COURSE STRUCTURE AND EVALUATION SCHEME

B. Tech. Aeronautical Engineering

(w.e.f. session 2025-26)

2nd Year Scheme and Syllabus

B.Tech.(Aeronautical Engineering) Model Curriculum Structure

SEMESTER-III

Sl. No.	Subject Codes	Category	Subject	Periods			Evaluation Scheme					Subject Total	Credit
							Sessional Exam			ESE			
				L	T	P	CT	TA	Total	TE	PE		
1	AHT-006	BSC	Probability and Statistics & Complex Variables	3	1	0	30	20	50	100		150	4
2	AHT-007 / AHT-008	HSC	Technical Communication/Universal Human Values	2 / 3	1 / 0	0 / 0	30	20	50	100		150	3
4	ANT-001	DC	Theory of Structures	3	1	0	30	20	50	100		150	4
5	ANT-002	DC	Aerodynamics - I	3	1	0	30	20	50	100		150	4
6	ANT-003	DC	Fluid Mechanics and Hydraulics	3	1	0	30	20	50	100		150	4
7	ANP-001	DLC	Mechanics of Solids Lab	0	0	2		25	25		25	50	1
8	ANP-002	DLC	Fluid Mechanics and Hydraulics Lab	0	0	2		25	25		25	50	1
9	ANP-003	DLC	Introduction to Machine Elements and Drawing	0	1	2		25	25		25	50	1
10	ANP-004	DLC	Internship-I/Mini Project-I*	0	0	2			50			50	1
11	CST-006/CST-005	NC	Cyber Security[#]/Python Programming[#]	2	0	0	15	10	25	50			
12	GP-03	NC	General Proficiency						50				
			Total									**950**	**23**
12			**Open Elective (Optional)**	3	1	0	30	20	50	50			**4**

*The Mini Project-I or Internship-I (3-4 weeks) conducted during summer break after II semester and will be assessed during III semester

 # The content of the course is based on the case studies.

Probability and Statistics & Complex Variables (AHT-006)

L T P: 3 1 0

Course Objectives

The course aims to enable students to:

1. Understand and apply the principles of **probability theory**, including random variables and their distributions.
2. Explore and compute the **functions of random variables** and their statistical properties.
3. Analyze **data statistically**, including the use of measures of central tendency, correlation, regression, and hypothesis testing.
4. Gain a foundational understanding of **complex analysis**, including analyticity, integration, and series expansions.
5. Apply **Cauchy's integral formula**, **residue theorem**, and **conformal mappings** in solving integrals and visualizing complex transformations.
6. Develop computational skills using tools like **Python/Jupyter Notebooks** or **MATLAB** to solve and visualize problems involving statistics and complex functions.

Particulars

UNIT I: Basic Probability and Random Variables (8 Hrs)

- Sample space, events, classical and conditional probability
- Independent events, **Bayes' theorem**
- **Discrete and continuous random variables**
- Probability density function (PDF) and cumulative distribution function (CDF)
- **Functions of random variables**, expectation, variance, moments
- **Hands-on**: Python/MATLAB exercises to simulate random experiments, compute expectations, plot distributions

UNIT II: Probability Distributions and Correlation (8 Hrs)

- Discrete distributions: **Binomial**, **Poisson**, their mean and variance
- Poisson approximation to binomial distribution
- Continuous distributions: **Normal**, **Exponential** and their properties
- Measures of **central tendency** (mean, median, mode) and **dispersion**
- **Correlation and regression analysis** (linear models)
- **Hands-on**: Fit distributions to data, visualize PDFs/CDFs, compute correlation/regression using statistical libraries (e.g., NumPy, pandas, matplotlib)

UNIT III: Statistical Inference and Hypothesis Testing (8 Hrs)

- Introduction to inferential statistics
- Null and alternate hypotheses, **type I and type II errors**, level of significance
- Large sample tests:
  - Single proportion, difference of proportions
  - Single mean, difference of means
- Small sample tests:
  - **t-test**, **F-test**, **Chi-square test**
- One-way ANOVA (if time permits)
- **Hands-on**: Perform hypothesis testing using real-life datasets in Python or MATLAB, interpret output of `scipy.stats`

UNIT IV: Complex Variables – Analytic Functions and Differentiation (8 Hrs)

- Concept of complex numbers and functions, limit and continuity
- Differentiation of complex functions, **analytic functions**
- **Cauchy-Riemann equations** (without proof), harmonic functions and their conjugates
- Elementary complex functions (exponential, trigonometric, logarithmic) and their properties
- **Hands-on**: Visualize complex mappings, gradient plots for harmonic functions

UNIT V: Complex Integration and Series Expansions (8 Hrs)

- Line integrals in the complex plane
- **Cauchy's Theorem and Cauchy's Integral Formula**
- Zeros and singularities of analytic functions
- **Taylor's and Laurent's series**
- Residues and **Cauchy Residue Theorem**
- **Conformal mappings** and **Möbius transformations**
- **Hands-on**:
    - Numerically evaluate contour integrals
    - Create interactive plots for Möbius transformations
    - Visualize complex series convergence
    - Build interactive widgets in Jupyter/MATLAB to explore mapping and residue behavior

Textbooks

1. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 35th Ed., 2010
2. Ronald E. Walpole et al., *Probability and Statistics for Engineers and Scientists*, 9th Ed., Pearson
3. J.W. Brown and R.V. Churchill, *Complex Variables and Applications*, 7th Ed., McGraw-Hill, 2004

Reference Books

1. S.C. Gupta and V.K. Kapoor, *Fundamentals of Mathematical Statistics*, Khanna Publishers
2. Miller and Freund's, *Probability and Statistics for Engineers*, 8th Ed., Pearson
3. Sheldon Ross, *A First Course in Probability*, 6th Ed., Pearson
4. Erwin Kreyszig, *Advanced Engineering Mathematics*, 9th Ed., Wiley
5. N.P. Bali and Manish Goyal, *A Textbook of Engineering Mathematics*, Laxmi Publications

Course Outcomes (COs)

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

- **CO1**: Formulate and solve probability problems using discrete and continuous random variables
- **CO2**: Analyze experimental data using statistical measures, including correlation and regression
- **CO3**: Test statistical hypotheses using appropriate inferential techniques
- **CO4**: Analyze complex functions for analyticity, series expansions (Taylor's, Laurent's), and singular behavior
- **CO5**: Solve real integrals using Cauchy's integral and residue theorems; visualize complex transformations and mappings using software tools

Technical Communication (AHT-007)

L T P: 2 1 0

Course Objectives

This course aims to enable students to:

- Produce effective technical documents using both traditional and modern tools employed by engineering and computer science professionals.
- Communicate clearly and persuasively in professional settings using appropriate rhetorical strategies, templates, and formatting norms.
- Master the nuances of pronunciation, phonetics, and intonation, strengthening verbal communication.
- Develop vocabulary, language proficiency, and critical writing skills, including the ability to translate thoughts into structured essays.
- Understand ethical considerations and cultural sensitivity essential for communication in global and diverse environments.
- Explore individual styles of presentation and employ digital tools like ChatGPT, Grammarly, etc., for enhanced communication.

Particulars

Unit 1 (8 Hrs): Fundamentals of Technical Communication

- Introduction to Technical Communication: Definition, Nature, and Features
- General vs. Technical Communication
- Communication Flow: Downward, Upward, Lateral (Horizontal)
- Barriers to Effective Communication and Strategies to Overcome Them
- Importance and Scope of Communication in Technical Fields

Unit 2 (8 Hrs): Forms of Technical Communication

- Technical Report Writing: Purpose, Structure, and Style
- Thesis/Project/Synopsis Writing: Methods and Organization
- Research Paper Writing: Style, Citation Norms, and Plagiarism Ethics
- Seminar & Conference Paper Writing: Strategies and Content Management
- Essay Writing: **From Thought to Expression** – Brainstorming, Structuring Arguments, Coherence, and Flow
- 7 Cs of Effective Writing: Concreteness, Completeness, Clarity, Conciseness, Courtesy, Correctness, Consideration

Unit 3 (8 Hrs): Technical Presentation and Personal Style

- Forms and Strategies of Presentations: Classroom, Seminar, Public Speaking
- Individual Presentation Preferences: **Developing Personal Style**
- Audience Engagement: Quizzes, Polls, Interjections, and Feedback
- Overcoming Stage Fright and Building Confidence
- Use of Multimedia Tools: PowerPoint, Canva, Prezi
- **Introduction to AI Tools**: ChatGPT for drafting & brainstorming, Grammarly for proofreading & editing

Unit 4 (8 Hrs): Communication Skills in Professional Context

- Interview and Group Discussion: Techniques and Common Pitfalls
- Seminar/Conference Presentation: Structure, Focus, Argumentation
- Developing Critical Thinking through Communication
- Techniques of Narration, Description, and Exposition in Technical Contexts
- **Ethical and Cross-Cultural Communication** in a Global Workplace
- Role of AI Assistants and Grammar Tools in Enhancing Professional English

Unit 5 (8 Hrs): Non-Verbal Communication and Voice Modulation

- Kinesics: Definition, Significance, and Components of Body Language
- Voice Dynamics: Pitch, Tone, Rhythm, Intonation, Pronunciation
- Phonetics: Vowel & Consonant Sounds, Articulation Techniques
- Accent Neutralization and Speech Clarity
- Integration of Speech Tools: Text-to-Speech & Speech-to-Text Applications for Practice

Reference Books

1. *Technical Communication – Principles and Practices* by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2007, New Delhi.
2. *Business Correspondence and Report Writing* by R.C. Sharma & Krishna Mohan, Tata McGraw Hill, 2001, New Delhi.
3. *Practical Communication: Process and Practice* by L.U.B. Pandey, AITBS Publications, 2014, Delhi.
4. *Modern Technical Writing* by Theodore A. Sherman et al., Prentice Hall, U.S.
5. *Scientific and Technical Writing* by S.D. Sharma, Vikas Publishing, Delhi.
6. *Skills for Effective Business Communication* by Michael Murphy, Harvard University, U.S.
7. *Business Communication for Managers* by Payal Mehra, Pearson, Delhi.
8. **Supplementary Tools**: ChatGPT (OpenAI), Grammarly, QuillBot, Hemingway Editor (Free Web Tools)

Course Outcomes

Upon successful completion, students will be:

- **CO1**: Capable of understanding and applying technical communication principles in professional environments.
- **CO2**: Skilled in producing diverse forms of technical documents, including essays and research papers.
- **CO3**: Confident in presenting ideas using their **individual style** and modern digital tools.
- **CO4**: Competent in applying communication techniques for workplace success and cross-cultural collaboration.
- **CO5**: Able to evaluate and enhance their voice modulation, pronunciation, and non-verbal cues using tech-based feedback tools.

Universal Human Values (AHT-008)

Course Objectives: **L T P: 3 1 0**

This course is designed to:

- Enable students to develop a **holistic perspective** through self-exploration regarding themselves (as human beings), their families, society, and nature/existence.
- Foster understanding of harmony at various levels of life and nature and how to **live in alignment with these principles**.
- Strengthen self-reflection and encourage the development of ethical commitment and the **courage to act**.
- Engage students in meaningful discussions and reflections on **values, integrity, morality, etiquette, and social behavior**, leading to **personal growth and social responsibility**.

Particulars

Unit 1 (8 Hrs): Introduction to Value Education

- Meaning and Purpose of Value Education
- Universal Human Values: Self-exploration, Natural Acceptance, and Experimental Validation
- Human Aspirations and the Right Understanding of Relationship and Physical Facilities
- Living in Harmony at Different Levels: Individual, Family, Society, and Nature
- **Universal Norms** that define:
    - **Integrity** (truthfulness, honesty, consistency of character)
    - **Morality** (distinguishing right from wrong based on human values)
    - **Etiquette** (civility, conduct, and social mannerisms)
    - **Social Behaviour** (responsibility, cooperation, empathy, tolerance)

Unit 2 (8 Hrs): Harmony in the Human Being

- Understanding the Human Being as a Coexistence of Self ('I') and Body
- Needs of the Self and Needs of the Body
- Body as an Instrument of 'I'
- Characteristics, Activities, and Harmony of 'I'
- Harmony between 'I' and the Body: Sanyam (Self-regulation) and Health
- Physical Needs and Prosperity
- Programs to Ensure Sanyam and Health
- Introduction to **Indian Value System – Traditional and Modern**:
    - Traditional values (Dharma, Karma, Truth, Ahimsa)
    - Modern ethical shifts (Secularism, Democratic responsibility, Scientific temper)

Unit 3 (8 Hrs): Harmony in the Family and Society

- Values in Human-Human Relationships
- Nine Universal Values: Trust, Respect, Affection, Care, Guidance, Reverence, Glory, Gratitude, Love
- Distinguishing Intention and Competence
- Respect and Differentiation
- Harmony in Society: Justice, Resolution, Prosperity, Fearlessness, and Coexistence
- Universal Human Order: Concept of an Undivided Society and Universal Family
- **The Effect of Social Isolation and Social Networks on Human Behavior**:
    - Psychological and emotional impacts of isolation
    - Role of digital/social media networks on human relationships, empathy, and community life

Unit 4 (8 Hrs): Harmony in Nature and Existence

- Harmony in Nature: Interconnectedness and Interdependence
- Four Orders of Nature: Material Order, Plant/Bio Order, Animal Order, Human Order
- Understanding Existence as Co-existence
- Harmony at All Levels of Existence
- Respect for Natural Cycles and Ecological Balance
- Sustainable Coexistence and Environmental Ethics

Unit 5 (8 Hrs): Harmony in Professional Ethics

- Natural Acceptance of Human Values in Professional Life
- Definitiveness of Ethical Human Conduct
- Humanistic Education, Humanistic Constitution, and Humanistic Universal Order
- Competence in Professional Ethics: Honesty, Responsibility, Excellence
- **Case Studies** on Ethical Dilemmas and Decision-Making
- Transition from Current State to Universal Human Order: Individual and Societal Level
- Application of Universal Human Values in Engineering and Technology Professions

Text Book

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

Reference Books

1. *Jeevan Vidya: Ek Parichaya*, A. Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999
2. *Human Values*, A.N. Tripathi, New Age International Publishers, New Delhi, 2004
3. *The Story of Stuff*
4. *The Story of My Experiments with Truth* – M.K. Gandhi
5. *Small is Beautiful* – E.F. Schumacher
6. *Slow is Beautiful* – Cecile Andrews
7. *Economy of Permanence* – J.C. Kumarappa
8. *Bharat Mein Angreji Raj* – Pandit Sunderlal
9. *Rediscovering India* – Dharampal
10. *Hind Swaraj or Indian Home Rule* – M.K. Gandhi
11. *India Wins Freedom* – Maulana Abul Kalam Azad
12. *Vivekananda* – Romain Rolland
13. *Gandhi* – Romain Rolland

Course Outcomes

By the end of the course, students will:

- **CO1**: Become more aware of themselves and their surroundings (family, society, nature)
- **CO2**: Be more responsible and capable of addressing problems with sustainable, human-centric solutions
- **CO3**: Enhance their **critical thinking abilities** with a grounding in human values
- **CO4**: Develop commitment toward ethical behavior and societal well-being
- **CO5**: Begin to apply these values in their day-to-day personal and professional lives
- **CO6**: Understand and reflect on the **universal norms of human integrity and morality**, the **richness of Indian value systems**, and the **impact of social conditions like isolation or hyper-connectedness** on human character and conduct.

