NON - DESTRUCTIVE TESTING 7

Fundamentals of NDT - Acoustic Emission Technique, Radiography, Thermography, Ultrasonic, Eddy Current testing, Fluorescent Penetrant Testing.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- elaborate the various experimental techniques which is used to determine the structural properties
- execute the physics of strain measurement techniques
- analyse the principles and techniques of photoelastic measurement to perform a structural analysis
- perform the Moire method of analysis
- different method of NDT and its applications.

TEXT BOOKS

1. Dr. Sadhu Singh, "Experimental stress analysis", Khanna Publications.(1989).
2. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", College House Enterprises, New York, 2005

REFERENCES

1. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G, Pant B. and Ramachandra, K., "Experimental Stress Analysis", Tata McGraw-Hill, New Delhi, (1984).
2. Ramesh K, "Digital Photoelasticity, Advanced Techniques and Applications", Springer, (2000).
3. Jindal U C, "Experimental Stress Analysis", 1st edition, Pearson, (2012).
4. Allesandro Freddi, Giorgio Olmi, Luca Cristofolini, "Experimental Stress Analysis for Materials and Structures", Springer, (2015).

WEB LINKS

1. <http://nptel.ac.in/courses/112106068/>
2. <https://swayam.gov.in/course/1309-experimental-stress-analysis-an-overview>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	-	2	-	-	-	2	-	2	2	3	3
CO2	3	2	3	3	3	3	-	-	-	-	3	-	3	2
CO3	2	2	3	3	2	3	-	-	3	-	2	2	2	3
CO4	-	1	3	2	2	2	-	-	3	-	3	2	2	2
CO5	-	3	-	3	2	2	-	-	3	-	3	2	3	2



COURSE OBJECTIVES

To enable the students to

- understand the needs for avionics for both Civil and military aircraft.
- introduce various digital electronic principles and working operations of digital circuit.
- integrate the digital electronics with cockpit equipments
- understand the various principles in flight disk and cockpit panels.
- study the communication and navigation equipment

UNIT I COMMUNICATION SYSTEM AND MODULATIONS**9**

Communication systems: signals, analogue, digital and coded forms, time and frequency representation, signal spectra, types of distortion Information : Nature and measure, influence of bandwidth and signal/noise ratio on channel capacity, elements of Shannon's theorem and its implications - Problems of communicating in presence of noise - Modulation: Amplitude, angle and phase modulations, single and vestigial sideband forms - demodulation, Super heterodyne principle, automatic gain and frequency control, typical circuit arrangements.

UNIT II PULSE MODULATION, TRANSMISSION AND PERFORMANCE**10**

sampling principles, sampling criterion, quantization and quantization noise, selection of number and distribution of quantization levels, bandwidth requirements, examples of coding and decoding circuits. Transmission lines and their circuit representation, characteristic impedance, complex propagation constant, standing wave ratio, matching and impedance charts - Channel Amplitude and phase distortion, phase and group delay distortion caused by multiple effects. Noise, origin, measurements, noise figure and noise temperature effect on channel performance - Frequency and time division multiplexing

UNIT III RADIATION AND PROPAGATION**8**

Principles: application of basic formulae for unipole and dipole, aerials, effective height, directional, properties, gain, impedance, linear arrays, traveling wave aerials, rhombicas, parasitic elements - Influence of ionosphere and troposphere reflection from earth's surface, field strength calculations, fading diversity reception.

UNIT IV SPECIAL SYSTEMS**9**

VHF, UHF, Fibre optics and Laser Technology, Satellite communication and related equipment, electronic counter measures, low-level TV and Head-down displays, CR T displays, Direction finding. Air borne telemetry systems. Laser and infrared systems, Air data and flight recording systems. Satellite communication, spread spectrum technology: satellite transponders, earth terminals

UNIT V SURVEILLANCE AND FLIGHT CONTROL SYSTEM**9**

Introduction, secondary radar, The mode S system, Performance determination, Traffic Alert and Collision Avoidance System (TCAS), Weather Radar, checking weather Radar operation, Low-frequency weather mapping systems, roll channel operation, pitch channel operation, yaw channel operation, Autopilot system, Air data computers

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- identify the hardware required for aircraft.
- develop the knowledge about the digital avionics architecture
- perform the autopilot and cockpit display related concepts.
- elaborate the needs of avionics systems used in aircrafts.
- identify the communication and navigation techniques used in aircrafts.

TEXT BOOKS

1. Mike Tooley and David Wyatt "Aircraft communication and Navigation system", Elsevier first edition 2007
2. Albert D.Helfrick, "Modern Aviation Electronics", Pearson Education, 2nd Edition, 2008.

REFERENCES

1. Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000.
2. Brain Kendal, "Manual of Avionics", The English Book House, 3rd Edition, New Delhi, 1993
3. Jim Curren, "Trend in Advanced Avionics", IOWA State University, 1992.

WEB LINKS

1. <http://nptel.ac.in/courses/101105059/>
2. <https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005/lecture-notes>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	-	2	-	-	-	2	-	2	2	3	3
CO2	3	2	3	3	3	3	-	-	-	-	3	-	3	2
CO3	2	2	3	3	2	3	-	-	3	-	2	2	2	3
CO4	-	1	3	2	2	2	-	-	3	-	3	2	2	2
CO5	-	3	-	3	2	2	-	-	3	-	3	2	3	2



COURSE OBJECTIVES

To enable the students to

- study the procedure of the formation of aerodrome and its design.
- learn about the various maintenance activities for airport maintenance.
- understand the air traffic control, procedure and air traffic service.
- familiarize the procedure of the formation of aerodrome and its design and air traffic control.
- acquire the knowledge about the various navigation and lighting facilities.

UNIT I BASIC CONCEPTS**9**

Objectives of ATS - parts of ATC service - scope and provision of ATCS -VFR and IFR operations - classification of ATS air spaces -varies kinds of separation - altimeter setting procedures – Establishment designation and identification of units providing ATS -division of responsibility of control.

UNIT II AIR TRAFFIC SERVICES**9**

Area control service, assignment of cruising levels minimum flight altitude ATS routes and significant Points RNAV And RNP - Vertical, lateral and longitudinal separations based on time distance - ATC Clearances flight plans - position report. Comparison of various ATC services.

UNIT III FLIGHT INFORMATION, ALERTING SERVICES, COORDINATION,**9****EMERGENCY PROCEDURES AND RULES OF THE AIR**

Flight Information, Alerting Services, Coordination, Emergency Procedures and Rules of the Air Radar service basic radar terminology - identification procedures using primary / secondary radar - performance checks use of radar in area and approach control services - assurance control and coordination between radar and non radar control - emergencies - flight information and advisory service - alerting service and emergency procedures - rules of the air. Study about communication between aircraft and ATC.

UNIT IV AERODROME DATA, PHYSICAL CHARACTERISTICS AND OBSTACLE RESTRICTION**9**

Aerodrome data - basic terminology - aerodrome reference code - aerodrome reference point -aerodrome elevation - aerodrome reference temperature - instrument runway, physical characteristics; length of primary / secondary runway - width of runways - minimum distance between parallel runways etc – obstacles restriction. Comparison between domestic and international airports.

UNIT V VISUAL AIDS FOR NAVIGATION, VISUAL AIDS FOR DENOTING OBSTACLES EMERGENCY AND OTHER SERVICES**9**

Visual aids for navigation wind direction indicator - landing direction indicator - location and characteristics of signal area - markings, general requirements - various markings - lights, general requirements – aerodrome beacon, identification beacon - simple approach lighting system and various lighting systems - VASI and PAPI - visual aids for denoting obstacles; object to be marked and lighter - emergency and other services.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- exhibit the concept of air traffic rules and clearance procedures for airline operation.
- analyze the various air traffic data for air traffic services.
- elaborate the influence of aerodrome design factors for service establishments.
- gain knowledge on aerodrome design.
- compare the different services of Air Traffic Control.

TEXT BOOKS

1. Virendra kumar and Sathish Chandra, "Airport Planning and Design", Galgotia publications Pvt Ltd, New Delhi, 2012.
2. Aeronautical Information Publication (India) Vol. I and II, the English book store, 17-1, Connaught New Delhi, 2006

REFERENCES

1. Nolan M. S, "Fundamentals Air Traffic Control", Latest Edition, YESDEE Publishers, 2010
2. Seth B. Young, Alexander T. Wells, "Airport Planning and Management" McGraw-Hill Education, New 2011.

WEB LINKS

1. http://npTELac.in/courses/105101008/downloads/cete_40.pdf
2. <http://npTELac.in/courses/105107123/40>
3. <http://npTELac.in/courses/108105057/Pdf/Lesson-28.pdf>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	3	3	2	-	3	-	-	-	-	2	3	3
CO2	-	2	2	3	3	-	2	-	-	-	-	2	3	2
CO3	-	2	3	3	2	-	2	-	-	-	-	2	2	3
CO4	-	3	2	2	3	-	3	-	-	-	-	2	2	2
CO5	-	3	3	2	3	-	3	-	-	-	-	2	3	2



PROGRAMME ELECTIVE II

AE16251

INDUSTRIAL AERODYNAMICS

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- introduce the basic concepts of wind energy collectors.
- understand the aerodynamics of ground vehicles.
- gain the basic concepts of building aerodynamics.
- build up necessary features for induced vibrations.
- acquire knowledge about the industrial gas turbines.

UNIT I WIND ENERGY COLLECTORS 9

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height. Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.

UNIT II GROUND VEHICLE AERODYNAMICS 9

Power requirement and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of cars, trains and hovercraft.

UNIT III BUILDING AERODYNAMICS 9

Pressure distribution on low rise buildings, Wind forces on buildings, Environmental winds in city blocks. Special Problems of tall buildings, Building codes, Building ventilation and Architectural aerodynamics.

UNIT IV FLOW INDUCED VIBRATIONS 9

Effect of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Buffeting, Vortex Shedding, Galloping and flutter.

UNIT V INDUSTRIAL GAS TURBINES 9

Working of gas turbines, Special features of industrial and stationary gas turbines as compared to aircraft gas Turbines.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- exhibit the basic components and functions of wind energy collectors
- elaborate the aerodynamic performance of ground vehicles.
- analyze about the aerodynamics of various building
- identify the effects and functions of induced vibrations
- classify the subsystem of Industrial turbines.

TEXT BOOKS

1. T. Yomi Obidi, "Ground Vehicle Aerodynamics with Applications", SAE International, 2014.
2. Lawson, "Building Aerodynamics", Cambridge University Press, 2010.

REFERENCES

1. Tomomichi Nakamura, Shigehiko Kaneko, "Flow-Induced Vibrations: Classifications and Lessons From Practical Experiences", Second Edition, Academic Press, 2013.

2. A. R. Jha, "Wind Turbine Technology", CRC Press, 2010.

WEB LINKS

1. <http://www.wind-power-program.com/betz.htm>
2. <https://ntrl.bts.gov/DOCS/ch2.html>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO2	3	3	2	3	2	-	2	-	-	-	3	2	3	2
CO3	2	2	3	2	3	-	3	-	-	-	3	2	2	3
CO4	3	2	3	2	3	-	3	-	-	-	3	2	2	2
CO5	3	1	3	2	3	-	3	-	-	-	2	2	3	2



COURSE OBJECTIVES

To enable the students to

- introduce the students about the practical elements of experimental aerodynamics and to develop an appreciation for how aerodynamic data are acquired.
- gain a working knowledge of experimental test facilities, techniques and equipment commonly used in the field of experimental aerodynamics
- present the flow visualization techniques involved in aerodynamic testing
- understand the instruments which is used to measure the physical properties such velocity, pressure and temperature
- provide the students with an opportunity to apply modern instrumentation and measurement techniques to the acquisition of aerodynamic data

UNIT I BASIC MEASUREMENTS IN FLUID MECHANICS 9

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, Experiments on Taylor Proudman theorem and Ekman layer.

UNIT II WIND TUNNEL MEASUREMENTS 9

Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels ,Power losses in a wind tunnel, Instrumentation and calibration of wind tunnels, Turbulence - Wind tunnel balance, Principle and application and uses.