Theory of Structures (ANT-001)

L T P: 3 1 0

Course Objectives:

The course aims to enable students to:

1. Understand fundamental concepts in the mechanics of deformable bodies, focusing on stress, strain, and elasticity principles.
2. Analyze the structural behavior of beams, trusses, shafts, and columns under various loading and support conditions.
3. Develop an understanding of material behavior and structural performance in slender, hollow, and aerospace-relevant components.
4. Apply the theory of elasticity and structural analysis to real-world problems, especially in aerospace and aircraft structures.
5. Interpret and apply structural design codes and industry standards relevant to mechanical and aerospace engineering applications.

Unit 1: Introduction to Theory of Elasticity & Aircraft Structures (8 Hrs)

- Aircraft as a load-bearing structure: Introduction to structural components like wings, fuselage, empennage.
- Concepts of stress and strain in 3D, equilibrium and compatibility conditions.
- Isotropic materials, constitutive relations for elastic solids, Hooke's Law.
- Generalized plane strain, stress transformation, principal stresses and strains.
- Mohr's Circle: graphical method for stress analysis.
- Airy's stress function and its applications.

Unit 2: Axial Loads, Torsion & Thermal Stresses (8 Hrs)

- Mechanical properties of materials: Elastic constants, Poisson's ratio, working stress, factor of safety.
- Axial deformation: Bars of uniform and varying cross-section.
- Thermal stresses in composite bars.
- **Torsion** in solid and hollow circular shafts: stress distribution, angle of twist.
- Power transmission and design of shafts. *(Include examples from aerospace drive shafts)*

Unit 3: Shear Force, Bending Moment, and Stresses in Beams (8 Hrs)

- Introduction to beam types and loading conditions.
- Shear force and bending moment diagrams for various load combinations.
- Euler-Bernoulli beam theory, assumptions, limitations.
- Bending stress distribution, flexural formulas for different sections: I, C, T, and thin-walled sections.
- Shear stress variation across beam cross-sections.
- Concept of beams of uniform strength.

Unit 4: Deflection of Beams and Column Stability (8 Hrs)

- Beam deflection: Double integration method, Macaulay's method, Moment-area method, Conjugate beam method.
- Superposition principle.
- Columns: Types, end conditions.
- Buckling of slender columns: Euler's theory, Rankine-Gordon and Johnson's formulas.
- Concept of eigenvalues and modes in beam-columns.

Unit 5: Redundant and Indeterminate Structures (8 Hrs)

- Trusses: Classification, perfect frames, analysis using method of joints and sections.
- Determinate vs. indeterminate structures.
- Order of redundancy, compatibility conditions.
- Analysis methods: Area moment method, Clapeyron's theorem of three moments, Slope deflection method, Moment distribution method.

Textbooks

1. R. K. Bansal – *Strength of Materials*, Laxmi Publications, 5th Ed., 2012
2. T. H. G. Megson – *Aircraft Structures for Engineering Students*, Butterworth-Heinemann, 5th Ed., 2012
3. Timoshenko & Gere – *Mechanics of Materials*, McGraw-Hill, 3rd Ed., 1993

Reference Books

1. C. L. Dym, I. H. Shames – *Solid Mechanics*, McGraw-Hill, 7th Ed., 2007
2. S. Timoshenko – *Strength of Materials Vol I & II*, CBS Publishers, 3rd Ed., 2004
3. R. K. Rajput – *Strength of Materials*, S. Chand & Co., 1st Ed., 1999
4. S. Timoshenko, D. H. Young – *Elements of Strength of Materials*, Van Nostrand, 4th Ed., 1977

Course Outcomes

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

- **CO1**: Identify the role of different structural elements in an aircraft and describe their loading conditions, materials, and behavior under stress.
- **CO2**: Calculate shear force, bending moment, and deflections in beams and analyze torsion and axial load effects.
- **CO3**: Use the theory of elasticity to analyze stress and strain in 2D and 3D problems, including transformation and principal stress analysis.
- **CO4**: Analyze statically indeterminate structures using classical methods and assess column stability.
- **CO5**: Apply knowledge to real-world aerospace structural systems using appropriate standards and best practices, with emphasis on hollow, slender structures.

Aerodynamics - I(ANT-002)

L T P: 3 1 0

Course Objectives:

This course aims to enable students to:

- Understand the basics of aerodynamics, including aerofoil and wing characteristics.
- Calculate aerodynamic forces and moments acting on aerofoils and wings under ideal flow conditions.
- Design a propeller and analyze aerodynamic interactions between various aircraft components.
- Gain foundational knowledge of fluid behavior in motion relative to solid bodies.
- Engage in practical learning through simulations and experiments to analyze and predict aerodynamic behavior in real-world applications.

Course Content:

Unit 1: Introductory Topics for Aerodynamics (8 Hrs)

- Properties of fluids: units, dimensions, phases of matter
- Pressure, temperature, density, viscosity, specific heats, enthalpy, entropy
- Standard Atmosphere (ISA)
- Types of flow: steady/unsteady, compressible/incompressible, viscous/inviscid
- One-dimensional flow equations
- Conservation laws: mass, momentum, and energy
- Equation of state, pressure coefficient

Unit 2: Potential Flow (8 Hrs)

- Potential flow theory: velocity potential, stream function, Laplace equation
- Flow singularities: uniform flow, source, sink, doublet, vortex
- Non-lifting and lifting flow over a cylinder
- Kutta-Joukowski theorem, Magnus effect, circulation

Unit 3: Finite Wing Theory (8 Hrs)

- Vortex motion: line, tube, sheet; Kelvin's and Helmholtz's theorems
- Biot-Savart law and applications; Rankine vortex
- Flow over finite wings: vortex model, bound vortices, induced drag
- Prandtl's lifting line theory: elliptic wing, taper, twist, sweepback, delta wings
- Lifting surface theory: Source panel, vortex panel, vortex lattice methods

Unit 4: Flow Past Non-Lifting Bodies and Interference Effects (8 Hrs)

- Method of singularities for non-lifting bodies
- Wing-body interference
- Propeller effects on wings, fuselage, and tail unit
- Flow over complete aircraft configuration

Unit 5: Conformal Transformation (8 Hrs)

- Conformal mapping techniques
- Kutta-Zhukovsky transformation:
  - Circle to straight line
  - Circle to ellipse
  - Circle to symmetric/chambered aerofoil
  - Circle to circular arc aerofoil

Textbooks:

1. E. L. Houghton and P. W. Carpenter, *Aerodynamics for Engineering Students*, Edward Arnold, 5th Edition, 1982.
2. J. D. Anderson, *Fundamentals of Aerodynamics*, McGraw-Hill, 5th Edition, 1985.
3. John J. Bertin and Russell M. Cummings, *Aerodynamics for Engineering Students*, Pearson, 5th Edition, 2009.

Reference Books:

- L. J. Clancy, *Aerodynamics*, Pitman, 1st Edition, 1986.
- L. H. Milne-Thomson, *Theoretical Aerodynamics*, Dover, 2nd Edition, 1985.
- K. Karamcheti, *Principles of Ideal-Fluid Aerodynamics*, Krieger Publishing, 2nd Edition, 1980.

Course Outcomes (COs):

By the end of the course, students will be able to:

- **CO1:** Explain the theoretical principles underlying ideal and real fluid aerodynamics.
- **CO2:** Apply conformal transformations to analyze and design aerodynamic shapes.
- **CO3:** Use computational fluid dynamics (CFD) tools to simulate and visualize aerodynamic flows.
- **CO4:** Analyze the aerodynamic effects of different wing geometries and configurations.
- **CO5:** Conduct wind tunnel experiments and interpret results for aerodynamic validation.

Fluid Mechanics and Hydraulics (ANT-003)

L T P: 3 1 0

Course Objectives :

The course should enable the students to learn:

- Illustrate about the basic properties of a fluid, hydrostatic forces on submerged bodies and different manometers.
- Derive the basic principles of a fluid-continuity, momentum, Euler and Bernoulli‘s equations.
- Explain the concept of boundary layer theory and importance of Prandtl‘s boundary layer theory.
- Understand the flow through pipes and their losses for different geometries

Particulars

Unit 1: Fluid Properties and Fluid Statics: (8 Hrs)

Fluid Properties and Fluid Statics: Density, specific weight, specific gravity, surface tension and capillarity, Newton‘s law of viscosity, incompressible and compressible fluid, numerical problems; Hydrostatic forces on submerged bodies - Pressure at a point, Pascal's law, pressure variation with temperature and height, center of pressure plane, vertical and inclined surfaces; Manometers - simple and differential Manometers, inverted manometers, micro manometers, pressure gauges and numerical problems. Buoyancy - Archimedes principle, metacenter, Meta centric height calculations; Stability

Unit 2: Fluid Kinematics and Basic Equations of Fluid Flow Analysis (8 Hrs)

Fluid Kinematics and Basic Equations of Fluid Flow Analysis: Stream line, path line, streak line, stream surface, stream tube, classification of flows, steady, unsteady, uniform, non-uniform, laminar, turbulent flows, one dimensional approximation, examples of real 1-D flows, two dimensional approximation, 2-D flow in wind tunnel; Continuity equations for 1-D and 2-D flows both compressible and incompressible, stream function for two dimensional incompressible flows; Vortices, irrotational flow, velocity potential function

Unit 3: Fluid Dynamics: (8 Hrs)

Fluid Dynamics: Basic laws for a system in integral form: Reynolds transport theorem, Conservation of mass, Newton‘s 2nd law; Application of the basic laws for a control volume; Kinematics; Motion of a fluid particle; Fluid deformation; Differential analysis of fluid motion: Continuity equation, Differential momentum equation, Surface and body forces, substantive derivative, local derivative and convective derivative, momentum equation, Euler's and Bernoulli's equation, phenomenological basis of Naviers- stokes equation, introduction to vortex flows, flow measurements : pressure, velocity and mass flow rate, viscosity, pivot-static tube, venture meter and orifice meter, viscometers. Statement of Buckingham‘s π- theorem, similarity parameters - Reynolds number, Froude number, concepts of geometric, kinematic and dynamic similarity, Reynolds number as a very approximate measure of ratio of inertia force and viscous force.

Unit 4: Boundary Layer Theory and Pipe Flow: (8 Hrs)

Boundary Layer Theory and Pipe Flow: Boundary layer - introductory concepts of boundary layer, large Reynolds number flows and Prandtl‘s boundary layer hypothesis Pressure drag and skin friction drag; Pipe flow - Reynolds experiment, Darcy‘s equation, major and minor losses in pipes and numerical problems. Flow between parallel plates, flow through long tubes –fully developed flow, Turbulent flow, variation of friction factor with Reynolds‘s Number, Moody's chart.

Unit 5: TURBO MACHINERY: (8 Hrs)

TURBO MACHINERY: Introduction and classification of fluid machines: Turbo machinery analysis; The angular momentum principle; Euler turbo machine equation; Velocity triangles; Application to fluid systems - Working principle overview of turbines, fans, pumps and compressors.

TEXT BOOKS:

1. Shames I H, ―Mechanics of Fluids, Kogakusha, Tokyo, 7th Edition, 2007.
2. R. K Bansal, ―Fluid mechanics and hydraulic machines, Laxmi publications ltd, 9th Edition, 2011.
3. Robert W Fox, Alan T McDonald, ―Introduction to fluid Mechanics, John Wiley and Sons, 6th Edition, 1995.
4. Streeter V. L, Wylie, E.B., ―Fluid Mechanics, McGraw-Hill, 9th Edition, 1983

REFERENCE BOOKS:

1. Yuan S W, ―Foundations of fluid Mechanics, Prentice-Hall, 2nd Edition, 1987.
2. Milne Thompson L M, ―Theoretical Hydrodynamics, MacMillan, 5th Edition, 1968.
3. Ratha krishnan. E, ―Fundamentals of Fluid Mechanics, Prentice-Hall, 5th Edition, 2007.
4. Som S. K, Biswas. G ―Introduction to fluid mechanics and fluid machines, Tata McGraw-Hill,2nd Edition, 2004

Course Outcomes:

CO1: Basic fluid mechanics and description of fluid motion
CO2: Various equations to solve fluid dynamics problems
CO3: Concept of boundary layer
CO4: They will be able to analyze and solve problems related to incompressible and compressible flow, including the application of the Navier-Stokes equations.
CO5: Students will learn to assess the impact of fluid flow on aircraft performance, stability, and control, integrating fluid mechanics principles into aeronautical design and analysis

Mechanics of Solids Lab (ANP-001)

L T P: 0 0 2

Course Objectives:

The course aims to enable students to:

- Understand and verify theoretical concepts of mechanics of solids through hands-on experiments.
- Learn standard testing methods for evaluating the mechanical properties of metallic materials such as mild steel, aluminum, brass, and cast iron.
- Gain experience with mechanical testing equipment for stress, strain, hardness, toughness, and deformation analysis.
- Develop skills in collecting, analyzing, and interpreting experimental data.
- Correlate experimental results with theoretical understanding of material behavior under different loading conditions.

List of Experiments:

Students should perform a minimum of 10 experiments from the following list or equivalent as per institutional setup. The selected experiments must align with the core theory syllabus.

1. **Brinell Hardness Test**
   - Objective: Determine the Brinell Hardness Number (BHN) of a metal specimen.
   - *Note: This directly supports material characterization topics in the theory course.*
2. **Rockwell Hardness Test**
   - Objective: Determine hardness of steel, brass, copper, and aluminum using Rockwell scale.
3. **Tensile Test on Mild Steel and Aluminum**
   - Objective: Determine tensile strength, yield strength, elongation, and Young's modulus.
   - *Critical for linking stress-strain behavior with theoretical Hooke's law and elastic/plastic deformation.*
4. **Torsion Test**
   - Objective: Determine modulus of rigidity (G) of mild steel or aluminum specimens.
   - *Reinforces the study of torsion in circular shafts.*
5. **Izod Impact Test**
   - Objective: Evaluate impact toughness of materials using the Izod method.
6. **Charpy Impact Test**
   - Objective: Evaluate material toughness using the Charpy method.
   - *Alternative: Consider replacing one impact test with "**Shear Centre Determination**" for richer structural learning.*
7. **Compression Test on Short Column**
   - Objective: Study material behavior under axial compression and determine compressive strength.
8. **Euler's Buckling Test on Long Column**
   - Objective: Determine Young's modulus from buckling load.
   - *Supports slender column theory studied in lectures.*
9. **Spring Testing**
   - Objective: Determine stiffness and modulus of rigidity of a helical spring wire.
10. **Deflection of Beams (Simply Supported & Cantilever)**
    - Objective: Determine Young's modulus via beam deflection under known loads.
    - *Suggestion: Provide clear separation or combine into one structured experiment with theory alignment.*

11. **Shear Centre Determination** *(Recommended to Replace One Impact Test)*
    - Objective: Determine the shear center location for an unsymmetrical section.
    - *Highly valuable for structural mechanics learning.*

Reference Books:

1. Gere & Timoshenko, *Mechanics of Materials*, McGraw Hill, 3rd Edition, 1993.
2. R. S. Kurmi & Gupta, *Strength of Materials*, S. Chand, 24th Edition, 2005.
3. William Nash, *Strength of Materials*, Tata McGraw Hill, 4th Edition, 2004.

Course Outcomes (COs):

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

- **CO1:** Identify and evaluate fundamental mechanical properties (hardness, toughness, strength) of ferrous and non-ferrous materials through laboratory testing.
- **CO2:** Apply experimental techniques to measure stress, strain, and deformation in solid materials and validate theoretical models.
- **CO3:** Use standard laboratory equipment (UTM, torsion, impact, deflection rigs) and follow ASTM/IS testing procedures.
- **CO4:** Analyze experimental data, interpret results, and prepare technical reports demonstrating sound understanding and communication.
- **CO5:** Correlate lab results with theoretical principles of failure, aiding in material selection and mechanical design for structural and aerospace applications.

Fluid Mechanics and Hydraulics Lab (ANP-002)

L T P: 0 0 2

Course Objective

The course should enable the students to:

- Gain knowledge on working of centrifugal pumps, positive displacement pumps, hydraulic turbines centrifugal blowers and steam turbines.
- Compare performance of various machines at different operating points.
- Knowledge of various flow meters and the concept of fluid mechanics.
- Students will gain practical experience in conducting experiments that demonstrate fundamental principles of fluid mechanics, including fluid statics, dynamics, and flow behavior
- They will explore the application of hydraulic principles in real-world scenarios, such as pipe flow, open channel flow, and fluid machinery, enhancing their understanding of hydraulic systems.

Particulars

List of Experiments

Minimum 10 experiments out of the following (or similar experiments).

1. Calibration: Calibration of Venturi meter and orifice meter.
2. Pipe Flow Losses: Determination of pipe flow losses in rectangular and circular pipes
3. Bernoulli's Theorem: Verification of Bernoulli's theorem.
4. Reynolds Experiment: Determination of Reynolds Number of fluid flow
5. Impact of Jet on Vanes: Study Impact of jet on Vanes.
6. Centrifugal Pumps: Performance test on centrifugal pumps.
7. Reciprocating Pumps: Performance test on reciprocating pumps.
8. Pelton Wheel Turbine: Performance test on piston wheel turbine.
9. Francis Turbine: Performance test on Francis turbine.
10. Flow Through Weirs: Rate of discharge Flow through Weirs
11. Flow Through Notch: Flow through rectangular and V-Notch
12. Flow Though Orifice Mouth Piece: Flow analysis of different shapes of mouth pieces

REFERENCE BOOKS:

1. Yuan S W, ―Foundations of fluid Mechanics, Prentice-Hall, 2nd Edition, 1987.
2. Milne Thompson L M, ―Theoretical Hydrodynamics, MacMillan, 5th Edition, 1968.
3. Rathakrishnan. E, ―Fundamentals of Fluid Mechanics, Prentice-Hall, 5th Edition, 2007.
4. Som S. K., Biswas. G, ―Introduction to fluid mechanics and fluid machines, Tata McGraw- Hill, 2nd Edition, 2004.

Course Outcomes:

CO1: Obtain the necessary practical skills & real time knowledge
CO2: Apply scientific method for analysing the qualitatively & quantitatively to solve the problems.
CO3: Flow behaviour in various geometry of cross sectional
CO4: Students will improve their technical communication skills by preparing detailed lab reports and

presentations that summarize their findings and methodologies.

CO5: They will enhance their ability to perform computational fluid dynamics (CFD) simulations, comparing experimental results with numerical predictions.

Introduction to Machine Elements and Drawing (ANP-003)

L T P: 0 0 2

Course Objective

The course should enable the students to:

- To equip students with the ability to select and understand the functions of various machine elements in engineering assemblies.
- To develop proficiency in computer-aided drafting (CAD) software for creating precise technical drawings and shop floor documentation.
- To introduce solid modeling techniques, enabling students to create and manipulate 3D representations of machine parts and assemblies.
- To foster creativity and problem-solving skills through design exercises and projects, applying theoretical knowledge to practical engineering challenges.
- Students will enhance their problem-solving abilities by applying theoretical knowledge to design simple machine elements and systems, fostering creativity and innovation in engineering design.

Particulars

List of Experiments

1. **Experiment 1: Introduction to Sectioning and Dimensioning**
   - Practice creating sectional views of simple machine components.
   - Learn basic dimensioning techniques to accurately represent part details.
2. **Experiment 2: Limits, Fits, and Tolerances**
   - Study and apply concepts of limits, fits, and tolerances on sample parts.
   - Calculate and interpret tolerance zones for mating components.
3. **Experiment 3: Selection and Function of Machine Elements**
   - Explore different machine elements (like bearings, gears, keys) and understand their functions.
   - Identify appropriate elements for typical mechanical assemblies.
4. **Experiment 4: Drafting of Machine Elements Using CAD**
   - Create detailed drawings of various machine elements using computer-aided drafting software.
   - Practice adding views, dimensions, and annotations.
5. **Experiment 5: Shop Floor Drawing Preparation**
   - Understand the requirements and standards for shop floor drawings.
   - Prepare and interpret shop floor drawings for manufacturing.
6. **Experiment 6: Introduction to Solid Modeling Tools**

- Learn basics of solid modeling software interfaces and tools.
- Create basic 3D shapes and features.

7. **Experiment 7: Solid Modeling of Simple Machine Parts**
   - Model common machine parts such as shafts, keys, and pulleys in 3D CAD software.
   - Apply constraints and dimensions within the model.
8. **Experiment 8: Assembly Modeling of Machine Components**
   - Assemble multiple solid models to create a functioning mechanical sub-assembly.
   - Check for proper fits and clearances.
9. **Experiment 9: Design Exercise/Project - Simple Machine Part**
   - Design and model a simple machine component or part from scratch using CAD software.
   - Include all relevant dimensions and tolerances.
10. **Experiment 10: Compilation and Presentation of Design Project**
    - Prepare detailed drawings and a presentation documenting the design process.
    - Demonstrate an understanding of drafting, modeling, and manufacturing constraints.

Reference Books:

1. Ajeet Singh, Machine Drawing: Includes AutoCAD, 2nd ed., Tata McGraw-Hill (2012).
2. John, K. C., Textbook of Machine Drawing, PHI Learning (2009).
3. Junnarkar, N. D., Machine Drawing, Pearson Education (2007)
4. Bhatt, N. D. and Panchal, V. M., Machine Drawing, 49th ed., Charotar Publishing (2014).
5. Sidheswar, N., Kanniah, P., and Sastry, V. V. S., Machine Drawing, Tata McGraw-Hill(2001)
6. Narayana, K. L., Kannaiah, P., and Venkata Reddy K., Machine Drawing, 4th ed., New Age International (2010).

Course Outcomes:

CO1: Identify and understand the fundamental machine elements such as gears, bearings, shafts, and fasteners used in mechanical systems.
CO2: Develop technical drawings using standard drawing conventions and tools, adhering to industry standards for machine components.
CO3: Apply principles of mechanical design to create and analyze simple machine assemblies and their interactions.
CO4: Interpret and modify engineering drawings based on design requirements and functional considerations.
CO5: Understand the role of machine elements in the performance and reliability of mechanical systems, and assess their design and material selection.

Internship I/ Mini Project I (ANP-004)

Course Objectives

The course should enable the students to:

- Create an Industrial environment and culture within the institution.
- Identify the issues and challenges of an industry.
- Prepare report on the application of emerging technologies in the selected industry.
- Learn and understand the concept of entrepreneurship.
- Inculcate innovative thinking.

Course Outcomes:

On completion of the course, student will be able to–

CO1: Develop his abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project or Internship.

CO2: Understand the importance of document design by compiling Technical Report on the Mini Project or Internship work carried out.

CO3: Comment and evaluate other students research questions and internship proposals.

CO4: Prepare a detailed report or presentation documenting the project or internship experience, including project outcomes, challenges faced, and lessons learned

CO5: Work collaboratively with industry professionals or project teams, improving communication and teamwork skills in a professional environment

Python Programming (CST-005)

L T P: 2 0 0

Course Objectives

The course should enable the students to:

- Be introduced with the basic principles and concepts of python programming, and how python programming concepts are useful in problem-solving.
- Write clear and effective python code.
- Perform file operations to read and write data in files.
- Create applications using Python Programming.
- Students will learn to utilize Python libraries and frameworks for various applications, such as data analysis, web development, and automation.

Particulars

Unit 1 **(8 Hrs)**

Introduction and Syntax of Python Program: Features of Python, Interactive, Object-oriented, Interpreted, platform-independent, Python building blocks -Identifiers, Keywords, Indention, Variables, Comments, Python environment setup – Installation and working of IDE, Running Simple Python scripts to display a welcome message, Python variables. Python Data Types: Numbers, String, Tuples, Lists, Dictionary. Declaration and use of datatypes, Built-in Functions.

Unit 2 **(8 Hrs)**

Python Operators and Control Flow statements: Basic Operators: Arithmetic, Comparison/ Relational, Assignment, Logical, Bitwise, Membership, Identity operators, Python Operator Precedence. Control Flow: Conditional Statements (if, if...else, nested if), Looping in python (while loop, for loop, nested loops), loop manipulation using continue, pass, break, else.

Unit 3 **(8 Hrs)**

Data Structures in Python: String: Concept, escape characters, String special operations, String formatting operator, Single quotes, Double quotes, Triple quotes, Raw String, Unicode strings, Built-in String methods. Lists: Defining lists, accessing values in lists, deleting values in lists, updating lists, Basic List Operations, and Built-in List functions. Tuples: Accessing values in Tuples, deleting values in Tuples, and updating Tuples, Basic Tuple operations, and Built-in Tuple functions. Sets: Accessing values in Set, deleting values in Set, and updating Sets, Basic Set operations, Built-in Set functions. Dictionaries: Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary, Basic Dictionary operations, Built-in Dictionaries functions.

Unit 4 **(8 Hrs)**

Python Functions, modules, and Packages: Use of Python built-in functions (e.g., type/data conversion functions, math functions etc.). User-defined functions: Function definition, Function call, function arguments and parameter passing, Return statement, Scope of Variables: Global variable and Local Variable. Modules: Writing modules, importing modules, importing objects from modules, Python built-in modules (e.g., Numeric, mathematical module, Functional Programming Module), Packages.

Unit 5 **(8 Hrs)**

File Handling: Opening files in different modes, accessing file contents using standard library functions,

Reading, and writing files, closing a file, Renaming, and deleting files, File related standard functions.

Text Books:

- Charles R. Severance, “Python for Everybody: Exploring Data Using Python 3”, 1st Edition, Create Space Independent Publishing Platform, 2016.
- Allen B. Downey, "Think Python: How to Think Like a Computer Scientist”, 2nd Edition, Green Tea Press, 2015.
- Ch Satyanarayana, “Python Programming”, 1st Edition, universities press (India) private limited 2018.

Reference Books:

1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014
2. Mark Lutz, “Programming Python”, 4th Edition, O’Reilly Media, 2011.ISBN-13: 978-9350232873
3. Wesley J Chun, “Core Python Applications Programming”, 3rd edition, Pearson Education India, 2015. ISBN-13: 978-9332555365
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, “Data Structures and Algorithms in Python”,1st Edition, Wiley India Pvt Ltd, 2016. ISBN-13: 978- 8126562176
5. Reema Thareja, “Python Programming using problem-solving approach”, Oxford university.

Course Outcomes

On successful completion of the course, the student will be able to:

CO1: Develop essential programming skills in computer programming concepts like data types.
CO2: Examine Python syntax and semantics and be fluent in the use of Python flow control and functions.
CO3: Illustrate the process of structuring the data using lists, tuples, and dictionaries.
CO4: Demonstrate using built-in functions and operations to navigate the file system.
CO5: Interpret the concepts of modules and user-defined functions in Python.

Cyber Security (CST-006)

L T P: 2 0 0

Course Objectives

The course should enable the students to:

- Familiarize with network security, network security threats, security services, and
- countermeasures.
- Be aware of computer security and Internet security.
- Study the defensive techniques against these attacks.
- Familiarize with cyber forensics, cybercrimes, and Cyberspace laws.
- Understand ethical laws of computers for different countries, Offences under cyberspace and
- the Internet in India.

Particulars

Unit 1 **(8 Hrs)**

Introduction to Cyber Security: Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, the motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., CIA Triad.

Unit 2 **(8 Hrs)**

Cyber Forensics: Introduction to cyber forensic, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

Unit 3 **(8** Hrs)

Cybercrime (Mobile and Wireless Devices): Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops and desktop.