UNIT III FLOW VISUALIZATION AND ANALOGUE METHODS 9

Visualization techniques, Smoke tunnel, Hele-Shaw apparatus, Interferometer, Fringe-Displacement method, Shadowgraph, Schlieren system, Background Oriented Schlieren (BOS) System, Hydraulic analogy, Hydraulic jumps, Electrolytic tank.

UNIT IV PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS 9

Pitot-Static tube characteristics, Velocity measurements, Hot-wire anemometry, Constant current and Constant temperature Hot-Wire anemometer, Hot-film anemometry, Laser Doppler Velocimetry (LDV), Particle Image Velocimetry (PIV), Pressure Sensitive Paints, Pressure measurement techniques. Pressure transducers, Temperature measurements.

UNIT V DATA ACQUISITION SYSTEMS AND UNCERTAINTY ANALYSIS 9

Data acquisition and processing Signal conditioning, Estimation of measurement errors, Uncertainty Calculation. Uses of uncertainty analysis.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- execute the basic measurements used in aerodynamics
- operate different types of wind tunnels and calibration of the instruments associated with them.
- elaborate the various instruments used in wind tunnel.

- identify the various instruments used to measure the air properties
- analyze the uncertainty situations by using instruments.

TEXT BOOKS

1. F Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids", CRC Press - Taylor and Francis, 2007
2. Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press,

REFERENCES

1. Pavian, Henry Christensen, "Experimental Aerodynamics", 1st edition, Pitman Pub, 2006
2. G P Russo, "Aerodynamic Measurements: From Physical Principles to Turnkey Instrumentation", publishing, 2011

WEB LINKS

1. <http://nptel.ac.in/courses/101106040/>
2. <http://soliton.ae.gatech.edu/labs/windtunl/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	-	2	-	2	-	-	2	3	3
CO2	2	3	2	3	2	-	2	-	-	-	-	3	3	2
CO3	-	2	3	2	3	-	3	-	3	-	-	2	2	3
CO4	3	2	3	2	3	-	2	-	3	-	-	2	2	2
CO5	2	1	3	3	2	-	3	-	2	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- introduce the basic concepts of hypersonic aerodynamics
- understand the methods for hypersonic inviscid flows
- know about the viscous hypersonic flow theory
- build up necessary features for viscous interactions in hypersonic flows
- study about the high temperature effects in hypersonic flows

UNIT I FUNDAMENTALS OF HYPERSONIC AERODYNAMICS 9

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.

UNIT II SIMPLE SOLUTION METHODS FOR HYPERSONIC INVISCID FLOWS 9

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.

UNIT III VISCOUS HYPERSONIC FLOW THEORY 9

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.

UNIT IV VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9

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.

UNIT V HIGH TEMPERATURE EFFECTS IN HYPERSONIC FLOWS 9

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.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- exhibit the components and functions hypersonic aerodynamics
- carry out the aerodynamic performance of hypersonic inviscid flows
- elaborate the viscous hypersonic flow theory
- identify the effects and functions of viscous interactions in hypersonic flows
- identify the effects and functions of viscous interactions in hypersonic flows

TEXT BOOKS

1. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", Mc.Graw hill Series, New York, 1996.

REFERENCES

1. John D. Anderson, Jr., "Modern Compressible flow with historical Perspective", Mc Graw Hill Publishing Company, New York, 1996.
2. John T. Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc., Washington. D.C.1994.

WEB LINKS

1. <http://nptel.ac.in/courses/101103003/>
2. <https://arc.aiaa.org/doi/abs/10.2514/3.25879>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	-	2	-	2	-	-	2	3	3
CO2	2	3	2	3	2	-	2	-	-	-	-	3	3	2
CO3	-	2	3	2	3	-	3	-	3	-	-	2	2	3
CO4	3	2	3	2	3	-	2	-	3	-	-	2	2	2
CO5	2	1	3	3	2	-	3	-	2	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- know the importance of non dimensional number
- understand the application of various types of wind tunnels
- learn the basic measurement procedure involving wind tunnel testing
- interpret the basic concepts of measurement of forces and moments on models during the wind tunnel
- perform the flow visualization

UNIT I PRINCIPLES OF MODEL TESTING 8

Methods of Dimension analysis- Buckingham - theorem - non-dimensional numbers - model laws - Scale effect and types of similarities

UNIT II WIND TUNNELS 9

Classification - special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions - layouts - sizing and design parameters

UNIT III CALIBRATION OF WIND TUNNEL 9

Test section speed - horizontal buoyancy - flow angularities - turbulence measurements - associated instrumentation - calibration of supersonic tunnels

UNIT IV WIND TUNNEL MEASUREMENTS 10

Pressure and velocity measurements - force measurements - three component and six component balances - internal balances

UNIT V FLOW VISUALIZATION 9

Smoke and tuft grid techniques - Water flow visualization method - dye injection special techniques -optical methods of flow visualization

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the methods of dimensional analysis
- acquire knowledge about wind tunnel
- calibrate the wind tunnel
- understand the wind tunnel measurement
- visualize the flow over the component by using various techniques

TEXT BOOKS

1. Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984,
2. NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998

REFERENCES

1. Rae, W.H. and Pope, A. "Low Speed Wind Tunnel Testing", John Wiley Publication, 2003
2. Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press, Taylor and Francis, 2006
3. Antonio Viviani, Giuseppe Pezzella, "Aerodynamic and Aero thermodynamic Analysis of Space Mission

Vehicles", Springer Aerospace Technology, 2015

4. Pavian, Henry Christensen, "Experimental Aerodynamics", 1st edition, Pitman Publishing, 2001.
5. F Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids", CRC Press - Taylor and Francis, 2007.

WEB LINKS

1. <http://nptel.ac.in/courses/101106040/8>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	3	3	-	-	-	3	2	-	2	3	2
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CO3	2	2	2	3	1	-	-	-	-	-	-	3	2	3
CO4	3	2	3	3	2	-	-	-	-	-	-	3	2	3
CO5	3	2	1	2	2	-	-	-	-	-	-	3	3	3



OPEN ELECTIVE I

AEI6901

AIRCRAFT RULES AND REGULATIONS

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the responsibility of owner / operator / CAR of aircraft
- learn the procedure for the preparation of aircraft maintenance and TBO
- enhance the knowledge on various procedures for issue and revalidation of organization certifications
- understand the procedures for various classifications and inspection procedures
- know the various logbook, documents used in aircrafts and its importance

UNIT I C.A.R. SERIES 'A' and C.A.R. SERIES 'B' 9

Introduction to FAA – IATA regulations and its relevance to CAR – Responsibilities of operators / owners – Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate – Airworthiness regulations and safety oversight of engineering activities of operators - Issue Approval of Cockpit check list - MEL, CDL: Deficiency list (MEL and CDL) – Preparation and use of cockpit checklist and emergency list.

UNIT II C.A.R. SERIES 'C' and C.A.R. SERIES 'D' 9

Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings and recordings; Maintenance control by Reliability. Method. Reliability Programmes (Engines) – Aircraft maintenance programme and their approval – On condition maintenance of reciprocating engines – TBO – Revision programme – Maintenance of fuel and oil uplift and consumption records – Light aircraft engines – Fixing routine maintenance periods.

UNIT III C.A.R. SERIES 'E' and C.A.R. SERIES 'F' 9

Approval of organizations in categories A, B, C, D, E, F, and G – Requirements of infrastructure at stations other than parent base. Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness Requirements for renewal of Certificate of Airworthiness.

UNIT IV C.A.R. SERIES 'L' and C.A.R. SERIES 'M' 9

Issue of AME License, its classification and experience requirements, Mandatory / Inspections.

UNIT V C.A.R. SERIES 'X' 9

Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits and to be Physician's kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document carried on board on Indian registered aircraft; Procedure for issue of tax permit.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- identify the various aviation standards in quality assurance, safety rules and regulations.
- differentiate the certification standards and licensing standards.
- predict various aeronautical organization standards and regulations.
- conclude the Aviation laws and regulations related to each type of organization.
- analyze flight testing certification standards.

TEXT BOOKS

1. „Civil Aviation Requirements with Latest Amendment (Section 2 Airworthiness)“, Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi, 2000.
2. FAA, Quality regulation document - VS 1300.2C

REFERENCES

1. Aircraft Manual (India) – Latest Edition, the English Book Store, 17-1, Connaught Circus, New Delhi.
2. Wg Cdr D P Sabharwal (Retd.), „Q and A – Objective and subjective for CARSection-2“.

WEB LINKS

1. <http://nptel.ac.in/courses/101104071/>
2. [http://nptel.ac.in/courses/101106035/001_Chapter%201_L1_\(01-10-2013\).pdf](http://nptel.ac.in/courses/101106035/001_Chapter%201_L1_(01-10-2013).pdf)
3. <http://nptel.ac.in/courses/101104071/8>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO3	-	2	3	3	2	-	2	-	-	-	-	2	2	3
CO4	-	3	2	2	3	-	3	-	-	-	-	2	2	2
CO5	-	3	3	2	3	-	3	-	-	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- learn how wind is generated and possible ways of extracting the same.
- estimate the resource potential.
- learn the aerodynamic forces and basics theories of wind turbine.
- make the students to understand the aerodynamic design aspects and controlling methods of wind turbines.
- introduce the environmental aspects of wind energy production.

UNIT I INTRODUCTION TO WINDENERGY 8

Background, Wind speed variation, Motivations, and Constraints, Historical perspective, Modern wind turbines, Components and geometry.

UNIT II WIND RESOURCES AND CHARACTERISTICS 8

General characteristics of the wind resource, Atmospheric boundary layer characteristics, Wind data analysis and resource estimation, Wind turbine energy production .

UNIT III WIND TURBINE AERODYNAMICS 11

Overview , Forces from wind, Lift and Drag forces, Airfoils and aerodynamic concepts ,1-D Momentum theory, Ideal horizontal axis wind turbine with wake rotation, blade element theory, General rotor blade shape performance prediction

UNIT IV WIND TURBINE DESIGN AND CONTROL 9

Brief design overview, Wind turbine control systems, Typical grid, connected turbine operation, Basic concepts of electric power, Electrical machines.

UNIT V ENVIRONMENTAL SITE AND ASPECTS 9

Wind turbine siting, Installation and operation, Wind farms, Overview of wind energy Economics, Electromagnetic interference, noise, Safety-Concepts in wind turbine development.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- operate a wind farm and economics of power generation.
- prepare and evaluate detailed project reports for establishing a wind farm.
- elaborate the aerodynamic forces and fundamental theories of wind turbine.
- design and analyze the aerodynamics performance of wind turbines.
- compare the environmental sites and aspects of wind farms.

TEXT BOOKS

1. Emil Simiu and Robert H Scanlan, "Wind effects on structures - Fundamentals and Applications to Design", John Wiley and Sons Inc New York, 2016.
2. Ahmad Hemami, "Wind Turbine Technology", Cengage learning, Canada, 2012.

REFERENCES

1. Tom Lawson, "Building Aerodynamics", Imperial College Press London, 2001
2. G P Russo, "Aerodynamic Measurements: From Physical Principles to Turnkey Instrumentation", Woodhead publishing, 2003.
3. N J Cook, "Design Guides to wind loading of buildings structures- Part I and II", Butterworths London, 2014
4. IS: 875 (1987) Part III Wind loads, Indian Standards for Building codes", 2009.

WEB LINKS

1. <http://nptel.ac.in/courses/101105059/>
2. <https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005/lecture-notes/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	-	2	-	2	-	-	2	3	3
CO2	2	3	2	3	2	-	2	-	-	-	-	3	3	2
CO3	-	2	3	2	3	-	3	-	3	-	-	2	2	3
CO4	3	2	3	2	3	-	2	-	3	-	-	2	2	2
CO5	2	1	3	3	2	-	3	-	2	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- impart the knowledge of human factors and spatial disorientation.
- study the cause of runway incursion.
- gain knowledge of weather related problems in low and high altitudes.
- learn about the various mid air collision issues and rectification procedures.
- know about various air crash investigation reports by NTSB.

UNIT I HUMAN FACTORS 9

Judgment and Decision Making – Accurate Situation Assessment Leads to good Situational Awareness – Crew Resource Management – Crew effectiveness – Spatial Disorientation – Types of Spatial Disorientation.