Unit 4 **(8 Hrs)**

Cyber Security (Organizational Implications): Introduction cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing, and the associated challenges for organizations. Cybercrime and Cyber terrorism: Introduction, intellectual property in cyberspace, the ethical dimension of cybercrimes, the psychology, mindset and skills of hackers and other cybercriminals.

Unit 5 **(8 Hrs)**

Cyberspace and the Law &Miscellaneous provisions of IT Act: Introduction to Cyber Security Regulations, International Law. The INDIAN Cyberspace, National Cyber Security Policy. Internet Governance – Challenges and Constraints, Computer Criminals, Assets and Threats.Other offences under the Information Technology Act in India, The role of Electronic Evidence and miscellaneous provisions of the IT Act.2008.

Text Books:

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley.
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

Reference Books:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu, J. David Irwin, CRC Press T&F Group.
3. Debby Russell and Sr. G.T Gangemi, "Computer Security Basics (Paperback)", 2ndEdition, O' Reilly Media, 2006.
4. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, New Delhi, 2006.
5. Cyberspace and Cybersecurity, George Kostopoulos, Auerbach Publications, 2012.
6. Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes, Second Edition, Albert Marcella, Jr., Doug Menendez, Auerbach Publications, 2007.
7. Cyber Laws and IT Protection, Harish Chander, PHI, 2013

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Course Outcomes

On successful completion of the course, the student will be able to:

CO1: Understand cyber-attacks and types of cybercrimes, and familiarity with cyber forensics
CO2: Realize the importance of cyber security and various forms of cyber-attacks and countermeasures.
CO3: Get familiar with obscenity and pornography in cyberspace and understand the violation of the Right to privacy on the Internet.
CO4: Appraise cyber laws and how to protect themselves and, ultimately, the entire Internet community from such attacks.
CO5: Elucidate the various chapters of the IT Act 2008 power of the Central and State Governments to make rules under IT Act 2008

B.Tech. (Aeronautical Engineering) SEMESTER-IV													
Sl. No.	**Subject Codes**	**Category**	**Subject**	**Periods**			**Evaluation Scheme**					**Subject Total**	**Credit**
							Sessional Exam			**ESE**			
				L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1	AHT-008 / AHT-007	HSC	Universal Human Values /Technical Communication	3 / 2	0 / 1	0 / 0	30	20	50	100		150	3
2	ANT-004	DC	Probability Distributions and Numerical Methods	3	1	0	30	20	50	100		150	4
3	ANT-005	DC	Low Speed Aerodynamics	3	1	0	30	20	50	100		150	4
4	ANT-006	DC	Aircraft Materials and Production	3	1	0	30	20	50	100		150	4
5	ANT-007	DC	Analysis of Aircraft Structures	3	1	0	30	20	50	100		150	4
6	ANT-008	DC	Aero-Thermodynamics	0	0	2		25	25		25	50	1
7	ANP-005	DLC	Aerodynamics Lab	0	0	2		25	25		25	50	1
8	ANP-006	DLC	Aerospace Structures Lab	0	0	2		25	25		25	50	1
	ANP-007	DLC	Aircraft Materials and Production Lab	0	0	2		25	25		25	50	1
9	CST-005/CST-006	NC	Python Programming/Cyber Security	2	0	0	15	10	25	50		75	
10	GP-04	NC	General Proficiency						50			50	
			Total									**950**	**23**
11			**Open Elective (Optional)**	3	1	0	30	20	50	100		150	**4**

Internship-II/Mini Project-II*
To be completed at the end of fourth semester (during Summer Break) & its evaluation/credit to be added in Fifth semester.

Universal Human Values (AHT-008)

L T P: 3 0 0

Course Objectives:

The course should enable the students for:

- Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
- Strengthening of self-reflection.
- Development of commitment and courage to act.
- Students will learn to apply human values in decision-making processes, promoting ethical behavior and social responsibility in their personal and professional lives.

Particulars

Unit 1 **(8 Hrs)**

Introduction - Value Education: Universal human values; self exploration, natural acceptance an experimental validation; Human aspirations, right understanding, relationship and physical facility, current scenario; Understanding and living in harmony at various levels.

Unit 2 **(8 Hrs)**

Harmony in the Human Being: Understanding human being, needs of self(I) and body; body as an instrument of 'I'; characteristics and activities of 'I' and harmony in 'I'; harmony of I with the Body: Sanyam and Health, Physical needs an prosperity; Programs to ensure Sanyam and Health.

Unit 3 **(8 Hrs)**

Harmony in the Family and Society: Values in human-human relationship; nine universal values in relationships; justice, truth, respect, trust; Difference between intention and competence; Respect and differentiation, Harmony in society: resolution, prosperity, fearlessness and coexistence; Universal harmonious order in society.

Unit 4 **(8 Hrs)**

Harmony in the Nature and Existence: Harmony in the nature. Four orders of nature; existence as co-existence, harmony at all levels of existence.

Unit 5 **(8 Hrs)**

Harmony in the Professional Ethics: Natural acceptance of human values, Definitiveness of Ethical Human Conduct; Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics; Case studies; transition from the present state to Universal Human Order: at individual level and societal level.

Text Books:

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

Reference Books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karam chand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Course Outcomes:

At the end of this course, the students:

CO1: Are expected to become more aware of themselves, and their surroundings (family, society, nature)
CO2: Would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
CO3: Would have better critical ability.
CO4: Would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
CO5: Would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

Technical Communication (AHT-007)

L T P: 2 1 0

Course Objectives:

The course should enable the students to:

- Produce technical documents that use tools commonly employed by engineering and computer science professionals.
- Communicate effectively in a professional context, using appropriate rhetorical
- approaches for technical documents, adhering to required templates, and complying with constraints on document format.
- Clarify the nuances of phonetics, intonation and pronunciation skills.
- Get familiarized with English vocabulary and language proficiency.
- Students will gain skills in visual communication, including the use of charts, graphs, and diagrams to support and clarify technical content.

Particulars

Unit 1 **(8 Hrs)**

Fundamentals of Technical Communication: Technical Communication: Introduction, Features; Distinction between General and Technical Communication; The flow of Communication: Downward; upward, Lateral or Horizontal; Barriers to Communication, Importance of communication.

Unit 2 **(8 Hrs)**

Forms of Technical Communication: Technical Report: Definition & importance; Thesis/Project writing: structure & importance; synopsis writing: Methods; Technical research Paper writing: Methods & style; Seminar & Conference paper writing; 7 Cs of effective business writing: concreteness, completeness, clarity, conciseness, courtesy, correctness, consideration.

Unit 3 **(8 Hrs)**

Technical Presentation: Strategies & Techniques: Presentation: Forms; interpersonal Communication; Class Room presentation; style; method, Public Speaking: method; Techniques: Clarity of substance; emotion; Humour; Modes of Presentation; Overcoming Stage Fear: Confident speaking; Audience Analysis & retention of audience interest; Methods of Presentation: Interpersonal; Impersonal; Audience Participation: Quizzes & Interjections.

Unit 4 **(8 Hrs)**

Technical Communication Skills: Interview skills; Group Discussion: Objective & Method; Seminar/Conferences Presentation skills: Focus; Content; Style; Argumentation skills: Devices: Analysis; Cohesion & Emphasis; Critical thinking; Nuances, exposition, narration and description.

Unit 5 **(8 Hrs)**

Kinesics & Voice Dynamics: Kinesics: Definitions; importance; Features of Body Language; Voice Modulation: Quality, Pitch; Rhythm; intonation, pronunciation, articulation, vowel and consonants sounds.

Reference Books

1. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2007, New Delhi.
2. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.

3. Practical Communication: Process and Practice by L.U.B. Pandey; A.I.T.B.S. Publications India Ltd.; Krishan Nagar, 2014, Delhi.
4. Modern Technical Writing by Sherman, Theodore A (et.al); Apprentice Hall; New Jersey; U.S.
5. A Text Book of Scientific and Technical Writing by S.D. Sharma; Vikas Publication, Delhi.
6. Skills for Effective Business Communication by Michael Murphy, Harward University, U.S.
7. Business Communication for Managers by Payal Mehra, Pearson Publication, Delhi.

Course Outcomes:

At the end of this course, the students will be:
CO1: Enabled to understand the nature and objective of Technical Communication relevant for the work place as Engineers.
CO2: Able to utilize the technical writing for the purposes of Technical Communication and its exposure in various dimensions.
CO3: Able to give imbibe inputs by presentation skills to enhance confidence in face of diverse audience.
CO4: Able to create a vast know-how of the application of the learning to promote their technical competence.
CO5: Enabling them to evaluate their efficacy as fluent & efficient communicators by learning the voice-dynamics.

Probability Distributions and Numerical Methods (ANT-004)

L T P: 3 0 0

Course Objectives:

This course enables students to:

- Understand and analyze problems involving multiple random variables, joint distributions, and regression.
- Learn the fundamentals of stochastic processes and Markov chains, which model time-dependent and probabilistic systems.
- Apply numerical techniques for solving algebraic and transcendental equations, interpolation, differentiation, integration, and differential equations.
- Use data analysis tools such as ANOVA and curve fitting for engineering applications.
- Enhance their computational and analytical skills to solve real-world problems involving uncertainty and approximation.

UNIT 1: Multiple Random Variables and ANOVA *(8 Hrs)*

- Joint probability mass and density functions
- Marginal distributions
- Covariance, correlation, and regression
- One-way ANOVA: analysis of variance for single-factor experiments

UNIT 2: Stochastic Processes and Markov Chains *(8 Hrs)*

- Classification and description of stochastic processes
- Stationary and non-stationary processes
- Average values of processes
- Markov chains, transition probability matrix
- Classification of states, limiting probabilities
- Applications in communication, queueing, and systems modeling

UNIT 3: Solution of Algebraic & Transcendental Equations and Curve Fitting *(8 Hrs)*

- Numerical methods: Bisection, Regula-Falsi, Newton-Raphson, Iteration method
- Curve fitting using method of least squares
- Fitting:
  - Linear ($y = a + bx$)
  - Parabolic ($y = ax^2 + bx + c$)
  - Nonlinear: exponential ($y = ae^{bx}$), power ($y = a \cdot x^b$), and geometric ($y = a \cdot b^x$)

UNIT 4: Interpolation and Numerical Differentiation *(8 Hrs)*

- Finite differences: Forward, Backward, and Central
- Newton’s forward and backward interpolation
- Gauss's interpolation formulae
- Lagrange’s interpolation for unequal intervals

- Numerical differentiation using interpolation

UNIT 5: Numerical Integration and ODEs *(8 Hrs)*

- Numerical integration:
  - Trapezoidal rule
  - Simpson's 1/3rd and 3/8th rule
- Solving ODEs of first order using:
  - Taylor's series method
  - Picard's method
  - Euler's method
  - Runge-Kutta method (2nd and 4th order)

Textbooks:

1. **Sheldon M. Ross**, *Probability and Statistics for Engineers and Scientists*, Academic Press.
2. **S. S. Sastry**, *Introductory Methods of Numerical Analysis*, PHI Learning Pvt. Ltd., 5th Edition, 2012.
3. **B. S. Grewal**, *Higher Engineering Mathematics*, Khanna Publishers, 36th Edition, 2010.

Reference Books:

1. **T. T. Soong**, *Fundamentals of Probability and Statistics for Engineers*, John Wiley & Sons, 2004.
2. **B. V. Ramana**, *Higher Engineering Mathematics*, Tata McGraw Hill, 29th Reprint, 2017.

Course Outcomes (COs):

By the end of the course, students will be able to:

- **CO1:** Model and solve problems involving multiple random variables and use ANOVA for data analysis in engineering experiments.
- **CO2:** Analyze and simulate stochastic systems using concepts of random processes, Markov chains, and transition probabilities.
- **CO3:** Apply numerical methods to find approximate solutions to algebraic and transcendental equations.
- **CO4:** Fit curves (linear, polynomial, and exponential) to empirical data using least squares method.
- **CO5:** Estimate derivatives and definite integrals numerically and solve ordinary differential equations using appropriate numerical techniques.

Low Speed Aerodynamics (ANT-005)

L T P: 3 1 0

Course Objectives:

The course aims to enable students to:

- Understand the fundamentals of inviscid incompressible flow theory, aerofoil theory, and wing aerodynamics.
- Analyze aerodynamic forces and moments acting on aerofoils and wings under idealized conditions.
- Explore propeller aerodynamics and propulsion principles in low-speed flight regimes.
- Investigate flight performance metrics including lift, drag, range, endurance, and climb in steady and unsteady flight.
- Develop an understanding of viscous effects through boundary layer theory and flow separation, and validate theoretical predictions using wind tunnel experiments and computational tools.

Unit 1: Aerofoils and Inviscid Flow Theory *(8 Hrs)*

- Definitions: Aerodynamic forces and moments, wing planform, aspect ratio
- Aerofoil nomenclature: camber, chord, thickness, angle of attack
- Concept of circulation, starting vortex, Kutta condition
- Thin aerofoil theory (inviscid, incompressible)
- Pressure distribution and lift on symmetric and cambered aerofoils
- Centre of pressure and aerodynamic centre

Unit 2: Finite Wing Theory and Performance Metrics *(8 Hrs)*

- Wing of finite span: Induced drag, vortex generation
- Prandtl's lifting line theory: Lift distribution, elliptical lift distribution
- Aerofoil characteristics: CLC_LCL vs α, effect of aspect ratio
- Drag polar, CLC_LCL vs CDC_DCD, pitching moment coefficient
- Lift and drag estimation from pressure data
- Steady level flight, wing loading, and aerodynamic efficiency

Unit 3: Propellers and Low-Speed Propulsion *(8 Hrs)*

- Froude's momentum theory of propulsion
- Actuator disc model
- Airscrew terminology: geometric pitch, mean pitch, blade angle
- Vortex system of propeller
- Blade element theory and propeller performance in hover and forward flight

Unit 4: Aircraft Flight Performance *(8 Hrs)*

- Drag components: parasitic, induced, profile, and total drag
- Minimum drag and minimum power conditions
- Gliding flight: equilibrium conditions, glide angle, rate of sink
- Climbing flight: excess power, rate of climb
- Turning performance: turn radius, rate of turn
- Power and thrust required curves

Unit 5: Boundary Layer and Viscous Effects *(8 Hrs)*

- Concept of boundary layer: origin and growth
- Laminar and turbulent boundary layers
- Boundary layer parameters: displacement, momentum, energy thickness
- Transition and separation
- Boundary layer on flat plates (Blasius solution), effect of pressure gradients
- Introduction to thermal boundary layers (qualitative)

Textbooks:

1. E. L. Houghton & P. W. Carpenter, *Aerodynamics for Engineering Students*, Edward Arnold, 5th Edition
2. J. D. Anderson, *Fundamentals of Aerodynamics*, McGraw Hill, 5th Edition
3. John J. Bertin & Russell M. Cummings, *Aerodynamics for Engineers*, Pearson, 5th Edition

Reference Books:

- L. J. Clancy, *Aerodynamics*, Pitman, 1st Edition, 1986
- L. H. Milne-Thomson, *Theoretical Aerodynamics*, Dover, 2nd Edition
- K. Karamcheti, *Principles of Ideal-Fluid Aerodynamics*, Krieger Publishing

Course Outcomes (COs):

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

- **CO1:** Understand and analyze low-speed incompressible inviscid flows around aerofoils and wings.
- **CO2:** Apply lifting line theory to evaluate aerodynamic performance of finite wings.
- **CO3:** Analyze propeller performance and understand the principles of low-speed propulsion systems.
- **CO4:** Evaluate aircraft flight performance parameters including lift, drag, climb, and endurance using theoretical tools.
- **CO5:** Understand boundary layer behavior, flow separation, and its implications for aerodynamic design.
- **CO6 (Optional Enhancement):** Use CFD tools and wind tunnel experiments to simulate and validate low-speed aerodynamic phenomena.

Aircraft Materials and Production (ANT-006)

L T P: 3 1 0

Course Objectives:

The course aims to enable students to:

- Understand the structure, composition, and properties of metallic and non-metallic materials used in the aerospace industry.
- Learn conventional and advanced manufacturing processes for aerospace components.
- Understand inspection and testing methods for structural integrity.
- Explore the fabrication and application of composite materials in aircraft.
- Appreciate recent trends and developments in aerospace materials, including indigenization and super alloys.

Unit 1: Aircraft Engineering Materials *(8 Hrs)*
- Engineering materials used in aircraft: Ferrous and non-ferrous
- Iron-carbon phase diagram, steel classifications
- Heat treatment processes: annealing, normalizing, hardening, tempering
- Aluminum, titanium, and copper alloys – structure and applications
- Corrosion in aircraft materials: types, prevention, protective coatings

Unit 2: Casting, Welding, and Inspection Techniques *(8 Hrs)*
- Casting processes: sand casting, die casting, centrifugal, investment, shell molding
- Welding processes: arc, gas, resistance, laser, and electron beam welding
- Brazing, soldering techniques
- Non-Destructive Testing (NDT): ultrasonic, radiographic, magnetic particle, dye penetrant testing
- Introduction to flight testing of structural components

Unit 3: Sheet Metal and Aircraft Assembly Processes *(8 Hrs)*
- Sheet metal forming: shearing, punching, superplastic forming
- Bending operations: stretch forming, spinning, drawing
- Riveting techniques and aircraft fasteners
- Integral fuel tanks, aircraft structural joints
- Final assembly stages, jigs and fixtures, aircraft tooling systems

Unit 4: Conventional and Unconventional Machining *(8 Hrs)*
- Working principles and applications of:
    - Lathe, milling, shaper, grinding, drilling machines
    - CNC machining systems
- Unconventional processes:
    - Abrasive Jet Machining (AJM), Ultrasonic Machining (USM)
    - Electric Discharge Machining (EDM), Electrochemical Machining (ECM)
    - Laser Beam Machining (LBM), Electron Beam Machining (EBM), Plasma Arc Machining (PAM)

Unit 5: Composite Materials in Aerospace *(8 Hrs)*
- Building blocks: Fibers (glass, carbon, aramid), resins (epoxy, polyester)
- Types of composites: polymer matrix, metal matrix, ceramic matrix composites
- Fabrication techniques: hand lay-up, filament winding, resin transfer molding (RTM), pultrusion

- Characterization of composites: mechanical properties, fatigue, delamination, NDT for composites
- Applications of composites in aircraft: fuselage, wings, control surfaces
- Superalloys, indigenized alloys, emerging materials in aerospace structures

Textbooks:

1. S. Kalpakjian & S. R. Schmid, *Manufacturing Engineering and Technology*, Addison Wesley, 5th Edition
2. S. C. Keshu & K. K. Ganapathy, *Aircraft Production Technology and Management*, Interline Publishing, 3rd Edition
3. Douglas F. Horne, *Aircraft Production Technology*, Cambridge University Press, 1st Edition

Reference Books:

1. S. C. Keshu & K. K. Ganapathy, *Aircraft Production Techniques*, Interline Publishing
2. R. K. Jain, *Production Technology*, McGraw Hill
3. O. P. Khanna & M. Lal, *Production Technology*, Dhanpat Rai Publications

Course Outcomes (COs):

After completing this course, students will be able to:

- **CO1:** Classify and compare metallic materials and their heat treatment processes for aircraft applications.
- **CO2:** Select appropriate manufacturing techniques (casting, welding, machining) for different aerospace components.
- **CO3:** Apply knowledge of NDT methods for inspecting aircraft structures and ensuring material integrity.
- **CO4:** Understand and implement sheet metal and assembly processes involved in aircraft production.
- **CO5:** Identify, fabricate, and analyze composite materials used in aerospace, including emerging alloy systems and high-performance materials.

Analysis of Aircraft Structures (ANT-007)

L T P: 3 1 0

Course Objectives:
The course enables students to:

- Understand the functions, configurations, and behavior of aircraft structural components under various loading conditions.
- Apply analytical methods to analyze bending, shear, and torsion in thin-walled structures.
- Analyze stiffened panels and buckling of structural components in airframes.
- Idealize complex aircraft structures into analyzable models for practical applications.
- Integrate safety, fatigue, and environmental considerations into structural analysis and design.

UNIT 1: Aircraft Structural Components and Energy Methods *(8 Hrs)*
- Aircraft structural components: fuselage, wings, landing gear, control surfaces
- Types of loads: aerodynamic, gust, inertial, and ground loads
- Structural joints: riveted, bolted, welded
- Types of structures: monocoque, semi-monocoque
- Introduction to energy methods: Castigliano's theorems, unit load method, Maxwell's reciprocal theorem, Rayleigh-Ritz method, total potential energy, flexibility method

UNIT 2: Bending, Shear, and Torsion of Thin-Walled Beams *(8 Hrs)*
- Unsymmetrical bending: stress distribution, neutral axis
- Thin-walled open and closed sections: shear flow, shear center
- Bredt-Batho theory, warping, twist of open/closed sections
- Torsion of beams with combined open and closed sections
- Deflection due to bending and torsion
- Effects of temperature changes on structural members

UNIT 3: Structural Idealization and Aircraft Panels *(8 Hrs)*
- Structural idealization: simplification of skin-stringer structures
- Idealized beams under bending, shear, torsion
- Fuselage frames and ribs
- Wing and fuselage panel modeling
- Analysis of beams with variable cross-section and stringer distribution

UNIT 4: Plate Theory and Buckling of Aircraft Structures *(8 Hrs)*
- Thin plate theory: bending, distributed loading, twisting
- Energy methods for plates
- Buckling of plates: elastic/inelastic, critical loads, post-buckling
- Stiffened panel instability
- Tension field beams: complete/incomplete diagonal tension

UNIT 5: Application to Aircraft Structural Elements *(8 Hrs)*

- Wing spar and wing box analysis (open and closed sections)
- Three-boom shell model
- Cut-outs in wings and fuselages
- Tapered wing spars, deflection calculations
- Stiffeners and web construction in frames and ribs
- Introduction to landing gear structural analysis and load considerations

Textbooks:

1. T. H. G. Megson, *Aircraft Structures for Engineering Students*, Butterworth-Heinemann, 5th Edition
2. E. H. Bruhn, *Analysis and Design of Flight Vehicle Structures*, Tri-State Offset, 4th Edition

Reference Books:

1. B. K. Donaldson, *Analysis of Aircraft Structures – An Introduction*, McGraw Hill, 3rd Edition
2. S. Timoshenko, *Strength of Materials*, Volumes I & II, D. Van Nostrand

Course Outcomes (COs):

After completing this course, students will be able to:

- **CO1:** Identify aircraft structural components and classify different types of loads acting on them.
- **CO2:** Analyze thin-walled open and closed section beams under bending, torsion, and shear using classical methods.
- **CO3:** Apply structural idealization and energy methods to aircraft frames and panels.
- **CO4:** Evaluate structural instability, including plate buckling and post-buckling behavior in stiffened panels.
- **CO5:** Perform structural analysis of fuselage, wing, and landing gear, and integrate design considerations such as material selection, safety factors, and failure criteria.

Aero-Thermodynamics (ANT-008)

L T P: 3 1 0

Course Objectives:

The course should enable the students to learn:

- To introduce fundamental concepts in thermodynamics, heat transfer, and refrigeration and air conditioning. apply mathematical foundations, principles in solving thermodynamics problems.
- Students will gain a comprehensive understanding of the fundamental principles of thermodynamics and fluid mechanics as they apply to aerospace systems, including the laws of thermodynamics and the behavior of gases.
- They will learn to analyze the thermodynamic cycles relevant to aerospace applications, such as the Brayton and Rankine cycles, and understand their implications for engine performance and efficiency.
- Students will explore the concepts of compressible flow, including shock waves, expansion waves, and the effects of Mach number on aerodynamic performance.
- They will develop skills in applying thermodynamic principles to solve problems related to heat transfer, propulsion, and energy conversion in aerospace systems.

Particulars

Unit 1: **(8 Hrs)**

First Law of Thermodynamics: Concept of Continuum-Macroscopic approach-thermodynamic systems-properties-state, path and process, quasi-static process- work and heat-zeroth law and first law of thermodynamics-internal energy-enthalpy- applications of first law of thermodynamics to closed and open system.

Unit 2: **(8 Hrs)**

Second Law of Thermodynamics: Second law of Thermodynamics-Kelvin's and Clausius statements of second law-reversibility and irreversibility-carnot theorem-carnot cycle- reversed Carnot cycle- clausius inequality-concept of entropy-principle of energy-availability and Unavailability-Exergy for closed and an open system.

Unit 3: **(8 Hrs)**

Properties of Pure Substances and Power Cycle: Properties of pure Substances-Thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, P-V, P-T, T-V, H-S diagrams, PVT surfaces thermodynamics properties of steam, calculations of work done and heat transfer in non-flow and flow processes. Standard Rankine cycle, Reheat and Regeneration cycle.

Unit 4: **(8 Hrs)**

Air Standard Cylces and IC Engines Cycle-air standard Efficiency-Otto cycle-diesel cycle- dual cycle-Brayton cycle-components of IC engines-Two stroke and four stroke cycle engine-performance of IC engine-supercharging.

Unit 5: **(8 Hrs)**

Refrigeration, Air Conditioning and Psychrometry: Concepts of psychrometry, Psychrometric relation and charts-processes-Refrigeration Systems-Air-conditioning systems and its types- simple vapour compression system-vapour absorption system-Refrigerants.

TEXT BOOKS:

1. Nag. P.K., "Engineering Thermodynamics", McGraw Hill Education (India) Private Limited; Fifth edition, April 2013.
2. Rathakrishnan E, "Fundamentals of Engineering Thermodynamics", Prentice Hall India, revised edition 2005.
3. Yunus A. Cengel and Michael A. Boles, "Thermodynamics: An Engineering Approach" McGraw-Hill Science/Engineering/Math; 7th edition 2010.

REFERENCE BOOKS:

1. Ramalingam K.K. "Thermodynamics", Sci-Tech Publications, 2006
2. Holman.J.P., "Thermodynamics", 3rd Ed. McGraw-Hill, 2007.
3. Venwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1987
4. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
5. Merala C, Pother, Craig W, Somerton, "Thermodynamics for Engineers", Schaum Outline Series, Tata McGraw-Hill, New Delhi, 2004

Course Outcomes:

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

CO1: This course provides the basic knowledge about thermodynamic laws and relations, and their application to various processes.
CO2: Students will understand the fundamental principles of thermodynamics and fluid mechanics as they apply to aerospace systems and propulsion.
CO3: They will be able to analyze and predict the behavior of gases under various conditions, including compressible flow and heat transfer processes.
CO4: They will develop skills in applying the laws of thermodynamics to evaluate the efficiency and performance of propulsion systems and thermal management solutions.
CO5: Students will learn to integrate aero-thermodynamic principles into the design and optimization of aircraft and spacecraft, enhancing overall system performance and safety.

Aerodynamics Lab (ANP-005)

L T P: 0 0 2

Course Objective

The course should enable the students to:

- Understand the behavior of flow properties over different models using subsonic wind tunnel.
- Demonstrate experimentally the pressure distribution over circular, symmetric and cambered air foils and evaluate lift and drag.
- Illustrate flow visualization studies at low speeds over different aerodynamic bodies.
- They will learn to design and execute aerodynamic experiments, including the selection of appropriate models, instrumentation, and measurement techniques to collect accurate data.
- They will explore the practical applications of aerodynamics in various fields, such as aviation, automotive, and sports engineering, through real-world case studies and projects.

Particulars

List of Experiments

Minimum 10 experiments out of the following (or similar experiments).

1. Calibration of subsonic wind tunnel.
2. Pressure Distribution-Cylinder
3. Pressure Distribution-Symmetric Airfoil
4. Pressure Distribution-Cambered Airfoil
5. Force measurement using wind tunnel balance.
6. Flow over a Flat Plate.
7. Flow visualization studies in low speed over cylinder
8. Flow Visualization Studies - Airfoil Flow visualization studies in low speed over airfoil at different angles of incidence.
9. Wake analysis over a cylinder and airfoils
10. Blower Test Rig; Efficiency of blower test rig for 3 different vane settings.
11. Axial Flow Compressor; Efficiency of axial flow compressor
12. Centrifugal Flow Compressor

REFERENCE BOOKS:

1.L. J. Clancy, ―Aerodynamics", Pitman, 1st Edition, 1986.
2. Alan pope, ― Low Speed Wind Tunnel Testing, John Wiley, 2nd Edition, 1999.
3. N. M. Komerath, ―Low Speed Aerodynamics, Extrovert, 1st Edition, 2012.