UNIT II RUNWAY INCURSIONS 9

Runway Incursion severity categories – Reported Runway Incursions by Severity – Distribution by Aircraft type and Combination

UNIT III WEATHER 9

Air Masses and Fronts – Types of Fronts – Cloud Formations – Low, Medium, High clouds – Thunderstorms – Aircraft performance in Heavy rains – Icing conditions – Types of Clouds – Turbulence

UNIT IV MID AIR COLLISIONS 9

Mid air collision avoidance – Eye brain connection – Eye movement – Distant visual Acuity – Cockpit creates monocular visual areas – Effective scanning based on sectors – Enhancing visual skills.

UNIT V AIR CRASH INVESTIGATION - CASE STUDIES 9

American Airlines Flight 1420 – USA flight 1493 - Sky west flight 5569 - Delta Airlines flight 191 – Air France flight 4590 - TWA flight 800.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- compare the features of various human factors.
- describe the principle and avoidance of runway incursion.
- analyze the various weather problems during VFR and IFR flight.
- acquire and interpret data of various mid air collisions.
- acquire knowledge of old air crash and investigation procedures.

TEXT BOOKS

1. Krause, Shari Stamford, Air Safety/ Accident Investigation, analysis and applications, Tata McGraw Hill, New Delhi, 2009 .

REFERENCES

1. Seth B. Young, Alexander T. Wells, "Airport Planning and Management" McGraw- Hill Education, New Delhi, 2011.
2. M.S Nolan, "Fundamentals Air Traffic Control", Latest Edition, YESDEE Publishers, 2010

WEB LINKS

1. [http://nptel.ac.in/courses/101106035/001_Chapter%201_L1_\(01-10-2013\).pdf](http://nptel.ac.in/courses/101106035/001_Chapter%201_L1_(01-10-2013).pdf)
2. <http://www.nptel.ac.in/courses/112102107/16>
3. <http://nptel.ac.in/courses/112107143/40>

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CO4	3	2	3	2	3	-	2	-	3	-	-	2	2	2
CO5	2	1	3	3	2	-	3	-	2	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- understand the advanced concepts in Active Control Technology to the engineers
- provide the necessary mathematical knowledge that are needed in modeling physical processes
- have an exposure on various topics such as Automatic configuration management, design considerations
- know fly-by-wire concepts, flying qualities and control modes of combat aircraft
- deploy these skills effectively in the solution of problems in avionics engineering

UNIT I ACTIVE CONTROL FUNCTIONS**9**

Introduction-active control technology concepts-control configured vehicle-Design Philosophy, Aerodynamics: Relaxed static stability, Automatic Configuration management, side force control. Structures, Manoeuvre load control, Gust load alleviation, Ride smoothing, fatigue alleviation, Flutter-mode control, Propulsion and Flight Control Integration Technology (PROFIT)

UNIT II ACTIVE CONTROL DESIGN CONSIDERATIONS**10**

Stability augmentation, Command augmentation, Control of aircraft center of gravity, Elastic mode stabilization, and Gust load control, Reliability, redundancy

UNIT III FLY-BY-WIRE TECHNOLOGY**8**

Fly-By-Wire concepts. Primary and secondary electrical flight control system, Redundancy and architecture trade studies - analog and digital FBW Systems - Typical fly-by-wire flight control system elements - Application of fly-by-wire technology to civil and military aircraft.

UNIT IV FLYING QUALITIES**9**

Definition, Cooper - Harper rating scale - flying qualities requirements - Relaxed static stability flying qualities requirements - Lower order equivalent systems criteria Neal - Smith criteria.

UNIT V CONTROL MODES OF COMBAT AIRCRAFT**9**

Pitch rate Command - Attitude hold system - Carefree maneuvering - spin-stall prevention and similar. limiting concepts - Combat maneuvers

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of this course, students will be able to

- describe the knowledge of control function
- develop the active control design
- discuss about fly by wire system
- elaborate the needs of flying qualities
- differentiate the control modes used in aircrafts.

TEXT BOOKS

1. AGARD-AG-234, „Active controls aircraft Design“, 1978.
2. AGARD-CP-157, „Impact of active control technology in aircraft design“, 1975.

REFERENCES

1. AGARD-CP-260, „Stability and control”, 1978.
2. AGARD-CP-137, „Advance in Control systems”, 1974.
3. AGARD-CP-228, „Structural aspects of active Controls”, 1977.

WEB LINKS

1. <https://www.sciencedirect.com/science/article/pii/S147466701741086X>

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CO4	3	2	3	3	2	-	-	-	-	-	-	3	2	3
CO5	3	2	1	2	2	-	-	-	-	-	-	3	3	3



PAAVAI ENGINEERING COLLEGE, NAMAKKAL-637 008

AUTONOMOUS

B.E. AERONAUTICAL ENGINEERING

REGULATIONS 2015

CURRICULUM

SEMESTER - VII

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1.	PC	AE15701	Computational Fluid Dynamics	3	0	0	3
2.	PC	AE15702	Theory of Vibrations	3	0	0	3
3.	PC	AE15703	Aircraft Design	3	0	0	3
4.	PC	AE15704	Avionics	3	0	0	3
5.	PE	AE1535*	Programme Elective - III	3	0	0	3
6.	PE	AE1545*	Programme Elective - IV	3	0	0	3
Practical							
7.	PC	AE15705	Avionics and Aircraft Systems Laboratory	0	0	4	2
8.	PC	AE15706	Aircraft Design Project	0	0	2	1
9.	EE	AE15707	Comprehension and Technical Seminar	0	0	2	1
TOTAL				18	0	8	22

SEMESTER - VIII

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1.	PC	AE15801	Rockets and Missiles	3	0	0	3
2.	PE	AE1555*	Programme Elective - V	3	0	0	3
3.	PE	AE1565*	Programme Elective - VI	3	0	0	3
Practical							
4.	EE	AE15802	Project Work	0	0	12	6
TOTAL				9	0	12	15

Programme Elective – III

S.No.	Category	Course Code	Course Title	L	T	P	C
1.	PE	AE15351	Principle of Aero Elasticity	3	0	0	3
2.	PE	AE15352	Wind Power Engineering	3	0	0	3
3.	PE	AE15353	Theory of Plates and Shells	3	0	0	3
4.	PE	AE15354	Wind Tunnel Techniques	3	0	0	3

Programme Elective - IV

S.No.	Category	Course Code	Course Title	L	T	P	C
1.	PE	AE15451	Cryogenic Engineering	3	0	0	3
2.	PE	AE15452	Fuels and Combustion	3	0	0	3
3.	PE	AE15453	Advanced Propulsion Techniques	3	0	0	3
4.	PE	AE15454	Design of Flight Control System	3	0	0	3

Programme Elective – V

S.No.	Category	Course Code	Course Title	L	T	P	C
1.	PE	AE15551	Aircraft Safety	3	0	0	3
2.	PE	AE15552	Principles of UAV and MAV	3	0	0	3
3.	PE	AE15553	NDT for Aerospace Applications	3	0	0	3
4.	PE	AE15554	Missile Guidance and Controls	3	0	0	3

Programme Elective – VI

S.No.	Category	Course Code	Course Title	L	T	P	C
1.	PE	BA15151	Professional Ethics and Human Values	3	0	0	3
2.	PE	AE15651	Aviation Maintenance and Management	3	0	0	3
3.	PE	BA15451	Entrepreneurship Development	3	0	0	3
4.	PE	AE15652	Crisis Management in Aircraft Industry	3	0	0	3

SEMESTER VII

AE15701

COMPUTATIONAL FLUID DYNAMICS

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the basic flow equations, characteristics of mathematical model for a given flow.
- know the importance and significance of grid generation methods.
- gain the concepts of discretization, upwind differencing and implicit, explicit solutions
- familiarize with finite element techniques in computational fluid dynamics.
- identify aerospace application in computational fluid analysis.

UNIT I FUNDAMENTAL CONCEPTS

9

Introduction - Basic Equations of Fluid Dynamics - Review of Source sink Panel methods - lifting flows over arbitrary bodies. Mathematical properties of Fluid Dynamics Equations - Elliptic, Parabolic and Hyperbolic equations - Well posed problems - discretization of partial Differential Equations. Introduction to Finite

Difference method

UNIT II GRID GENERATION

9

Structured grids - Types and transformations - Generation of structured grids - Unstructured grids - Delany triangulation.

UNIT III DISCRETIZATION

9

Boundary layer Equations and methods of solution - Implicit time dependent methods for inviscid and viscous compressible flows - Concept of numerical dissipation - Stability properties of explicit and implicit methods - Conservative upwind discretization for Hyperbolic systems - Further advantages of upwind differencing.

UNIT IV FINITE VOLUME TECHNIQUES

9

Finite Volume Techniques - Cell Centered Formulation - Lax - Wendroff Time Stepping - Runge - Kutta Time Stepping - Multi - stage Time Stepping - Accuracy - Cell Vertex Formulation - Multistage Time Stepping - FDM like Finite Volume Techniques - Central and Up - wind Type Discretizations - Treatment of Derivatives. Flux - splitting schemes. Pressure correction solvers - SIMPLE, PISO. Vorticity transport formulation. Implicit/semi - implicit schemes

UNIT V APPLICATION OF CFD

9

Numerical solution of flow over a cylinder using 2-D panel methods using both vertex and source panel methods for lifting and non lifting cases respectively. Numerical solution of 1- D conduction - convection energy equation using time dependent methods using both implicit and explicit schemes - application of time split method for the above equation and comparison of the results

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- describe the flow phenomena in a flow field with correspondence with elliptic, parabolic and hyperbolic equations.

- clearly understand the steps involved in source and panel methods.
- describe the upwind concept and its effect in a given flow. Can understand the discretization of a flow model for analysis.
- can clearly understand the weighted variational formulae and Galerkin method of finite volume technique.
- know the numerical methods of aerospace application in computational analysis.

TEXT BOOKS

1. John F. Wendt (Editor), "Computational Fluid Dynamics - An Introduction", Springer - Verlag, Berlin, 1992.
2. Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics", Vols. I and II, Springer - Verlag, Berlin, 1988.

REFERENCES

1. Charles Hirsch, "Numerical Computation of Internal and External Flows", Vols. I and II. John Wiley and Sons, New York, 1988.
2. Anderson, Jr.D., "Fundamentals of Aerodynamics", McGraw-Hill, 2000.
3. Klaus A. Hoffmann and Steve T. Chiang. "Computational Fluid Dynamics for Engineers", Vols. I and II
4. Engineering Education System, P.O. Box 20078, W. Wichita, K.S., 67208 - 1078 USA, 1993.
5. Versteeg.H and Malalasekera W "An Introduction to Computational Fluid Dynamics: The Finite Volume Method" Prentice Hall, 2008

WEB LINKS

1. <http://nptel.ac.in/courses/112107080/>
2. <http://nptel.ac.in/courses/103106073/>
3. <http://nptel.ac.in/courses/112105045/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO4	2	1	2	-	-	2	-	-	-	-	2	2	3	2
CO5	3	2	3	-	2	2	-	-	-	-	2	1	3	2



COURSE OBJECTIVES

To enable the students to

- know about the basic terminologies
- gain the knowledge of the vibration measuring instrument
- study the vibration absorber
- learn the vibration of elastic bodies
- understand the different methods of finding natural frequency

UNIT I BASIC NOTIONS**6**

Simple harmonic motion - addition - Terminologies - Newton's Law - D'Alembert's principle - Energy Methods for free vibration

UNIT II SINGLE DEGREE OF FREEDOM SYSTEMS**9**

Free vibrations - Damped vibrations - Forced Vibrations, with and without damping - support excitation - Vibration measuring instruments

UNIT III MULTI DEGREES OF FREEDOM SYSTEMS**12**

Two degrees of freedom systems - Static and Dynamic couplings vibration absorber - Principal co - ordinates, and Principal modes and orthogonal condition - Eigen value problems. Hamilton's principle - Lagrangean equation application.

UNIT IV CONTINUOUS SYSTEMS**9**

Vibration of elastic bodies - Vibration of strings - Longitudinal, Lateral and Torsional vibrations.