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Course Outcomes

At the end of this course, student will be able to:

CO1: Point out the pressure distribution of symmetrical and unsymmetrical airfoil and 2D cylinder.
CO2: Examine flow visualization of airfoil and bluff bodiesterials.
CO3: Students will explore the effects of different design parameters on aerodynamic performance, fostering critical thinking and problem-solving skills in real-world applications.
CO4: They will enhance their ability to document and present findings through detailed lab reports, emphasizing clarity and technical communication.
CO5: Students will explore the effects of different design parameters on aerodynamic performance, fostering critical thinking and problem-solving skills in real-world applications.

Aerospace Structures Lab (ANP-006)

L T P: 0 0 2

Course Objective

The course should enable the students to:

- Provide basic knowledge on the mechanical behavior of materials like aluminum, mild steel, and cast iron.
- Visualize the crack detection using various NDT methods and also discuss the changing strength due to these defects.
- Understand the concept of locating the shear centre for open and closed section of beams.
- Obtain buckling strength of both long and short columns using different elastic supports.
- They will learn to design and conduct experiments using appropriate testing methods, such as static and dynamic load tests, to evaluate the structural integrity and failure modes of aerospace structures.

Particulars

List of Experiments

Minimum 10 experiments out of the following (or similar experiments).

1. Direct Tension Test; Tensile testing using UTM, mechanical and optical extensometers, stress strain curves and strength test or various engineering materials.
2. Deflection Test; Stress and deflections of beams for various end conditions, verification of Maxwell's theorem
3. Buckling Test; Compression tests on long columns, Critical buckling loads.
4. Buckling Test; Compression tests on short columns, Critical buckling loads, south well plot.
5. Bending Test; Unsymmetrical Bending of a Beam.
6. Shear Centre for Open Section; Shear Centre of an open Section beam.
7. Shear Centre for Closed Section; Shear Centre of a closed Section beam.
8. Wagner's Theorem; Wagner beam – Tension field beam.
9. Sandwich Panel Tension Test; Fabrication and determine the young's modulus of a sandwich structures.
10. Non-Destructive Testing; Study of non-destructive testing procedures using dye penetration.
11. Non-Destructive Testing; Magnetic particle inspection and ultrasonic techniques.
12. Vibration Test; Determination of natural frequency of beams under free and forced vibration using

Reference Books:

1. Megson, T.H.G., Aircraft Structures for Engineering Students, 4th edn., Elsevier, 2007, ISBN 0-750-667397.
2. Peery, D.J. and Azar, J.J, Aircraft Structures, 2nd ed, McGraw-Hill, 1982, ISBN 0-07-049196-8.
3. Bruhn. E.H, Analysis and Design of Flight Vehicles Structures, Tri-state Off-set Company, USA, 1965.
4. Lakshmi Narasaiah, G., Aircraft Structures, BS Publications, 2010.

Course Outcomes

At the end of this course, student will be able to:

CO1: Various load testing methodology and selecting the suitable structure for different components.
CO2: Students will gain hands-on experience in testing and analyzing the mechanical properties of aerospace materials and structures under various loading conditions.
CO3: They will learn to design and conduct experiments to evaluate the strength, stiffness, and failure modes of different structural components.
CO4: Students will develop skills in using advanced instrumentation and measurement techniques to collect and analyze data accurately.
CO5: They will enhance their ability to interpret experimental results and relate them to theoretical principles of structural analysis and design.

AIRCRAFT MATERIALS AND PRODUCTION LAB (ANP-007)

L T P: 0 0 2

Course Objective

The course should enable the students to:

- Understand the basic conventional machining operation using for aircraft structural members production.
- Illustrate other unconventional machining techniques required for aircraft production.
- Perform the basic computer numerical control machining operation required for aircraft production technology.
- Students will develop skills in manufacturing processes relevant to the aerospace industry, including machining, welding, and composite fabrication, and understand the implications of these processes on material properties and structural integrity.
- They will learn to conduct mechanical tests, such as tensile, compression, and fatigue tests, to assess the performance and durability of aircraft materials under different conditions.

Particulars

List of Experiments

Minimum 10 experiments out of the following (or similar experiments).

1. Basic Metallurgy - I: Preparation and study of microstructure of pure materials like Cu and Al. Hardenability of steels by Jominy End Quench test.
2. Basic Metallurgy - II: Study of microstructures of non-ferrous alloys. Study of microstructure of heat-treated steel.
3. Lathe Operations: Introduction- lathe machine, plain turning, Step turning & grooving, Taper turning-compound rest/offset method & Drilling using lathe, External threading-Single start.
4. Shaping & Slotting; Shaping-V-Block & Slotting-Keyways.
5. Grinding & Milling: Grinding-Cylindrical /Surface/Tool & cutter. Milling-Polygon /Spur gear.
6. Drilling; Drilling, reaming, counter boring, Counter sinking Taping.
7. Cnc Machining; Basic operations, Introduction to CNC programming.
8. Welding Processes I; Gas Welding, Brazing, Electric and Black smithy, Soldering.
9. Welding Process II; Arc welding. Spot welding, Seam welding, TIG welding and MIG Welding.
10. Basic Casting; Sand Casting using different patterns (any two).
11. Riveting Aluminium Sheets; Spot and Blind Rivets on aluminium sheets.

Reference Books:

1. Keshu S. C, Ganapathy K. K, ―Air craft production techniques, Interline Publishing House, Bangalore, 3rd Edition, 1993.
2. R. K Jain-Khanna, ―Production technology, Mc Graw Hill, 1st Edition, 2002.
3. O. P Khanna, Lal. M. Dhanpat Rai, ―Production technology, 5th Edition, 1997.

Course Outcomes

At the end of this course, student will be able to:

CO1: Operate the various machines used in production, different welding techniques.
CO2: Students will improve their ability to document and present their findings through detailed lab reports, emphasizing the relationship between material selection, production methods, and aircraft performance.
CO3: They will enhance their understanding of quality control and inspection methods used in the aerospace industry to ensure material and product integrity.
CO4: Students will develop skills in manufacturing processes relevant to aircraft production, including machining, welding, and composite fabrication techniques.
CO5: They will learn to conduct mechanical tests, such as tensile, compression, and fatigue tests, to evaluate material properties and performance.

Python Programming (CST-005)

L T P: 2 0 0

Course Objectives

The course should enable the students to:

- Be introduced with the basic principles and concepts of python programming, and how python programming concepts are useful in problem-solving.
- Write clear and effective python code.
- Perform file operations to read and write data in files.
- Create applications using Python Programming.
- They will explore object-oriented programming principles, including classes, inheritance, and polymorphism, to design and implement modular and reusable code.

Particulars

Unit 1 **(8 Hrs)**

Introduction and Syntax of Python Program: Features of Python, Interactive, Object-oriented, Interpreted, platform-independent, Python building blocks -Identifiers, Keywords, Indention, Variables, Comments, Python environment setup – Installation and working of IDE, Running Simple Python scripts to display a welcome message, Python variables. Python Data Types: Numbers, String, Tuples, Lists, Dictionary. Declaration and use of datatypes, Built-in Functions.

Unit 2 **(8 Hrs)**

Python Operators and Control Flow statements: Basic Operators: Arithmetic, Comparison/ Relational, Assignment, Logical, Bitwise, Membership, Identity operators, Python Operator Precedence. Control Flow: Conditional Statements (if, if...else, nested if), Looping in python (while loop, for loop, nested loops), loop manipulation using continue, pass, break, else.

Unit 3 **(8 Hrs)**

Data Structures in Python: String: Concept, escape characters, String special operations, String formatting operator, Single quotes, Double quotes, Triple quotes, Raw String, Unicode strings, Built-in String methods. Lists: Defining lists, accessing values in lists, deleting values in lists, updating lists, Basic List Operations, and Built-in List functions. Tuples: Accessing values in Tuples, deleting values in Tuples, and updating Tuples, Basic Tuple operations, and Built-in Tuple functions. Sets: Accessing values in Set, deleting values in Set, and updating Sets, Basic Set operations, Built-in Set functions. Dictionaries: Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary, Basic Dictionary operations, Built-in Dictionaries functions.

Unit 4 **(8 Hrs)**

Python Functions, modules, and Packages: Use of Python built-in functions (e.g., type/data conversion functions, math functions etc.). User-defined functions: Function definition, Function call, function arguments and parameter passing, Return statement, Scope of Variables: Global variable and Local Variable. Modules: Writing modules, importing modules, importing objects from modules, Python built-in modules (e.g., Numeric, mathematical module, Functional Programming Module), Packages.

Unit 5 **(8 Hrs)**

File Handling: Opening files in different modes, accessing file contents using standard library functions, Reading, and writing files, closing a file, Renaming, and deleting files, File related standard functions.

Text Books:

1. Charles R. Severance, “Python for Everybody: Exploring Data Using Python 3”, 1st Edition, Create Space Independent Publishing Platform, 2016.
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist”, 2nd Edition, Green Tea Press, 2015.
3. Ch Satyanarayana, “Python Programming”, 1st Edition, universities press (India) private limited 2018.

Reference Books:

1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014
2. Mark Lutz, “Programming Python”, 4th Edition, O’Reilly Media, 2011.ISBN-13: 978-9350232873
3. Wesley J Chun, “Core Python Applications Programming”, 3rd edition, Pearson Education India, 2015. ISBN-13: 978-9332555365
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, “Data Structures and Algorithms in Python”,1st Edition, Wiley India Pvt Ltd, 2016. ISBN-13: 978- 8126562176
5. Reema Thareja, “Python Programming using problem-solving approach”, Oxford university

Course Outcomes

On successful completion of the course, the student will be able to:

CO1: Develop essential programming skills in computer programming concepts like data types.
CO2: Examine Python syntax and semantics and be fluent in the use of Python flow control and functions.
CO3: Illustrate the process of structuring the data using lists, tuples, and dictionaries.
CO4: Demonstrate using built-in functions and operations to navigate the file system.
CO5: Interpret the concepts of modules and user-defined functions in Python.

Cyber Security (CST-006)

L T P 2 0 0

Course Objectives

The course should enable the students to:

- Familiarize with network security, network security threats, security services, and counter measures.
- Be aware of computer security and Internet security.
- Study the defensive techniques against these attacks.
- Familiarize with cyber forensics, cybercrimes, and Cyberspace laws.
- Understand ethical laws of computers for different countries, Offences under cyberspace and the Internet in India.

Particulars

Unit 1 **(8 Hrs)**

Introduction to Cyber Security: Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, the motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., CIA Triad.

Unit 2 **(8 Hrs)**

Cyber Forensics: Introduction to cyber forensic, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

Unit 3 **(8 Hrs)**

Cybercrime (Mobile and Wireless Devices): Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops and desktop.

Unit 4 **(8 Hrs)**

Cyber Security (Organizational Implications): Introduction cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing, and the associated challenges for organizations. Cybercrime and Cyber terrorism: Introduction, intellectual property in cyberspace, the ethical dimension of cybercrimes, the psychology, mindset and skills of hackers and other cybercriminals.

Unit 5 **(8 Hrs)**

Cyberspace and the Law &Miscellaneous provisions of IT Act: Introduction to Cyber Security Regulations, International Law. The INDIAN Cyberspace, National Cyber Security Policy. Internet Governance – Challenges and Constraints, Computer Criminals, Assets and Threats. Other offences under the Information Technology Act in India, The role of Electronic Evidence and miscellaneous provisions of the IT Act.2008.

Text Books:

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley.
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

Reference Books:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.
3. Debby Russell and Sr. G.T Gangemi, "Computer Security Basics (Paperback)", 2ndEdition, O'Reilly Media, 2006.
4. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, New Delhi, 2006.
5. Cyberspace and Cybersecurity, George Kostopoulos, Auerbach Publications, 2012.
6. Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes, Second Edition, Albert Marcella, Jr., Doug Menendez, Auerbach Publications, 2007.
7. Cyber Laws and IT Protection, Harish Chander, PHI, 2013.

Course Outcomes

On successful completion of the course, the student will be able to:
CO1: Understand cyber-attacks and types of cybercrimes, and familiarity with cyber forensics
CO2: Realize the importance of cyber security and various forms of cyber-attacks and countermeasures.
CO3: Get familiar with obscenity and pornography in cyberspace and understand the violation of the Right to privacy on the Internet.
CO4: Appraise cyber laws and how to protect themselves and, ultimately, the entire Internet community from such attacks.
CO5: Elucidate the various chapters of the IT Act 2008 power of the Central and State Governments to make rules under IT Act 2008.

3rd Year Scheme and Syllabus

B.Tech. (Aeronautical Engineering) SEMESTER-V

S.No.	Subject Codes	Category	Subject	Periods			Evaluation Scheme					Subject Total	Credit
							Sessional Exam			ESE			
				L	T	P	CT	TA	Total	TE	PE		
1	ANT-009	DC	Aircraft Propulsion	3	1	0	30	20	50	100		150	4
2	ANT-010	DC	Aircraft Performance and stability	3	1	0	30	20	50	100		150	4
3	ANT-011	DC	Aircraft System and Controls	3	0	0	30	20	50	100		150	3
4	ANT-XXX	DE	Departmental Elective - 1	3	1	0	30	20	50	100		150	4
5	ANT-XXX	DE	Departmental Elective - 2	3	0	0	30	20	50	100		150	3
6	ANT-019	DC	Computer Aided Aircraft Engineering Drawing	0	0	2		25	25		25	50	1
7	ANP-008	DLC	Flight Control Lab	0	0	2		25	25		25	50	1
8	ANP-009	DLC	Aircraft Propulsion Lab	0	0	2		25	25		25	50	1
9	ANP-010	DLC	Mini Project-II or Internship-II*	0	0	2			50			50	1
10	AHT-009/AHT-010	NC	Constitution of India / Essence of Indian Traditional Knowledge	2	0	0	15	10	25	50		75	
11	GP-05	NC	General Proficiency						50			50	
			Total	**17**	**3**	**8**						**950**	**22**
12			Open Elective (Optional)	3	1	0	30	20	50	50		150	4

*The Mini Project-II or Internship-II (4-6 weeks) conducted during summer break after IV semester and will be assessed during V semester

	Departmental Elective - 1		**Departmental Elective - 2**
ANT-012	Finite Element Methods	ANT-016	Rockets and Missiles
ANT-013	Advanced Solid Mechanics	ANT-017	Wind Tunnel Technique
ANT-014	Design and Analysis of Composite Structures	ANT-018	Unmanned Air Vehicles
ANT-015	Space Mechanics		

Aircraft Propulsion (ANT-009)

L T P: 3 1 0

Course Objectives :

The course should enable the students to learn:

- Analyse parametric cyclic analysis, performance parameters, efficiency, specific impulse of all air breathing engines.
- Know the design and performance of subsonic and supersonic inlets, types of combustion chambers and factors affecting the combustors.
- Discuss the types of nozzles, flow conditions in nozzles, interaction of nozzle flow with adjacent surfaces and thrust reversal
- Explain different types of compressors and turbines, work done, velocity diagrams and stage efficiency calculations
- They will explore the principles of propulsion system design, including component selection, cycle analysis, and the integration of propulsion systems with airframe designs for optimal performance.

Particulars

Unit 1: **(8 Hrs)**

Air-Breathing Engines Classes: Classification, operational envelopes; Description and function of gas generator, turbojet, turbofan, turboprop, turbo shaft, ramjet, scramjet, turbojet/ramjet combined cycle engine; Engine thrust, takeoff thrust, installed thrust, thrust equation; Engine performance parameters, specific thrust, specific fuel consumption and specific impulse, thermal efficiency, propulsive efficiency, engine overall efficiency and its impact on aircraft range and endurance; Engine cycle analysis and performance analysis for turbojet, turbojet with afterburner, turbofan engine, turboprop engine.

Unit 2: **(8 Hrs)**

Inlets And Combustion Chambers: Internal flow and stall in subsonic inlets, relation between minimum area ratio and eternal deceleration ratio, diffuser performance, supersonic inlets, starting problem on supersonic inlets, shock swallowing by area variation; Classification of combustion chambers, combustion chamber performance, effect of operating variables on performance, flame stabilization.

Unit 3: **(8 Hrs)**

Nozzles: Theory of flow in isentropic nozzles, nozzles and choking, nozzle throat conditions, nozzle efficiency, losses in nozzles. Over expanded and under expanded nozzles, ejector and variable area nozzles, interaction of nozzle flow with adjacent surfaces, thrust reversal.

Unit 4: **(8 Hrs)**

Compressors: Principle of operation of centrifugal compressor and axial flow compressor, work done and pressure rise, velocity triangles, degree of reaction, free vortex and constant reaction designs of axial flow compressor, performance characteristics of centrifugal and axial flow compressors, stage efficiency calculations, cascade testing.

Unit 5: **(8 Hrs)**

Turbines: Principle of operation of axial flow turbines, limitations of radial flow turbines, work done and pressure rise, velocity triangles, degree of reaction, free vortex and constant angle designs, performance characteristics, sample ramjet design calculations, flame stability problems in ramjet combustors, integral ram rockets.

TEXT BOOKS:

1. Hill, P.G. & Peterson, C.R. ―Mechanics & Thermodynamics of Propulsion Addison Wesley Longman INC, 1999.
2. Mattingly J.D., ―Elements of Propulsion: Gas Turbines and Rocket, AIAA, 1991.

REFERENCE BOOKS:

1. Cohen, H. Rogers, G. F.C. and Saravanamuttoo, H.I.H. ―Gas Turbine Theory, Longman, 1989.
2. Oates, G.C. - Aero thermodynamics of Aircraft Engine Components, AIAA Education Series, New York, 1985

Course Outcomes:

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

CO1: Review the basic thermodynamic principles and fundamentals of gas turbine engines.
CO2: Outline the concepts of subsonic and supersonic inlets for jet engines.
CO3: Evaluate the operating characteristics of compressors and turbines in terms of blade shapes, angles, and direction of rotation.
CO4: Describe the fundamentals of combustion chamber, nozzle, ramjet and rocket propulsion.
CO5: Students will learn to integrate propulsion system considerations into the overall aircraft design process, addressing issues related to fuel efficiency, emissions, and operational performance.

AircraftPerforand Stability (ANT-0`10)

L T P: 3 1 0

The course should enable the students to learn:

- Learn the different Regimes of aircraft and performance requirements at different atmospheric conditions.
- Understand the different type of velocities and gives differences between stall velocity and maximum and minimum velocities.
- Estimate the time to climb and descent and gives the relation between rate of climb and descent and time to climb and descent at different altitudes.
- Illustrate the velocity and radius required for different type of maneuvers like pull-up, pull down and steady turn.
- They will explore the methods for assessing and improving aircraft stability and control, including the use of stability derivatives and the design of control systems to enhance handling characteristics.

Particulars

Unit 1: **(8 Hrs)**

Introduction to Aircraft Performance: The role and design mission of an aircraft; Performance requirements and mission profile; Aircraft design performance, the standard atmosphere; Off-standard and design atmosphere; Measurement of air data; Air data computers; Equations of motion for performance - the aircraft force system; Total airplane drag- estimation, drag reduction methods; The propulsive forces, the thrust production engines, power producing engines, variation of thrust, propulsive power and specific fuel consumption with altitude and flight speed; The minimum drag speed, minimum power speed; Aerodynamic relationships for a parabolic drag polar.

Unit 2: **(8 Hrs)**

Cruise Performance: Maximum and minimum speeds in level flight; Range and endurance with thrust production, and power producing engines; Cruise techniques: constant angle of attack, constant mach number; constant altitude, methods- comparison of performance. The effect of weight, altitude and temperature on cruise performance; Cruise performance with mixed power-Plants.

Unit 3: **(8 Hrs)**

Climb and Descent Performance: Importance of Climb and descent performance, Climb and descent technique generalized performance analysis for thrust producing, power producing and mixed power plants, maximum climb gradient, and climb rate. Energy height and specific excess power, energy methods for optimal climbs - minimum time, minimum fuel climbs. Measurement of best climb performance. Descent performance in Aircraft operations. Effect of wind on climb and decent performance.

Unit 4: **(8 Hrs)**

Aircraft Manoeuvre Performance: Lateral maneuvers- turn performance- turn rates, turn radius- limiting factors for turning performance. Instantaneous turn and sustained turns, specific excess power, energy turns. Longitudinal aircraft maneuvers, the pull-up, maneuvers. The maneuver envelope, Significance. Maneuver boundaries, Maneuver performance of military Aircraft, transport Aircraft.

Unit 5: **(8 Hrs)**

Safety Requirements -Take-off And Landing Performance and Flight Planning: Estimation of takeoff distances. The effect on the takeoff distance of weight wind, runway conditions, ground effect. Takeoff performance safety factors. Estimation of landing distances. The discontinued landing, Baulk landing, air safety procedures and requirements on performance. Fuel planning fuel requirement, trip fuel, Environment effects, reserve, and tankering.

TEXT BOOKS:

1. Anderson, J.D. Jr., ―Aircraft Performance and Design, International edition McGraw Hill, 1st Edition, 1999, ISBN: 0-07-001971-1.
2. Eshelby, M.E., ―Aircraft Performance theory and Practice, AIAA Education Series, AIAA, 2nd Edition, 2000, ISBN: 1-56347-398-4.

REFERENCE BOOKS:

1. McCormick, B.W, ―Aerodynamics, Aeronautics and Flight Mechanics, John Wiley, 2nd Edition, 1995, ISBN: 0-471-57506-2.
2. Yechout, T.R. et al., ―Introduction to Aircraft Flight Mechanics, AIAA Education Series, AIAA, 1st Edition, 2003, ISBN: 1-56347-577-4.
3. Shevel, R.S., ―Fundamentals of Flight, Pearson Education, 2nd Edition, 1989, ISBN: 81-297- 0514-1.

Course Outcomes:

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

CO1: Aerodynamic characteristics, engine performance, and effects of flight altitude on aircraft performance.
CO2: Predict and analyse the performance of an airplane for accelerating and Non-accelerating cases.
CO3: Calculate the range and endurance of propeller and jet driven airplane.
CO4: Describe the different aircraft maneuvers.
CO5: Students will gain a comprehensive understanding of the fundamental principles of aircraft performance, including takeoff, climb, cruise, descent, and landing phases.

Aircraft Systems and Controls (ANT-011)

L T P: 3 0 0

Course Objectives :

The course should enable the students for:

- Explain the concept and meaning of system and classify the various systems required for aircraft and their contribution in order to fulfil the aircraft tasks.
- Describe the various types of Electrical power generations and distribution in aircraft.
- Impart the knowledge of pneumatic, hydraulic and environmental control system.
- Demonstrate different actuators, flight control system and advanced flight actuation system.
- They will explore the integration of avionics systems, including navigation, communication, and surveillance technologies, and their role in enhancing aircraft safety and operational efficiency.

Unit 1 **(8 Hrs)**

Introduction To Aircraft Systems: System concepts, everyday examples of systems, sub-systems; Generic system definition, inputs, outputs, feedback, external influence. Aircraft systems- airframe systems, vehicle systems, avionics systems, mission systems and their sub-systems; Specification of requirements, mission requirements, performance requirements; Operating environment conditions.

Unit 2 **(8 Hrs)**

Electrical Systems and Air Conditioning, Pressurizing Systems: Electrical loads in aircraft. Electrical power generation and control- DC, AC- types. Power distribution- primary, secondary. Power conversion and energy storage; Load protection; Electrical load management systems, variable speed constant frequency (VSCS) cycloconverter, 270 V DC systems; Basic air cycle systems; Vapour cycle systems, boost-strap air cycle system; Evaporative vapour cycle systems; Evaporative air cycle systems; Oxygen systems; Fire protection systems, de-icing and anti icing systems.

Unit 3 **(8 Hrs)**

Hydraulic Systems and Pneumatic Systems: Hydraulic systems: Study of typical workable system, function, merits, application, system loads, design requirements; Principal components; Hydraulic fluid: required properties, operating fluid pressures, temperatures, and flow rates; Hydraulic piping, pumps, reservoir, accumulator; Landing gear and brake management systems. Pneumatic systems; Advantages; - Working principles; Typical air pressure system; Brake system; Typical pneumatic power system; Components, landing gear systems; Classification.

Unit 4 **(8 Hrs)**

Engine Control and Fuel Systems: Principle of operation of aircraft gas turbine engines; Engine - airframe interfaces; Control of fuel flow, air flow, exhaust gas flow- need, means, system parameters, basic inputs and outputs; Limited authority control systems, full authority control systems- examples; Engine monitoring-

sensors, indicators; Power off takes- need, types, effect on engine performance; Fuel systems- characteristics, components, operating modes; Fuel tank safety- fuel inserting system.

Unit 5 **(8 Hrs)**

Airplane Control Systems: Flight control systems- primary and secondary flight control conventional systems; Power assisted and fully powered flight controls ; Power actuated systems; Engine control systems; Push pull rod system, flexible push full rod system; Components; Modern control systems; Digital fly by wire systems , control laws, implementation; Auto pilot system active control technology, communication and navigation systems instrument landing systems; Control linkages, actuation- types, description and redundancy.

TEXT BOOKS:

1. Moir, I. and Sea bridge, A, ―Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, John Wiley, 3rd Edition 2008.
2. Moir, I. and Sea bridge, A, ―Design and Development of Aircraft Systems- An Introduction, AIAA Education Series, AIAA, 2004.

REFERENCE BOOKS:

1. Pallett, E.H.J., ―Aircraft Instruments and Integrated Systems, Longman Scientific &Technical 10th edition, 1992.
2. Harris, D, ―Flight Instruments and Automatic Flight Control Systems, 6th edition, 2004.
3. Bolton, W., ―Pneumatic and Hydraulic Systems, Butterworth-Heinemann.

Course Outcomes:

At the end of this course, the students:

CO1: The principles of flight control.
CO2: The principle and working of electronic and mechanical control systems.
CO3: Various types of aircraft instruments.
CO4: Static & dynamic characteristics of instruments.
CO5: Students will enhance their ability to troubleshoot and diagnose issues within aircraft systems, fostering critical thinking and problem-solving skills in real-world scenarios.

Finite Element Methods (ANT-012)

L T P: 3 0 0

Course Objectives :

The aim of the course is to provide the participants an overview on Finite Element Method, Material models, and Applications in Civil Engineering. At the end of the course, the participants are expected to have fair understanding of:

- Basics of Finite Element Analysis.
- Available material models for structural materials, soils and interfaces/joints.
- Modeling of engineering systems and Soil–Structure Interaction (SSI).
- Importance of interfaces and joints on the behavior of engineering systems.
- Implementation of material model in finite element method and applications

Unit 1 **(8 Hrs)**

Introduction to Finite Element Methods: General Procedure – Engineering Applications – Stress and Equilibrium, Strain – Displacement relations. Stress – strain relations: Finite Elements: 1- Dimensional, 2 – Dimensional, 3-Dimensional & Interpolation Elements One Dimensional Problems: 1-D Linear and 1-D Quadratic Elements - Finite element modeling, Coordinates and shape functions. Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

Unit 2 **(8 Hrs)**

Analysis of Trusses: Derivation of Stiffness Matrix for Plane Truss, Displacement of Stress Calculations. Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node beam element, Load Vector, Deflection.

Unit 3 **(8 Hrs)**

Finite element modeling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions, Estimation of Load Vector, Stresses Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements. Two dimensional four noded Isoparametric elements and numerical integration.

Unit 4 **(8 Hrs)**

Steady State Heat Transfer Analysis: one dimensional analysis of Slab, fin and two-dimensional analysis of thin plate.

Unit 5 **(8 Hrs)**

Dynamic Analysis: Formulation of finite element model, element - Mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar, truss and beam. Finite element – formulation to 3 D problems in stress analysis, convergence requirements, Meshgeneration. techniques such as semi-automatic and fully Automatic use of softwares such as ANSYS, ABAQUS, NASTRAN using Hexahedral and Tetrahedral Elements.

TEXT BOOKS:

1. Finite Element Methods: Basic Concepts and applications/Alavala/PHI
2. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu /Pearson

REFERENCE BOOKS:

1. An Introduction to the Finite Element Method / J. N. Reddy/ Mc Graw Hill
2. Finite Element Analysis / SS Bhavikatti / New Age
3. Finite Element Method/ Dixit/Cengage

Course Outcomes:

At the end of this course, the students:

CO1: At the end of the course, the student will be able to, Apply finite element method to solve problems in solid mechanics, fluid mechanics and heat transfer. Formulate and solve problems in one dimensional structures including trusses, beams and frames. Formulate FE characteristic equations for two dimensional elements and analyze plain stress, plain strain, axi-symmetric and plate bending problems. ANSYS, ABAQUS, NASTRAN, etc.
CO2: Students will apply FEM to real-world engineering problems, fostering critical thinking and problem-solving skills in the context of design and analysis in aerospace and mechanical engineering.
CO3: They will learn to assess the accuracy and convergence of finite element solutions, including error estimation and refinement techniques.
CO4: Students will develop skills in using commercial FEM software to analyze and interpret results, enhancing their ability to validate and verify numerical solutions against theoretical predictions
CO5: They will gain proficiency in formulating finite element models, including mesh generation, element selection, and boundary condition application for various engineering scenarios.