UNIT V APPROXIMATE METHODS AND ELEMENTS OF AEROELASTICITY**9**

Rayleigh's method - Holzer Method - Vibration due to coupling of bending and torsion - aeroelastic problems - collars triangle wing divergence - aileron control reversal - flutter - buffeting elements of servo elasticity

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of the course, the students will be able to

- perform basic concept of vibration
- describe the working principles of Dampers and vibration measuring instruments
- differentiate parameters of a vibrating system
- compute the vibration on elastic bodies
- analyze the natural frequency for different kinds of methods

TEXT BOOKS

1. Timoshenko S., "Vibration Problems in Engineering" – John Wiley and Sons, New
2. Tse. F.S., Morse, I.F., Hinkle, R.T., "Mechanical Vibrations", – Prentice Hall, New York, 1984
3. Tongue. B. H., "Principles of Vibration", Oxford University Press, 2000.

REFERENCES

1. Gowda T, D.V.Girish, T.Jagadeesha, "Mechanical vibrations", McGraw Hill Edu, 2012.
2. Singiresu S. Rao "Mechanical Vibrations" 5th edition, Prentice Hall, 2010
3. Rao S S "Mechanical Vibrations" Prentice Hall, Fifth edition, 2010.

WEB LINKS

1. <http://nptel.ac.in/courses/112103111/>
2. <http://nptel.ac.in/courses/112103112/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO3	2	2	3	2	3	-	3	-	-	-	3	2	2	3
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CO5	3	1	3	2	3	-	3	-	-	-	2	2	3	2



COURSE OBJECTIVES

To enable the students to

- familiarize students with the important issues and methodologies of aircraft design.
- understand the effect of wing loading of aircraft design.
- construct the wing, fuselage and tail arrangements of an aircraft.
- acquire the knowledge on sizing and thrust calculation of aircraft engine.
- illustrate the process of aircraft synthesis as an outcome of the integration of the disciplines of performance and stability and control.

UNIT I INTRODUCTION TO AIRCRAFT DESIGN 9

Operational specification - mission requirements - Design process - flow chart - Survey of various types of airplanes Take - off weight - Preliminary Estimate - Tire selection - landing gear design - Spread sheet approach.

UNIT II PRELIMINARY AIRCRAFT DESIGN 8

Selection of wing loading - Initial Airplane layout, Three view drawings, Arrangement of surfaces, mass, moment and inertia properties and balance Diagram, Wing loading effect on take-off, landing, climb, acceleration, range, Combat - flight ceiling - glide rate.

UNIT III DESIGN OF AIRCRAFT STRUCTURAL COMPONENTS 8

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 for fuselage. Tail arrangements: Horizontal and vertical tail sizing, Tail planform shapes, Airfoil selection type, Tail Placement, Spread sheets for tail design.

UNIT IV DESIGN OF PROPULSION SYSTEM 9

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, Piston and turbo-prop sizing, Propeller spread sheets.

UNIT V PERFORMANCE ESTIMATION AND STABILITY ANALYSIS 11

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, lift and drag determination, Active lift enhancement, Drag polar, Power to climb. Static stability: Control surface sizing. Effect of static margin on performance Lateral and directional static Stability, contribution of airframe components, Aileron sizing, rudder area sizing.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- conduct trade-off between the conflicting demands of different disciplines by performing a detailed preliminary design of a complete aircraft.
- select the wing planform based on the mission requirements
- design the control surfaces based on the stability requirements

- estimate weight, wing loading and other performance parameters related to conceptual design of a complete aircraft.
- select the appropriate power plant for the aircraft and Identify design features of aerospace structures, and calculate load factors

TEXT BOOKS

1. Tomas C Corke., "Design of Aircraft," Person Education, LPE, 2003.
2. John P Fielding, Introduction to Aircraft Design Cambridge University Press, 1999

REFERENCES

1. Darrol Stinton D., "The Design of the Aeroplane", Black Well Science, 2nd Edition, 2001.
2. Daniel P. Raymer, "Aircraft Design: A Conceptual approach", AIAA Education Services, 1992.
3. "Jane's All the Worlds Aircraft" Janes Information Group, 2017

WEB LINKS

1. https://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/amt_handbook/
2. https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/pilot_handbook.pdf

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CO5	-	3	-	3	2	2	-	-	3	-	3	2	3	2



COURSE OBJECTIVES

To enable the students to

- understand the needs for avionics for both Civil and military aircraft.
- introduce various digital electronic principles and working operations of digital circuit.
- integrate the digital electronics with cockpit equipments
- understand the various principles in flight deck and cockpit panels.
- study the communication and navigation equipment

UNIT I INTRODUCTION TO AVIONICS

9

Basics of Avionics-Basics of Cockpits-Need for Avionics in civil and military aircraft and space systems - Design Integrated Avionics Architecture - Military and Civil system - Typical avionics System and Sub systems - and Technologies.

UNIT II DIGITAL AVIONICS BUS ARCHITECTURE

9

Avionics Bus architecture – Data buses MIL – RS 232 - RS422 - RS 485-AFDX/ARINC 664 - MIL STD 1553 B- ARINC 429 – ARINC 629 - Aircraft system Interface

UNIT III FLIGHT DECK AND COCKPITS

9

Control and display technologies CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – ARINC 818-Civil cockpit and military cockpit: MFDS, PFDS-HUD, HMD, HMI

UNIT IV AVIONICS SYSTEMS

9

Communication Systems – Navigation systems – Flight control systems – Radar electronic Warfare – Utility Systems Reliability and maintainability Fundamentals - Certification - Military and civil aircrafts.

UNIT V ON BOARD NAVIGATION SYSTEMS

9

Over view of navigational aids, Flight planning, Area navigation, required time of arrival, RNAV architecture , performance aspects, approach and landing challenges, regulatory and safety aspects, INS, GPS and GNSS characteristics.

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of the course, the students will be able to

- analyze the hardware required for aircraft.
- develop the knowledge about the digital avionics architecture
- discuss about the autopilot and cockpit display related concepts.
- elaborate the needs of avionics systems used in aircrafts.
- compare the communication and navigation techniques used in aircrafts.

TEXT BOOKS

1. R.P.G. Collinson, "Introduction to Avionics", Chapman and Hall Publications, 1996.
2. Spitzer, C.R. "Digital Avionics Systems", Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987.

REFERENCES

1. Cary R. Spitzer, "The Avionics Handbook", CRC Press, 2000.
2. Middleton, D.H. "Avionics Systems", Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
3. Brain Kendal, "Manual of Avionics", The English Book House, 3rd Edition, New Delhi, 1993
4. Jim Curren, "Trend in Advanced Avionics", IOWA State University, 1992.

WEB LINKS

1. nptel.ac.in/courses/117105082
2. <https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-682-prototyping-avionics-spring-2006/>

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CO5	2	1	3	3	2	-	3	-	2	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- understand the basic cockpit system operations of aircraft
- familiarize the basic circuits used in avionic systems.
- impart the knowledge of hydraulic landing gear system.
- learn about the various types of microprocessor.

LIST OF EXPERIMENTS

1. Aircraft Jacking Up and Leveling procedure
2. Control System Rigging check procedure
3. Brake Torque Load Test on wheel brake units
4. Landing gear retraction test
6. Pressure Test procedure on fuel system components
7. Addition/Subtraction of binary numbers.
8. Multiplexer/Demultiplexer Circuits.
9. Encoder/Decoder Circuits.
10. Timer Circuits, Shift Registers, Binary Comparator Circuits.
11. Addition and Subtraction of 8-bit and 16-bit numbers.
12. MIL-Std – 1553 Data Buses Configuration.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- test the control systems
- use the microprocessor
- identify the operations of circuits
- analyze the problems in landing gear and brake system.

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CO3	1	2	3	1	1	-	-	-	-	-	2	2	2	3
CO4	3	2	2	1	3	2	-	-	-	-	3	2	2	2



COURSE OBJECTIVES

To enable the students to

- design and Analyze an Airplane (any other flight vehicle)
- understand the basic concepts of shear force, shear flow and bending moment diagram.
- impart the knowledge of analyzing and comparing the performance of various aircraft.
- learn the preparation of design project report.

LIST OF EXPERIMENTS

1. Comparative configuration study of different types of airplanes
2. Comparative study on specification and performance details of aircraft
3. Preparation of comparative data sheets
4. Work sheet layout procedures
5. Comparative graphs preparation and selection of main parameters for the design
6. Preliminary weight estimations, selection of main parameters,
7. Power plant selection, Aerofoil selection, Wing tail and control surfaces
8. Performance and stability analysis
9. Structural design study – Theory approach
10. Shear force diagram and bending moment diagram for wing and fuselage.
11. Balancing and maneuvering loads on tail plane, Aileron and Rudder loads.
12. Shear flow and the diagram for the wing and fuselage structure.
13. Preparation of a detailed design report with three view drawings.

TOTAL PERIODS 30

COURSE OUTCOMES

At the end of this course, students will be able to

- understand the design requirements
- compare the data of different aircraft
- analyze the performance of aircraft
- estimate the design factor for a wing and fuselage.

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	-	2	-	-	-	2	2	3	3
CO2	3	3	2	3	2	-	2	-	-	-	3	2	3	2
CO3	2	2	3	2	3	-	3	-	-	-	3	2	2	3
CO4	3	2	3	2	3	-	3	-	-	-	3	2	2	2



COURSE OBJECTIVES

To enable the students to

- clear various competitive exams
- understand the basic concepts in the field of aeronautics.
- learn the basic of flight mechanics and aerodynamics
- regain the basics of structure and propulsion

FLIGHT MECHANICS

Basics: Atmosphere: Properties, standard atmosphere. Classification of aircraft. Airplane (fixed wing aircraft) configuration and various parts

Airplane performance: Pressure altitude; equivalent, calibrated, indicated air speeds; Primary flight instruments: Altimeter, ASI, VSI, Turn-bank indicator. Drag polar; takeoff and landing: steady climb and descent, absolute and service ceiling; cruise, cruise climb, endurance or loiter; load factor, turning flight, V-n diagram; Winds: head, tail and cross winds

Static stability: Angle of attack, sideslip; roll, pitch and yaw controls; longitudinal stick fixed and free stability, horizontal tail position and size; directional stability, vertical tail position and size; dihedral stability. Wing dihedral, sweep and position; hinge moments, stick forces

AERODYNAMICS

Basic Fluid Mechanics: Conservation laws: Mass, momentum (Integral and differential form); Potential flow theory: sources, sinks, doublets, line vortex and their superposition; Viscosity, Reynolds number

Airfoils and wings: Airfoil nomenclature; Aerodynamic coefficients: lift, drag and moment; Kutta-Joukowski theorem; Thin airfoil theory, Kutta condition, starting vortex; Finite wing theory: Induced drag, Prandtl lifting line theory; Critical and drag divergence Mach number

Compressible Flows: Basic concepts of compressibility, Conservation equations; One dimensional compressible flows, Fanno flow, Rayleigh flow; Isentropic flows, normal and oblique shocks, Prandtl-Meyer flow; Flow through nozzles and diffusers

STRUCTURES

Strength of Materials: States of stress and strain. Stress and strain transformation. Mohr's Circle. Principal stresses. Three-dimensional Hooke's law. Plane stress and strain; Failure theories: Maximum stress, Tresca and von Mises; Strain energy. Castigliano's principles. Analysis of statically determinate and indeterminate trusses and beams. Elastic flexural buckling of columns.

Flight vehicle structures: Characteristics of aircraft structures and materials. Torsion, bending and flexural shear of thin-walled sections. Loads on aircraft

Structural Dynamics: Free and forced vibrations of undamped and damped SDOF systems. Free vibrations of undamped 2-DOF systems.

PROPULSION

Basics: Thermodynamics, boundary layers and heat transfer and combustion thermochemistry. Thermodynamics of aircraft engines: Thrust, efficiency and engine performance of turbojet, turboprop, turbo shaft, turbofan and ramjet engines, thrust augmentation of turbojets and turbofan engines. Aerothermodynamics of non-rotating propulsion components such as intakes, combustor and nozzle.

Axial compressors: Angular momentum, work and compression, characteristic performance of a single axial compressor stage, efficiency of the compressor and degree of reaction. Axial turbines: Axial turbine stage efficiency

Centrifugal compressor: Centrifugal compressor stage dynamics, inducer, impeller and diffuser.

Rocket propulsion: Thrust equation and specific impulse, vehicle acceleration, drag, gravity losses, multi-staging of rockets. Classification of chemical rockets, performance of solid and liquid propellant rockets

TOTAL PERIODS 30

COURSE OUTCOMES

At the end of the course, the students will be able to

- explore the basic concepts of flight dynamics, aerodynamics, structures and propulsion.
- plan missions to prepare for their successful professional careers.
- excel in professional career and higher education by acquiring knowledge.
- clear the competitive exams

TEXT BOOKS

1. John D. Anderson "Introduction to Flight", McGraw-Hill Higher Education, 7th edition, 2011.
2. Courtland D. Perkins, Robert E. Hage, "Airplane Performance stability and Control", Wiley India Pvt Ltd, 2011.

REFERENCES

1. Robert Nelson, "Flight Stability and Automatic Control", 2nd Edition, McGraw Hill Education (India) Private Limited, 2007.
2. Anderson J.D, "Fundamentals of Aerodynamics", 5th Edition, McGraw Hill Education India Private Limited, 2010.
3. Radhakrishnan E, "Gas Dynamics", Fifth Edition, PHI Learning Private Limited – New Delhi, 2014.
4. Megson T M G, "Aircraft Structures for Engineering Students", Butterworth Heinemann, 2012.
5. Thammaiah Gowda, D.V.Girish, T.Jagadeesha "Mechanical vibrations", McGraw Hill Education, 2012.
6. P.G. Hill and C.R. Peterson, "Mechanics and Thermodynamics of Propulsion", Addison – Wesley Longman INC, 2009.
7. G. P. Sutton, "Rocket Propulsion Elements", John Wiley and Sons Inc., New York, 8th Edition, 2010.

WEB LINKS

1. https://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/amt_handbook/

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	-	2	-	-	-	2	2	3	3
CO2	3	3	2	3	2	-	2	-	-	-	3	2	3	2
CO3	2	2	3	2	3	-	3	-	-	-	3	2	2	3
CO4	3	2	3	2	3	-	3	-	-	-	3	2	2	2



SEMESTER VIII

AE15801

ROCKETS AND MISSILES

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- know the classification of Rockets and Missiles
- understand the aerodynamic forces of Rockets and Missiles
- estimate the velocity and altitude of the circumstance
- learn the various stage of Rockets and Missiles
- introduce the various control methods of Rockets and Missiles

UNIT I CLASSIFICATION OF ROCKETS AND MISSILES 8

Various methods of classification of missiles and rockets – Basic aerodynamic characteristics of surface to surface, surface to air, air to surface and air to air missiles – Examples of various Indian space launch vehicles and missiles – Current status of Indian rocket programme with respect to international scenario

UNIT II AERODYNAMICS OF ROCKETS AND MISSILES 8

Airframe components of rockets and missiles – forces acting on a missile while passing through atmosphere – classification of missiles – slender body aerodynamics – method of describing forces and moments – lift force and lateral moment – lateral aerodynamic damping moment – longitudinal moment – drag estimation – upwash and downwash in missile bodies – rocket dispersion.

UNIT III ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD 11

One dimensional and two-dimensional rocket motions in free space and homogeneous gravitational fields – description of vertical, inclined and gravity turn trajectories – determination of range and altitude – simple approximations to determine burn out velocity and altitude – estimation of culmination time and altitude.

UNIT IV STAGING OF ROCKETS AND MISSILES 9

Design philosophy behind multistaging of launch vehicles and ballistic missiles – optimization of multistage vehicles – stage separation techniques in atmosphere and in space – stage separation dynamics and lateral separation characteristics.

UNIT V CONTROL OF ROCKETS AND MISSILES 9

Introduction to aerodynamic and jet control methods – various types of aerodynamic control methods for tactical and short range missiles- aerodynamic characteristics - various types of thrust vector control methods including secondary injection thrust vector control for launch vehicles and ballistic missiles.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- identify the types of Rockets and Missiles
- analyze the aerodynamic characteristics of Rockets and Missiles
- compute the trajectory
- compare the various stages of Rockets and Missiles
- analyze the controls of Rockets and Missiles

TEXT BOOKS

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman and Co., Ltd, London, 1982
2. Sutton, G.P., "Rocket Propulsion Elements", John Wiley and Sons Inc., New York, 5th Edition, 1993.

REFERENCES

1. Parker, E.R., "Materials for Missiles and Spacecraft", McGraw Hill Book Co. Inc. 1982.
2. Mathur M.L and Sharma, R.P "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers and Distributors, Delhi, 1988.

WEB LINKS

1. <http://nptel.ac.in/courses/112106073/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	-	2	-	2	-	-	2	3	3
CO2	2	3	2	3	2	-	2	-	-	-	-	3	3	2
CO3	-	2	3	2	3	-	3	-	3	-	-	2	2	3
CO4	3	2	3	2	3	-	2	-	3	-	-	2	2	2
CO5	2	1	3	3	2	-	3	-	2	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- get trained in preparing project reports and how to face reviews and viva voce examinations.
- develop ability to identify problems to solve through project works.
- acquire knowledge on literature review related to project problem and how to find the gap.
- gain exposure to required design procedure, experimental setup, analysis package to solve the identified problem.

GUIDELINES

1. The students are expected to get formed into a team of convenient groups of not more than 4 members for a project.
2. Every project team shall have a guide who is the member of the faculty of the institution.
3. The group has to identify and select the problem to be addressed as their project work through literature survey and finalize a comprehensive aim and scope of their work.
4. Reviews of the progress of the project work have to be conducted by a team of faculty (minimum 3 and a maximum of 5) along with their faculty guide as a member the review team.
5. Progress of project work has to be monitored by the project guide and committee periodically.
6. Attendance for review is mandatory. If a student fails to attend review for some valid reasons, one more chance may be given.
7. The project report should be submitted by the students around the first week of April.

TOTAL PERIODS 180

COURSE OUTCOME

At the end of the course, the students will be able to

- take up any challenging practical problems and find solution by formulating proper methodology
- collect literature through research journals and identify the gap in selected area
- devise the methodology to find solution through gathering complete knowledge on materials/design procedure/analysis and optimisation techniques/ availability of experimental setup/ company permission and other documentation procedures to execute the project.
- prepare project report as per format and confidently face viva voce with proper PPT for presentation

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	3	2	3	3	-	3	-	3	2	3	3
CO2	3	2	2	3	2	2	-	-	2	-	2	2	3	2
CO3	2	3	3	2	2	2	2	-	2	-	3	-	2	3
CO4	2	3	2	3	1	3	-	-	3	-	2	2	2	2



PROGRAMME ELECTIVE III

AE15351

PRINCIPLE OF AERO ELASTICITY

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- make the students to understand aero elastic phenomena
- understand the theoretical concepts of material behavior with particular emphasis on their elasticity properties
- solve steady state aero elastic problems.
- know the flutter phenomena
- learn the various noise sources found on different types of airplane

UNIT I AEROELASTIC PHENOMENA 6

Stability versus response problems - The aero-elastic triangle of forces - Aeroelasticity in Aircraft Design - Prevention of aeroelastic instabilities. Influence and stiffness coefficients. Coupled oscillations.

UNIT II DIVERGENCE OF A LIFTING SURFACE 10

Simple two dimensional idealizations-Strip theory - Integral equation of the second kind - Exact solutions for simple rectangular wings - „Semi rigid” assumption and approximate solutions - Generalized coordinates - Successive approximations - Numerical approximations using matrix equations.

UNIT III STEADY STATE AEROLASTIC PROBLEMS 9

Loss and reversal of aileron control - Critical aileron reversal speed - Aileron efficiency - Semi rigid theory and successive approximations - Lift distribution - Rigid and elastic wings. Tail efficiency. Effect of elastic deformation on static longitudinal stability.

UNIT IV FLUTTER PHENOMENON 14

Non-dimensional parameters - Stiffness criteria - Dynamic mass balancing - Dimensional similarity. Flutter analysis - Two dimensional thin airfoils in steady incompressible flow - Quasi steady aerodynamic derivatives. Galerkin method for critical flutter speed - Stability of disturbed motion - Solution of the flutter determinant - Methods of determining the critical flutter speeds - Flutter prevention and control.

UNIT V INTRODUCTION TO THEORY OF PLATES AND SHELLS 6

Classical plate theory - Assumptions - Governing equations - Boundary conditions - Navier's method of solution for simply supported rectangular plates - Levy's method of solution for rectangular plates under different boundary conditions.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- acquire knowledge about aeroelasticity
- compare theoretical concepts of material behavior with particular emphasis on their elasticity property
- analyze the problems in aeroelasticity
- identify the flutter prevention and control measures
- examine the various noise sources found on different types of airplane

TEXT BOOKS

1. Y.C. Fung, "An Introduction to the Theory of Aeroelasticity", John Wiley and Sons Inc., New York, 2008.
2. E.G. Broadbent, "Elementary Theory of Aeroelasticity", Bun Hill Publications Ltd., 1986

REFERENCES

1. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, "Aeroelasticity", II Edition Addison Wesley Publishing Co, Inc, 1996.
2. R.H. Scanlan and R.Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.
3. R.D.Blevins, "Flow Induced Vibrations", Krieger Pub Co., 2001.
4. G.J.J.Ruijgrok, "Elements Of Aviation Acoustics", Yes Pub Pvt.2004.

WEB LINKS

1. <http://nptel.ac.in/syllabus/101104005/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	-	2	-	-	-	2	2	3	3
CO2	3	3	2	3	2	-	2	-	-	-	3	2	3	2
CO3	2	2	3	2	3	-	3	-	-	-	3	2	2	3
CO4	3	2	3	2	3	-	3	-	-	-	3	2	2	2
CO5	3	1	3	2	3	-	3	-	-	-	2	2	3	2



COURSE OBJECTIVES

To enable the students to

- learn how wind is generated and possible ways of extracting the same.
- estimate the resource potential.
- learn the aerodynamic forces and basics theories of wind turbine.
- make the students to understand the aerodynamic design aspects and controlling methods of wind turbines.
- introduce the environmental aspects of wind energy production.

UNIT I INTRODUCTION TO WIND ENERGY 8

Background, Wind speed variation, Motivations, and Constraints, Historical perspective, Modern wind turbines, Components and geometry.

UNIT II WIND RESOURCES AND CHARACTERISTICS 8

General characteristics of the wind resource, Atmospheric boundary layer characteristics, Wind data analysis and resource estimation, Wind turbine energy production.

UNIT III WIND TURBINE AERODYNAMICS 11

Overview, Forces from wind, Lift and Drag forces, Airfoils and aerodynamic concepts, 1-D Momentum theory, Ideal horizontal axis wind turbine with wake rotation, blade element theory, General rotor blade shape performance prediction.

UNIT IV WIND TURBINE DESIGN AND CONTROL 9

Brief design overview, Wind turbine control systems, Typical grid, connected turbine operation, Basic concepts of electric power, Electrical machines.

UNIT V ENVIRONMENTAL SITE AND ASPECTS 9

Wind turbine siting, Installation and operation, Wind farms, Introduction To offshore wind turbine Overview of wind energy Economics, Electromagnetic interference, noise, Safety-Concepts in wind turbine development.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- Operate wind farm and economics of power generation.
- prepare and evaluate detailed project reports for establishing a wind farm.
- elaborate the aerodynamic forces and fundamental theories of wind turbine.
- design and analyze the aerodynamics performance of wind turbines.
- compare the environmental sites and aspects of wind farms.

TEXT BOOKS

1. Emil Simiu and Robert H Scanlan, "Wind effects on structures - Fundamentals and Applications to Design", John Wiley and Sons Inc New York, 2016.
2. Ahmad Hemami, "Wind Turbine Technology", Cengage learning, Canada, 2012.

REFERENCES

1. Tom Lawson, "Building Aerodynamics", Imperial College Press London, 2001
2. G P Russo, "Aerodynamic Measurements: From Physical Principles to Turnkey Instrumentation", Wood head publishing, 2003.
3. N J Cook, "Design Guides to wind loading of buildings structures - Part I and II", Butterworths London, 2014
4. IS: 875 (1987) Part III Wind loads, Indian Standards for Building codes", 2009.

WEB LINKS

1. <http://nptel.ac.in/courses/101105059/>
2. <https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005/lecture-notes/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	-	2	-	2	-	-	2	3	3
CO2	2	3	2	3	2	-	2	-	-	-	-	3	3	2
CO3	-	2	3	2	3	-	3	-	3	-	-	2	2	3
CO4	3	2	3	2	3	-	2	-	3	-	-	2	2	2
CO5	2	1	3	3	2	-	3	-	2	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- gives exposure to formulation of governing equations
- study the behavior of the plates and shells with different geometry under various types of loads.
- acquiring the knowledge of plates and shells, students are able to take up works of mechanical, civil, structural, and aeronautical engineering
- study the methods of analysis
- understand the basic concept of shells and structures

UNIT I INTRODUCTION	8
Classical Plate Theory - Assumptions - Governing Equation - Boundary Conditions.	
UNIT II PLATES OF VARIOUS SHAPES	10
Navier's Method of Solution for Simply Supported Rectangular Plates - Levy's Method of Solution for Rectangular Plates under Different Boundary Conditions - Circular plates. Different edge conditions and loads.	
UNIT III FREE VIBRATION ANALYSIS	8
Stability and Free Vibration Analysis of Rectangular Plates with various end conditions.	
UNIT IV APPROXIMATE METHODS	10
Rayleigh - Ritz, Galerkin Methods - Finite Difference Method - Application to Rectangular Plates for Static, Vibration and Stability Analysis.	
UNIT V SHELLS	9
Basic Concepts of Shell Type of Structures - Membrane and Bending Theories for Circular Cylindrical Shells.	
TOTAL PERIODS	45

COURSE OUTCOMES

At the end of the course, the students will be able to

- identify the exposure to formulation of governing equations
- analyze the strain, stress of plates and shells
- different types of plates
- analysis of various approximation methods
- acquire the knowledge on shells

TEXT BOOKS

1. Timoshenko, S.P. Woinowsky. S., and Kreger, Theory of Plates and Shells, McGraw-Hill Book Co. 1990.

REFERENCES

1. Flugge, W. Stresses in Shells, Springer – Verlag, 1985.
2. Harry Kraus, „Thin Elastic Shells“, John Wiley and Sons, 1987.

WEB LINKS

1. <http://nptel.ac.in/courses/101106040/8>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	-	2	-	2	-	-	2	3	3
CO2	2	3	2	3	2	-	2	-	-	-	-	3	3	2
CO3	-	2	3	2	3	-	3	-	3	-	-	2	2	3
CO4	3	2	3	2	3	-	2	-	3	-	-	2	2	2
CO5	2	1	3	3	2	-	3	-	2	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- know the importance of non dimensional number
- understand the application of various types of wind tunnels
- learn the basic measurement procedure involving wind tunnel testing
- interpret the basic concepts of measurement of forces and moments on models during the wind tunnel testing
- perform the flow visualization

UNIT I PRINCIPLES OF MODEL TESTING 8

Methods of Dimension analysis - Buckingham - theorem - non - dimensional numbers - model laws - Scale effect and types of similarities

UNIT II WIND TUNNELS 9

Classification - special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions - layouts - sizing and design parameters

UNIT III CALIBRATION OF WIND TUNNEL 9

Test section speed - horizontal buoyancy - flow angularities - turbulence measurements - associated instrumentation - calibration of supersonic tunnels

UNIT IV WIND TUNNEL MEASUREMENTS 10

Pressure and velocity measurements - force measurements - three component and six component balances - internal balances

UNIT V FLOW VISUALIZATION 9

Smoke and tuft grid techniques - Water flow visualization method - dye injection special techniques - optical methods of flow visualization

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- analyze the methods of dimensional analysis
- acquire knowledge about wind tunnel
- calibrate the wind tunnel
- measure the wind tunnel
- visualize the flow over the component by using various techniques

TEXT BOOKS

1. Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984.
2. NAL-UNI Lecture Series 12: "Experimental Aerodynamics", NAL SP 98 01 April 1998

REFERENCES

1. Rae, W.H. and Pope, A. "Low Speed Wind Tunnel Testing", John Wiley Publication, 2003
2. Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press, Taylor and Francis, 2006

3. Antonio Viviani, Giuseppe Pezzella, "Aerodynamic and Aerothermodynamic Analysis of Space Mission Vehicles", Springer Aerospace Technology, 2015
4. Pavian, Henry Christensen, "Experimental Aerodynamics", 1st edition, Pitman Publishing, 2001.
5. F Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids", CRC Press - Taylor and Francis, 2007.

WEB LINKS

1. <http://nptel.ac.in/courses/101106040/8>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO2	3	2	2	3	2	2	-	-	2	-	2	2	3	2
CO3	2	3	3	2	2	2	2	-	2	-	3	-	2	3
CO4	2	3	2	3	1	3	-	-	3	-	2	2	2	2
CO5	3	2	2	2	2	2	-	-	3	-	2	2	3	2



PROGRAMME ELECTIVE IV

AE15451

CRYOGENIC ENGINEERING

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the behaviour of materials at low temperatures
- learn about various liquefaction systems for refrigeration.
- familiarize the students for different cryogenic applications.
- develop skills for designing cryogenic systems including refrigeration, storage and transfer of cryogenics, and instrumentation
- know the safety considerations for different types of fuels.

UNIT I BASIC PRINCIPLES OF CRYOGENIC 7

Historical Background - Introduction to cryogenic propellants and their properties, Liquid hydrogen, Liquid helium, Liquid nitrogen and liquid oxygen - Theory behind the production of low temperature, Cascade process, Joule Thompson Effect.

UNIT II REFRIGERATION AND GAS-LIQUEFACTION SYSTEMS 11

Basic principles of low temperature heat transfer - Refrigeration system and its types - Cryogenic liquefaction process, Production of Low Temperatures: Liquefaction systems, Various liquefaction cycles, Ideal, Cascade, Linde Hampson, Claude, Stirling cycles and their derivatives, Ultra-low temperature refrigerators, Cryocoolers.

UNIT III CRYO INSULATION AND DEVICES 9

Storage vessel - Thermal shields and insulation, Effect of size and shape of storage vessel on heat inleak, Vapor shielding, Vacuum insulation, Evacuated porous insulation, Solid foams, Multilayer insulation, Composite insulation, Critical radius of insulation. Heat exchangers for cryogenic applications, Cryogenic Instrumentation: strain, Displacement and position, Pressure, Flow, Liquid level, Density and Temperature measurement for cryogenic applications.

UNIT IV PERFORMANCE ANALYSIS OF CRYOGENIC ROCKETS 11

Design concepts of cryogenic rockets - Selection of propellants and its challenges, Boil-off rate, Thrust and velocity gain, Specific impulse - Propellant feed system - Tank pressurization and vent system - Two phase flow and heat transfer in reduced gravity - Process design parameters - Launch-window - Effect of cryogenic liquids on properties of aerospace materials.

UNIT V SUPERCONDUCTIVITY AND SAFETY 7

Matter at low temperatures - Electrical and Magnetic properties of Superconductors - Specific heat - thermal conductivity - Electrical conductivity and basic properties of Superconductors - Vacuum Technology. Introduction Physiological hazards - Explosions and flammability - Safety considerations for liquid hydrogen and liquid oxygen - General safety principles.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- get introductory knowledge of cryogenic Engineering.
- compare the refrigeration process for different liquefaction systems.
- detailed knowledge of cryo-coolers, on which research is going on worldwide.
- interest to embark on a research career in Cryogenic Engineering.
- acquire the knowledge about cryogenics safety considerations.

TEXT BOOKS

1. Haseldom, G., Cryogenic Fundamentals, Academic Press, 1971.
2. Barron, R. F., Cryogenic Systems, Oxford University, 1985

REFERENCES

1. Mamata Mukhopadhyay, "Fundamentals of Cryogenic Engineering", PHI Learning Pvt limited, 2013.
2. Timmerhaus, Flynn, "Cryogenics Process Engineering", Plenum Press, New York, 2007
3. G.M Walker. "Cryocooler Part - 1 Fundamental", Plenum Press, New York and London, 2001.
4. G.M Walker. "Cryocooler Part - 2", Plenum Press, New York and London, 2005

WEB LINKS

1. <http://nptel.ac.in/courses/112101004/>
2. <http://www.university.youth4work.com/study-material/Cryogenic-Engineering-Lecture>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	3	2	3	3	-	3	-	3	2	3	3
CO2	3	2	2	3	2	2	-	-	2	-	2	2	3	2
CO3	2	3	3	2	2	2	2	-	2	-	3	-	2	3
CO4	2	3	2	3	1	3	-	-	3	-	2	2	2	2
CO5	3	2	2	2	2	2	-	-	3	-	2	2	3	2



COURSE OBJECTIVES

To enable the students to

- understand the thermodynamic of combustion.
- learn the different types of combustion chamber
- know the composition of various types of fuels and their properties
- familiarize the students on standard atmospheric conditions.
- make the students to understand the pollution from combustion of fuels and controlling them.

UNIT I SIMPLE THERMODYNAMICS OF COMBUSTION	12
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Stoichiometry, absolute enthalpy, enthalpy of combustion, laws of thermochemistry, pressure and temperature effect on enthalpy of formation, adiabatic flame temperature, chemical and equilibrium products of combustion. Fundamental laws of transport phenomena,. Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics.

UNIT II COMBUSTION IN GAS TURBINE , RAMJET AND SCRAMJET	8
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Combustion in gas turbine chambers, recirculation, combustion efficiency, flame holders, subsonic combustion in ramjet, supersonic combustion in scramjet. Subsonic and supersonic combustion controlled by decision mixing and heat convection

UNIT III COMBUSTION IN CHEMICAL ROCKET	8
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Combustion in liquid propellant rockets. Combustion of solid propellants, application of laminar flame theory to the burning of homogeneous propellants, Combustion in hybrid rockets. Combustion instability in rockets.

UNIT IV FUNDAMENTALS AND ENVIRONEMNTAL CONCERNS	8
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Air pollution, chemical composition of clean air, arrangement and nomenclature of the atmosphere, harmful effects of engine emissions, Aero-engine emissions, Tidal currents, tropospheric ozone formation, stratospheric ozone depletion.

UNIT V POLLUTANT EMISSIONS OF AERO-ENGINES	9
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The combustor, combustion of hydrocarbon fuel, formation of undesired combustion products, emission certifications, NOX reduction in aero-engines, climate effect estimates, fuel conservation, wing design for low pollution, weight reduction, alternate fuels for future transport airplanes.

TOTAL PERIODS	45
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COURSE OUTCOMES

At the end of the course, the students will be able to

- address various combustion problems by extending the earlier-gained knowledge of thermodynamics, fluid mechanics and heat/mass transfer.
- elaborate the operations of reciprocating engines, gas-turbine engines and rocket engines
- differentiate the different types of rocket propellants and its applications.
- evaluate the atmospheric pollutants and toxic substances in ozone.
- make quantitative and qualitative estimates of characteristics of various combustion processes

TEXT BOOKS

1. Kuo K.K. "Principles of Combustion" John Wiley and Sons, 2005.
2. D. P. Mishra, "Fundamentals of Combustion", Prentice Hall of India, New Delhi, 2008.
3. G.J.J.Ruijgrok and D.M, Van Paassen, "Elements of Aircraft Pollution", Yes Dee Publishing, 2005

REFERENCES

1. H. S. Mukunda, "Understanding Combustion", 2nd edition, Orient Blackswan, 2009.
2. Warren C. Strable, "An Introduction to Combustion", Taylor and Francis, 1993

WEB LINKS

1. <http://nptel.ac.in/courses/101104014/>
2. <http://nptel.ac.in/courses/105102089/8>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	3	3	-	-	-	3	2	-	2	3	2
CO2	1	3	2	2	2	-	-	-	1	2	-	1	2	3
CO3	2	2	2	3	1	-	-	-	-	-	-	3	2	3
CO4	3	2	3	3	2	-	-	-	-	-	-	3	2	3
CO5	3	2	1	2	2	-	-	-	-	-	-	3	3	3



COURSE OBJECTIVES

To enable the students to

- familiarize the students on advanced air breathing propulsion systems.
- design and performance calculations of augmented rockets.
- detailed knowledge about the supersonic combustor in scramjet
- provide students with an overview of nuclear propulsion system.
- introduce the students various technical details and operating principles of ion and electric propulsion

UNIT I THERMODYNAMIC CYCLE ANALYSIS OF AIR-BREATHING PROPULSION SYSTEMS 8

Air breathing propulsion systems like Turbojet, turboprop, ducted fan, Ramjet and Air augmented rockets, Inlet Thermodynamic cycles, Pulse propulsion, Combustion process in pulse jet engines, charging process, Subcritical, Critical and Supercritical charging.

UNIT II RAMJETS AND AIR AUGMENTED ROCKETS 8

Preliminary performance calculations, Diffuser design with and without spike, Supersonic inlets, Combustor and nozzle design, Integral Ram rocket.

UNIT III SCRAMJET PROPULSION SYSTEM 12

Fundamental considerations of hypersonic air breathing vehicles, Preliminary concepts in engine, Airframe integration, Calculation of propulsion flow path, Flow path integration, Various types of supersonic combustors, Fundamental requirements of supersonic combustors, Mixing of fuel jets in supersonic cross flow, Performance estimation of supersonic combustors.

UNIT IV NUCLEAR PROPULSION 9

Nuclear rocket engine design and performance, Nuclear rocket reactors, Nuclear rocket nozzles, Nuclear rocket engine control, Radioisotope propulsion, Basic thruster configurations, Thruster technology, Heat source development, Nozzle development, Nozzle performance of radioisotope propulsion systems.

UNIT V ELECTRIC AND ION PROPULSION 8

Basic concepts in electric propulsion, Power requirements and rocket efficiency, Classification of thrusters, Electrostatic thrusters, Plasma thruster, Fundamentals of ion propulsion, Performance analysis, Ion rocket engine, Electromagnetic interference, Noise, Safety, Concepts in wind turbine development.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- identify the thermodynamic cycle of air breathing propulsion systems.
- compute the performance of ramjet and augmented rockets.
- analyze about the performance of propulsion in supersonic combustor.
- applying the knowledge for evaluating the performance of nuclear propulsion.
- differentiate technical details of rocket propulsions.

TEXT BOOKS

1. G.P. Sutton, "Rocket Propulsion Elements", John Wiley and Sons Inc., New York, 1998.
2. William H. Heiser and David T. Pratt, Hypersonic Air breathing propulsion, AIAA Education Series, 2001

REFERENCES

1. Fortescue and Stark, Spacecraft Systems Engineering, 1999.
2. Cumpsty, Jet propulsion, Cambridge University Press, 2003.
3. Hill, P.G. and Peterson, C.R. "Mechanics and Thermodynamics of Propulsion" 2nd Edition Pearson Education, 1999.

WEB LINKS

1. <http://nptel.ac.in/courses/101104019/>
2. <http://ocw.mit.edu/courses/aeronautics-and-astronautics/16-512-rocket-propulsion-fall-2005/lecture-notes/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	3	3	3	-	-	-	-	3	1	3	2
CO2	3	2	2	2	-	1	-	-	-	-	2	2	3	2
CO3	2	3	3	-	-	1	-	-	-	-	3	2	2	2
CO4	2	1	2	-	-	2	-	-	-	-	2	2	3	2
CO5	3	2	3	-	2	2	-	-	-	-	2	1	3	2



COURSE OBJECTIVES

To enable the students to

- make the students to understand the mission considerations and requirement of control systems.
- familiarize the students in missile configurations and trajectory control.
- provide knowledge about the modeling of power plant and structural flexibility
- design a thrust vector control and control systems for a launch vehicles.
- learn the experiences of problems faced during the testing of control systems.

UNIT I PRELIMINARIES AND MISSION CONSIDERATIONS 9

Introduction to Flight vehicle - Control effects; Aerodynamic control, Thrust vector control, External forces and moments, Trajectory/Mission planning, Missiles - Derivation of Dynamic Equations - Applications of the generalized model.

UNIT II CONFIGURATION AND SIZING 9

Resolution of attitude errors in body axes frame - Control laws - control power plant sizing - Aerodynamic static margin - propulsion disturbances, control during Thrust tail-off region - Disturbance due to stage separation, control systems for out-of-atmosphere, trajectory, control impulse and actuator force requirement - Design of Back-up control schemes.

UNIT III LINEAR SYSTEM 9

Introduction - Control System design steps - Design objectives, Secondary injection and thrust vector control, Design of roll control system, design of lateral acceleration control system - Gain schedule adaptation, Propellant sloshing, Structural Flexibility.

UNIT IV ANALYSIS AND DESIGN OF ON-OFF REACTION CONTROL SYSTEM 9

Control system characteristics, Assumptions, Expressions for Vehicle state at different salient points during one oscillation, Expression for control impulse, Limit cycle characteristics, Stability conditions for the limit cycle, Limit cycle analysis for zero disturbance, Reaction control during Atmospheric phase.

UNIT V DESIGN VALIDATION AND FLIGHT TRIAL EXPERIENCES 9

Stability margins, steps response studies, six degree of freedom trajectory simulation, Software validation, End to End sign checks - Flight trial experiences.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- identify principles of trajectory and missiles.
- evaluate the practical issues in the design of control systems of these vehicles.
- acquire the importance of modeling in propellant sloshing and flexibility.
- analysis of system along with analysis of limit cycles and ensure their stability.
- identify the problems during implementing and designing the control systems.

TEXT BOOKS

1. N.V.Kadam, "Practical Design of Flight Control Systems for Launch Vehicles and Missiles", Allied publishers Pvt.Ltd,2009
2. Roger Pratt, " Flight control systems-practical issues in design and implementations", Institutions of Electrical Engineers, 2000

REFERENCES

1. J.F.White, Flight performance handbook for "Powered flight operations", John wiley and sons, Newyork, 1963.
2. A.L.Greensite, control Theory: Vol-II, "Analysis and design of space vehicle flight control systems", Spartan Books,1970

WEB LINKS

1. <http://nptel.ac.in/courses/101108057/18>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	-	-	1	3	-	-	-	-	2	3	2
CO2	2	3	2	2	3	2	3	-	-	-	-	2	3	2
CO3	3	2	3	2	3	-	-	-	-	-	-	2	2	2
CO4	-	2	2	2	3	-	-	-	-	-	3	2	3	2
CO5	3	2	2	2	2	-	-	-	-	-	-	2	3	2



PROGRAMME ELECTIVE V

AE15551

AIRCRAFT SAFETY

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- impart the knowledge of human factors and spatial disorientation.
- study the cause of runway incursion.
- gain knowledge of weather related problems in low and high altitudes.
- learn about the various mid air collision issues and rectification procedures.
- know about various air crash investigation reports by NTSB.

UNIT I HUMAN FACTORS 9

Judgment and Decision Making – Accurate Situation Assessment Leads to good Situational Awareness – Crew Resource Management – Crew effectiveness – Spatial Disorientation – Types of Spatial Disorientation.

UNIT II RUNWAY INCURSIONS 9

Runway Incursion severity categories – Reported Runway Incursions by Severity – Distribution by Aircraft type and Combination

UNIT III WEATHER 9

Air Masses and Fronts – Types of Fronts – Cloud Formations – Low, Medium, High clouds – Thunderstorms – Aircraft performance in Heavy rains – Icing conditions – Types of Clouds - Turbulence

UNIT IV MID AIR COLLISIONS 9

Mid air collision avoidance – Eye brain connection – Eye movement – Distant visual Acuity – Cockpit creates monocular visual areas – Effective scanning based on sectors – Enhancing visual skills.

UNIT V AIR CRASH INVESTIGATION - CASE STUDIES 9

American Airlines Flight 1420 – USA flight 1493 - Sky west flight 5569 - Delta Airlines flight 191 – Air France flight 4590 - TWA flight 800.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- compare the features of various human factors.
- describe the principle and avoidance of runway incursion.
- analyze the various weather problems during VFR and IFR flight.
- acquire and interpret data of various mid air collisions.
- acquire knowledge of old air crash and investigation procedures.

TEXT BOOKS

1. Krause, Shari Stamford, Air Safety/ Accident Investigation, analysis and applications, Tata McGraw Hill, New Delhi, 2009 .

REFERENCES

1. Seth B. Young, Alexander T. Wells, "Airport Planning and Management" McGraw-Hill Education, New Delhi, 2011.
2. M.S Nolan, "Fundamentals Air Traffic Control", Latest Edition, YESDEE Publishers, 2010

WEB LINKS

1. [http://nptel.ac.in/courses/101106035/001_Chapter%201_L1_\(01-10-2013\).pdf](http://nptel.ac.in/courses/101106035/001_Chapter%201_L1_(01-10-2013).pdf)
2. <http://www.nptel.ac.in/courses/112102107/16>
3. <http://nptel.ac.in/courses/112107143/40>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	3	-	3	2	1	-	3	-	3	2	3	2
CO2	-	3	2	3	2	3	2	-	2	-	3	2	3	2
CO3	3	2	2	3	2	1	2	-	3	-	2	2	2	2
CO4	3	2	2	-	2	2	3	-	3	-	-	3	3	2
CO5	2	2	2	-	2	2	3	-	3	-	-	3	3	2



COURSE OBJECTIVES

To enable the students to

- know the importance of unmanned aerial vehicle
- understand the application of UAV and MAV system
- learn the basic hardware's of UAV and MAV
- interpret the basic concepts of controlling of forces and moments on models during the payload
- Perform the flight analysis

UNIT I INTRODUCTION TO UAV AND MAV 9

Historical Background of UAVs and MAVs - classifications based on range and Endurance – basic terminology- models and prototypes - Preliminary, Conceptual and Detailed design stages.

UNIT II DESIGN OF UAV SYSTEM 9

Fixed wing -Rotor -VTOL-STOL- Blimb wing Airframe - flapping wing - dynamics –modeling fuselage structures - Airfoil selection - Propeller selection- Empennage design -Flight control surfaces specifications - Airframe Maintenance.

UNIT III HARDWARE SUPPORT 9

Autopilot sensors, servos, accelerometer, gyros, actuators, power supply processor, integration, installation, Configuration.

UNIT IV PAYLOADS AND CONTROLS 9

Payloads, Telemetry, tracking, Aerial photography, controls, PID feedback, radio control frequency range, modems, Memory system, simulation, ground test-analysis, trouble shooting

UNIT V PATH PLANNING 9

Path planning ,Trajectory generations, Obstacles avoidance ,Endurance ,Way points navigation ground control Software, Flight Endurance and Range, analysis of existing UAVs and MAVs.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the classification of UAV
- identify and analyze UAV system and structures
- evaluate the theory behind the hardware
- compute the effect of payload
- identify various types of planning and trajectory

TEXT BOOKS

1. Fahlstrom, P. and Gleason, T. 2012. Introduction to UAV Systems. 4th edition. United Kingdom. John Wiley and Sons Ltd.
2. Wolf, P., DeWitt, B., and Wilkinson, B. 2014. Elements of Photogrammetry with Applications in GIS, 4th edition. McGraw-Hill.
3. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010

REFERENCES

1. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001
2. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998
3. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
4. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

WEB LINKS

1. <http://nptel.ac.in/courses/101106035/>
2. <https://www.uavsystemsinternational.com/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	-	-	1	3	-	-	-	-	2	3	2
CO2	2	3	2	2	3	2	3	-	-	-	-	2	3	2
CO3	3	2	3	2	3	-	-	-	-	-	-	2	2	2
CO4	-	2	2	2	3	-	-	-	-	-	3	2	3	2
CO5	3	2	2	2	2	-	-	-	-	-	-	2	3	2



COURSE OBJECTIVES

To enable the students to

- provide knowledge on non-destructive testing methods for aerospace components,
- inspect the object using Radiography.
- understand the transmission techniques in ultrasonic.
- study the working principle with component level of each NDT methods
- know the various special techniques in NDT

UNIT I INTRODUCTION TO NDT**9**

Importance of NDT in quality assurance. Different types of non - destructive 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.

UNIT II RADIOGRAPHIC INSPECTION**9**

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.

UNIT III ULTRASONICS**9**

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.

UNIT IV VARIOUS TECHNIQUES IN NDT**9**

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.

UNIT V SPECIAL TECHNIQUES**9**

Acoustic emission testing (AET) principle, advantages, limitations, instrumentation and application of AET, infra-red thermography (IRT), vibrothermography - contact and non-contact inspection methods - LASER shearography - acoustic holography.

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of the course, the students will be able to

- differentiate various methods of non-destructive testing to evaluate the material integrity used in engineering application.
- apply the knowledge about radiography techniques during inspection of an object.
- analyze about the transmission techniques available in NDT.

- apply NDT process and its application in aerospace industry
- acquire the knowledge about the special techniques in NDT.

TEXT BOOKS

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", Wiley Interscience,, John Wiley and Sons, Inc, Publ.,
3. Baldev Raj, T. Jayakumar, M. Thavasimuthu, "Practical Non-Destructive Testing", Narosa Publishing, UK, 2007.

REFERENCES

1. Bray, Don E. and Don McBride: "Nondestructive Testing Techniques," Ultrasonic Testing of Aerospace Materials, John Wiley and Sons, New York, NY, 1992.
2. Metals Hand Book, Vol-17, 9th Edition, Non destructive evaluation and quality control, American society of metals. 2001
3. Baldev Raj, T. Jayakumar, M. Thavasimuthu, Nondestructive Testing, Narosa Publishing House, 1997.
4. C. Hellier, "Handbook of Nondestructive Evaluation", McGraw-Hill, 1994.
5. ASM Metals Handbook, V-17, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 2001.

WEB LINKS

1. <http://nptel.ac.in/courses/101106041/>
2. <http://nptel.ac.in/courses/101106043/1>
3. <http://nptel.ac.in/courses/101106042/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO3	2	3	3	-	-	1	-	-	-	-	3	2	2	2
CO4	2	1	2	-	-	2	-	-	-	-	2	2	3	2
CO5	3	2	3	-	2	2	-	-	-	-	2	1	3	2



COURSE OBJECTIVES

To enable the students to

- introduce the basic concepts of designing missile system and its components.
- design the missile using aerodynamic aspects
- study the various performance parameters of rockets and missiles.
- build up necessary features for guiding and controlling the missile trajectories.
- differentiate the different types of missile systems and subsystems.

UNIT I MISSILE SYSTEMS

9

Introduction - Development of Missile systems - classifications - missile system elements - missile ground systems - radars technology - launchers - coordinate frames - basics of trajectory dynamics.

UNIT II MISSILE AERODYNAMICS

9

Missile aerodynamics- design methodology - aerodynamic prediction method - aerodynamic loads and performance analysis - wind tunnel and flight testing of missile models and missile prototypes.

UNIT III PROPULSION UNIT

9

Principles of jet propulsion and rocketry - nozzle theory and performance parameters of solid rockets and ramjet and compound jet engines - evaluation of flight performance - forces acting on vehicle - basic relations of motion.

UNIT IV MISSILE TRAJECTORY CONTROL

9

Types of trajectories - Vertical - inclined and gravity turn trajectories - Estimation of performance parameters - determination of range and altitude - numerical computation of ballistic trajectories, Applications.

UNIT V MISSILE SYSTEMS AND SUBSYSTEMS

9

Digital Electronic Control unit - Launcher electronic unit - Gyroscopic systems - Safety and arming devices servo integration with control surface - Thermal beacon and Xenon beacon - Integrated guided missiles - Case studies

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- acquire the basic concepts of missiles systems
- compare the various aerodynamical aspects of missiles.
- analyze about the performance characteristics of rockets and missiles.
- guide and control the missile systems.
- performance analysis of systems and subsystems of missiles.

TEXT BOOKS

1. George M.Siouris, "Missile Guidance and Control Systems", Latest Edition, Springer publishers, 2004.
2. S.N. Balakrishnan, A. Tsourdos, B.A. White, "Advances in Missile Guidance, Control, and Estimation", CRC Press, 2012.

REFERENCES

1. Albert J. Sobey and Alfred M. Suggs, "Control of aircraft and missile power plants: an introduction to the analysis design of engine control systems", John Wiley and Sons, New York, 2003
2. John H. Blakelock, "Automatic Control of Aircraft and Missiles", John Wiley and Sons, 2001.
3. Rafael Yanushevsky, "Modern Missile Guidance", CRC Press, 2008.
4. George M. Siouris, "Missile Guidance and Control Systems", Springer-Verlag Inc., 2004

WEB LINKS

1. <http://nptel.ac.in/courses/101108057/18>
2. <https://www.scienceabc.com/innovation/how-guided-missiles-work-guidance-control-system-line-of-sight-pursuit-navigation.html>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO3	2	2	2	3	1	-	-	-	-	-	-	3	2	3
CO4	3	2	3	3	2	-	-	-	-	-	-	3	2	3
CO5	3	2	1	2	2	-	-	-	-	-	-	3	3	3



COURSE OBJECTIVES

To enable the students to

- understand the aviation maintenance, characteristics of maintenance programs
- know the various technical services and product planning
- differentiate on time maintenance and hanger maintenance
- learn the various oversight functions and audit programs
- study about various human factors

UNIT I FUNDAMENTAL OF MAINTENANCE

9

Development of maintenance program – Maintenance Program Documents – Aviation Certification – Delivery Inspection – Types of Documentation – ATA documents standards – FAA requirements – Organization of maintenance and engineering – Manager level functions – Technical Services, Aircraft Maintenance, Overhaul shops, Maintenance Programs.

UNIT II TECHNICAL SERVICES

9

Production planning and control – Forecasting, Production planning, production control, Feedback for planning, Organization of PPandC – Technical Publications – Training for aviation maintenance – Maintenance Resource Management.

UNIT III MAINTENANCE AND MATERIAL SUPPORT

9

Line Maintenance – Functions, Maintenance control, Aircraft logbook, Ramp and terminal operations, Maintenance crew skill requirements – Hanger Maintenance – organization of hanger maintenance, Maintenance Support shops, Ground support equipments.

UNIT IV OVERSIGHT FUNCTIONS

9

Requirements for quality assurance – Quality Audits – ISO 9000 Quality standards – Technical Records, Reliability – Types, Elements of reliability probability, Administration and management of the reliability program – Maintenance safety – Industrial safety, safety regulations, maintenance safety program.

UNIT V HUMAN FACTORS IN MAINTENANCE

9

Human factors in maintenance – Basic definitions, System engineering, goals, Human factors in maintenance – Human factors responsibilities – Eight basic concepts of trouble shooting – ETOPS.

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of the course, the students will be able to

- compare various production planning techniques.
- analyze the different technical publications and aviation maintenance
- apply knowledge of various on time maintenance and hanger maintenance.
- perform the various quality audits and technical records
- calibrate ETOPS operations.

TEXT BOOKS

1. Harry A. Kinnison, "Aviation Maintenance Management: Tata McGraw Hill, New Delhi", 2010.
2. Cushing, S. "Fatal Words: Communication clashes and aircraft crashes", University of Chicago Press, 2004.

REFERENCES

1. Heppenheimer, "T. A. Turbulent Skies: The history of commercial aviation", New York, John Wiley and Sons.
2. Fink S., "Maintenance Management: Planning for the inevitable, New York", 2009.
3. Pauchant, T., Mitro, L., "Transforming the crisis prone organization: Preventing individual, organizational and environmental tragedies", San Francisco: Jossey-Bass

WEB LINKS

1. <http://nptel.ac.in/courses/101104071/>
2. <http://www.nptel.ac.in/courses/112102107/>

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	-	3	2	2	3	3	2	3	-	-
CO2	-	-	2	-	-	3	3	3	2	2	3	2	-	-
CO3	-	-	3	-	-	2	3	2	3	3	2	2	-	-
CO4	-	-	3	-	-	3	2	3	3	3	2	3	-	-
CO5	-	-	2	-	-	2	2	3	2	2	3	3	-	-



COURSE OBJECTIVES

To enable the students to

- acquire the knowledge about competencies required for an entrepreneur.
- impart knowledge in motivation techniques in entrepreneurship.
- discuss the various factors that has to be considered while preparing a business plan.
- understand the various sources of finance and accounting for business.
- describe the role of government and other agencies in promoting entrepreneurship.

UNIT I ENTREPRENEURSHIP 9

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur - Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT II MOTIVATION 9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT III BUSINESS 9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

UNIT IV FINANCING AND ACCOUNTING 9

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation – Income Tax, Excise Duty – Sales Tax.

UNIT V SUPPORT TO ENTREPRENEURS 9

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures – Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- acquire skills necessary to become an entrepreneur
- exhibit the skills required to manage small business
- analyze and develop a business plan.
- identify the various factors to be considered for launching a small business.
- comprehend the support rendered by government and other agencies in entrepreneurship development

TEXT BOOKS

1. Khanka. S.S., "Entrepreneurial Development" S.Chand and Co. Ltd., Ram Nagar, New Delhi, 2013.
2. Donald F Kuratko, "Entrepreneurship -Theory, Process and Practice", 9th Edition, Cengage Learning, 2014.

REFERENCES

1. Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, 2013.
2. Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis" 2nd Edition Dream tech, 2005.
3. Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, 2011.
4. EDII "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad, 1986.

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	3	1	-	2	2	2	-	2	3	2	3
CO2	-	2	2	-	2	-	-	-	-	-	1	1	1	3
CO3	-	1	1	-	1	1	-	-	-	1	1	3	-	3
CO4	1	1	-	-	-	-	1	-	3	1	1	3	1	2
CO5	1	1	-	-	-	-	2	-	2	1	-	3	-	1



COURSE OBJECTIVES

To enable the students to

- know the case studies of various causes, characteristics of crisis
- understand the management techniques already in vogue and apply them to the solutions of crisis problems.
- understand the psychology of crisis management
- learn the safety procedures given by ICAO
- study about the various air crash investigations

UNIT I INTRODUCTION TO CRISIS MANAGEMENT 9

Crisis management; Crisis management basics; Establishing a crisis management team; The role of the crisis manager; Organizational crisis and communication; Crisis Checklist Needs.

UNIT II TYPOLOGIES AND STAGES OF CRISIS MANAGEMENT 9

Crisis typologies - Coomb's typology - Characteristics of the crises - Consequences - Modeling crises - Crisis communication - Strategic communication Pre-crisis - Existing in pre-crisis phase, preparing for the worst - Post-Crisis.

UNIT III CRISIS MANAGEMENT AT AIRPORTS 9

Psychology of crisis management decisions; Emergency response scenarios; Contingency plans; Damage control; Various Crisis at Airport -SOP for Bomb Threat -Mitigating Hijack Crisis Situation Response to Acts of Unlawful Interference: Developing Plans.

UNIT IV WORLD AIRLINES AND AIRPORTS , WORLD AVIATION BODIES 9

Airports - Civil , Military Training-Domestic/International - Passenger/Cargo Terminals -World Airlines -World's Major Airports IATA / ICAO-National Aviation Authorities and Role of State and Central Governments Airports Authority of India - The National Transportation Board, Director General of Civil Aviation

UNIT V CRISIS IN AIRCRAFT INDUSTRY -CASE STUDIES 9

Northwest airlines flight 255; American airlines flight 191; Delta airlines flight 191; Trans world airlines flight 800; Pan American World Airways flight 103; US Air flight 427; Value jet flight 592; Malasian Airlines MH370.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- compare various crisis management techniques.
- analyze the different typology procedures in crisis management
- apply knowledge of crisis management at airports to solve aeronautical engineering problems.
- perform the various national air transportation procedures
- acquire knowledge about the various air crash investigations.

TEXT BOOKS

1. Sally J. Ray, "Strategic communication in crisis management: Lessons from the Airline Industry", 2009.
2. Heppenheimer, "T. A. Turbulent Skies: The history of commercial aviation", New York, John Wiley and Sons, 2005

REFERENCES

1. Cushing, S. "Fatal Words: Communication clashes and aircraft crashes", University of Chicago Press, 2004.
2. Fink S., "Crisis Management: Planning for the inevitable, New York", 2003.
3. Pauchant, T., Mitro, I., "Transforming the crisis prone organization: Preventing individual, organizational and environmental tragedies", San Francisco: Jossey-Bass

WEB LINKS

1. <http://nptel.ac.in/courses/122102006/9>
2. <http://nptel.ac.in/courses/110105052/>
3. <http://nptel.ac.in/courses/122102006/mod2/6.htm>

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CO2	-	2	2	-	2	-	-	-	-	-	1	1	1	3
CO3	-	1	1	-	1	1	-	-	-	1	1	3	-	3
CO4	1	1	-	-	-	-	1	-	3	1	1	3	1	2
CO5	1	1	-	-	-	-	2	-	2	1	-	3	-	1