Advanced Solid Mechanics (ANT-013)

L T P: 3 0 0

Course Objectives :

The course should enable the students for:

- Understand the theory of elasticity including stress strain/displacement and Hooke's law relationships.
- Analyze solid mechanics problems using classical methods and energy methods.
- Solve for stresses and deflections of beams under unsymmetrical loading and axisymmetric loading.
- Locate the shear center of thin wall beams and obtain stresses and deflections of beams on elastic foundations.
- Students will develop skills in evaluating the stability and failure of structures, including buckling analysis, fatigue assessment, and the study of crack propagation in materials.

Unit 1 **(8 Hrs)**

Traction and Stresses: Concept of traction, Cauchy's stress theorem, postulate of Cauchy stress tensor, traction on arbitrary planes, extreme normal and shear traction, octahedral shear stress, and other stress measure – engineering stress.

Unit 2 **(8 Hrs)**

Axisymmetric Analysis: Introduction, thick walled cylinder subjected to internal and external pressures – lame's problem. Stress in composite tubes- shrink fits, sphere with purely radial displacements, stresses due to gravitation, rotating disks of uniform thickness, disks of variable thickness, rotating shafts and cylinders.

Unit 3 **(8 Hrs)**

Bending of Curved Beams: Winkler- Bach formula, elasticity solution for: pure bending of curved beams, curved cantilever under end loading. Beams on elastic foundation, Derivation of the basic governing equation, solution to beam on an elastic foundation subjected to a point load at the center moment at the center, Udl over some length asymmetrically about the center.

Unit 4 **(8 Hrs)**

Fracture Mechanics Classes: Brittle fracture, stress intensity factor, fracture toughness, fracture conditions, fracture modes, plane stress and plane strain, plastic collapse at a notch, experimental determination of KIC, strain-energy release rate, elasto-plastic fracture mechanics, Green's theorem.

Unit 5 **(8 Hrs)**

Theories of Failure: Introduction, theories of failure, significance of the theories of failure, use of factor of

safety in design, a note on the use of factor of safety, Mohr's theory of failure.

TEXT BOOKS:

1.L. S. Srinath, ―Advanced Mechanics of Solids, Tata McGraw-Hill, New Delhi, 2009.
2.P. Raymond, ―Solid Mechanics in Engineering, Willey, 2001.

REFERENCE BOOKS:

1.M.H. Sadd, ―Elasticity: Theory, Applications, and Numerics , Academic Press, 2nd Edition, 2009.
2.R.G. Budynas, ―Advanced Strength and Applied Stress Analysis, McGraw Hill, 3rd Edition,1999.
3.A.P. Boresi, R.J. Schmidt, ―Advanced Mechanics of Materials, John Willey & Sons, 6th Edition, 2003.

Course Outcomes:

At the end of this course, the students:

CO1: To Learn Fracture mechanism and Technique to solve complex structure.
CO2: Students will improve their technical communication skills by preparing detailed reports and presentations that effectively convey their analyses, findings, and design recommendations in solid mechanics.
CO3: They will explore advanced topics such as fracture mechanics, fatigue analysis, and the mechanics of composite materials, enhancing their ability to address real-world engineering challenges.
CO4: Students will develop skills in using numerical methods, such as finite element analysis, to model and analyze the mechanical behavior of structures and materials under various conditions.
CO5: They will learn to apply mathematical and computational techniques to solve problems related to elasticity, plasticity, and viscoelasticity in engineering materials

Design and Analysis of Composite Structures (ANT-014)

L T P: 3 0 0

Course Objectives :

The course should enable the students for:

- Understand the fabrication, analysis and design of composite materials & structures.
- Explain basic composites technology, including materials and processes, manufacturing structural design, maintenance, proof of structures and other considerations.
- Identify the static testing procedure and repairing methodology of composite structural members and joints.
- Enrich to develop structural designs using composite materials.
- They will explore advanced analytical and numerical techniques, including finite element methods, for assessing the behavior and failure of composite components.

Unit 1 **(8 Hrs)**

Stress Strain Relation: Introduction- Advantages and application of composite materials, reinforcements and matrices; Generalized Hooke‘s Law; Elastic constants for uni directional, bi directional and tri directional composite materials..

Unit 2 **(8 Hrs)**

Methods of Analysis: Micro mechanics: Mechanics of materials approach, elasticity approach to determine material properties; Macro Mechanics; Stress-strain relations with respect to natural axis, arbitrary axis; Determination of material properties; Experimental characterization of lamina.

Unit 3 **(8 Hrs)**

Laminated Plates, Sandwich Constructions and Fabrication Process: Governing differential equation for a general laminate, angle ply and cross ply laminates; Failure criteria for composites. Basic design concepts of sandwich construction; Materials used for sandwich construction; Failure modes of sandwich panels; Various open and closed mould processes; Manufacture of fibers; Types of resins and properties and applications; Netting analysis.

Unit 4 **(8 Hrs)**

Damage Tolerance In Composites: Introduction, sources of damage, types of damage, FAR requirements and advisory circulars, building block approach; Impact damages: Damage growth under fatigue loads; residual strength: Tests and analytical methods; Detailed design: Basics of projections, drawing standards and conventions, introduction to CADD, design of composite parts and assembly design; Optimization: Fundamentals of optimization, mathematical concepts in optimization, Optimization of composite plates.

Unit 5 **(8 Hrs)**

TESTING OF COMPOSITE STRUCTURES: Factors influencing testing, test environment, test methods and standards, introduction to static testing of composite structures and examples; Repair of composite aircraft structures: Introduction to repair, repair philosophy, repair sequence, repair criteria, damage assessment, classification of repair, selection of repair joints, repair procedures, certification of repair.

TEXT BOOKS:

1. Gibson, R. F, ―Principles of Composite Material Mechanics, CRC Press, 2nd Edition, 2007.
2. Jones, R.M, Taylor & Francis, ―Mechanics of Composite Materials, 2nd Edition, 2010 (Indian Print).
3. Reddy, J.N., ―Mechanics of Laminated Composite Plates and Shells – Theory and Analysis, CRC Press, 2nd Edition, 2004.

REFERENCE BOOKS:

1. Agarwal, B.D., and Broutman, L.J., ―Analysis and Performance of Fibre Composites, John Wiley and sons. Inc., New York, 1995.
2. Lubin, G., ―Handbook on Advanced Plastics and Fibre Glass, Von Nostrand Reinhold Co., New York, 1989.
3. Autar K. Kaw ―Mechanics of Composite Materials, 2nd Edition, CRC Press, 2005.

Course Outcomes:

At the end of this course, the students:

CO1: Design of composite material.
CO2: Technique to solve and repair composite structure.
CO3: Students will understand the fundamental principles of composite materials and their behavior under various loading conditions.
CO4: They will be able to analyze and design composite structures using classical lamination theory and advanced analytical methods.
CO5: Students will gain proficiency in predicting failure modes and assessing the strength and stiffness of composite laminates.

Space Mechanics (ANT-015)

L T P: 3 0 0

Course Objectives:

The course should enable the students for:

- Impart the knowledge in two-body, restricted three-body and n-body problem, Hamiltonian dynamics, canonical transformations, Poincare surface sections.
- Analyze the basic Newtonian dynamics and spacecraft altitude dynamics.
- Provide necessary knowledge to study the satellite and interplanetary trajectories and Formal approaches for handling coordinate transformations.
- Solve the orbital problems related to Earth satellite orbits using Hamilton‘s and generate interplanetary orbits in the frame work of restricted three-body problem.
- They will explore the dynamics of spacecraft attitude control, including the use of reaction wheels, thrusters, and gyroscopes to maintain and change orientation in space.

Unit 1 **(8 Hrs)**

Introduction to Space Mechanics: Basic concepts: The solar system, Reference frames and coordinate systems, The celestial sphere, The ecliptic, Motion of vernal equinox, Sidereal time, Solar Time, Standard Time, The earth‘s atmosphere. The many body problem, Lagrange-Jacobi identity. The circular restricted three body problem, Libration points, Relative Motion in the N-body problem.

Unit 2 **(8 Hrs)**

The Two Body Problem: Equations of motion-General characteristics of motion for different orbits-Relations between position and time for different orbits, Expansions in elliptic motion, Orbital Elements. Relation between orbital elements and position and velocity: Launch vehicle ascent trajectories, General aspects of satellite injection. Dependence of orbital parameters on in-plane injection parameters, Launch vehicle performances, Orbit deviations due to injection errors.

Unit 3 **(8 Hrs)**

Perturbed Satellite Orbit: Special and general perturbations- Cowell‘s Method, Encke‘s method. Method of variations of orbital elements, General perturbations approach. Two-dimensional interplanetary trajectories, Fast interplanetary trajectories, Three dimensional interplanetary trajectories. Launch of interplanetary spacecraft. Trajectory about the target planet.

Unit 4 **(8 Hrs)**

Ballistic Missile Trajectories: The boost phase, the ballistic phase, Trajectory geometry, optimal flights. Time of flight, Re-entry phase. The position of the impact point, Influence coefficients.

Unit 5 **(8 Hrs)**

Low-Thrust Trajectories: Equations of Motion. Constant radial thrust acceleration, Constant tangential thrust (Characteristics of the motion), Linearization of the equations of motion, Performance analysis.

TEXT BOOKS:

1. J. W. Cornelisse, ―Rocket Propulsion and Spaceflight Dynamics, Pitman Publishing, London, 1979.
2. William E. Wiesel, ―Spaceflight Dynamics, McGraw-Hill, 3rd Edition, New Delhi, 2010.

REFERENCE BOOKS:

1. Vladimir A. Chobotov, ―Orbital Mechanics, AIAA Education Series, USA, 3rd Edition, 2002.
2. Kaplan, Marshall H., ―Modern Spacecraft Dynamics and Control, John Wiley & Sons, New York, 1976.
3. Wiesel, William E., ―Spaceflight Dynamics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2nd Edition 2007.
4. David A. Vellado, ―Fundamentals of Astrodynamics and Applications, Springer, Germany, 3rd Edition, 2007

Course Outcomes:

At the end of this course, the students:

CO1: Solar Systems and various coordinate systems
CO2: Effect of perturbation on satellite
CO3: Satellite orbits
CO4: Missile trajectory
CO5: They will learn to analyze and predict the trajectories of spacecraft using Kepler's laws and the principles of astrodynamics.

Rockets and Missiles (ANT-016)

L T P: 3 0 0

Course Objectives:

The course should enable the students for:

- To compute and analyze the various forces and moments acting on a rocket
- To formulate the equations of motions for flight and separation phases
- To understand the combustion and propulsion systems in rocket
- To select suitable materials for the rockets and missiles
- To understand the design, performance and testing aspects

Unit 1 **(8 Hrs)**

Rocket Dynamics: Classification of launch vehicles and missiles – Rocket systems - Airframe components - Forces and moments acting on a rocket – Propulsion, aerodynamics, gravity – inertial and non-inertial frames - coordinate transformation – Equations of motion for three-dimensional motion through atmosphere and vacuum, earth's atmosphere, numerical problems

Unit 2 **(8 Hrs)**

Solid Propulsion and Pyrotechnics: Solid propellant rockets - classification, components and their design considerations, propellant grain design - grain mechanical properties, ballistics and burn rate design issues - igniter design - types of nozzles and thrust vector control, pyrotechnic devices and systems-classification, mechanisms and application of pyrotechnic devices in rockets and missiles. Design problems in rocket systems.

Unit 3 **(8 Hrs)**

Liquid Propulsion and Control Systems: Liquid propellant rockets – classification and components - thrust chamber, feed systems, propellant tanks, turbo-pumps, types of valves and applications- their design considerations. Different bipropellant systems like cryogenics and their characteristics, pogo and slooh engine gimbal systems and thrusters for control. Spacecraft propulsion and control systems- Design problems.

Unit 4 **(8 Hrs)**

Multi-Staging of Rocket and Separation Dynamics: Navigation and guidance systems in rockets and missiles - aerodynamic control systems of missiles- multi-staging of rockets - vehicle optimization techniques -stage separation system – dynamics, separation techniques - rocket flight dispersion, numerical problems.

Unit 5 **(8 Hrs)**

Design, Materials and Testing of Rockets: Design requirements and selection, performance evaluation and assessment, space environment on the selection of materials for rockets and spacecraft, material selection for specific requirements, advance materials-super alloys and composite materials. Qualification of rocket and missile systems, types of testing and evaluation of design and function.

TEXT BOOKS:

1. Ramamurthi.K.: Rocket Propulsion. Macmillan Publishers India first edition. 2010.
2.Sutton.G.P. and Biblarz.O: Rocket Propulsion Elements. 7th edition. Wiley India Pvt Ltd. 2010.
3.Cornelisse, J.W, Schoyer H F R, and Wakker K F, "Rocket Propulsion and Space Dynamic", Pitman Publishing Co., 1979.

REFERENCE BOOKS:

1. Ronald Humble, Henry and Larson.Space Propulsion Analysis and Design. Mc Graw-Hill. 1995
2. George M. Siouris, Missile Guidance and Control Systems, Springer-Verlag New York, 2000.

Course Outcomes:

At the end of this course, the students:

CO1: To provide the design basics of rockets and missiles, their construction and functions.
CO2: To focus on design principles, performance, materials selection and testing of rockets and missiles.
CO3: To understand aerodynamics, flight dynamics, optimization of performance of multi-stage rockets and separation dynamics of rockets and missiles.
CO4: Students will enhance their ability to evaluate the impact of environmental factors, such as atmospheric conditions and gravitational forces, on rocket and missile performance and mission success.
CO5: They will explore the design and integration of various missile components, including guidance, control, and payload systems, to optimize performance and effectiveness.

Wind Tunnel Technique (ANT-017)

L T P: 3 0 0

Course Objectives:

The course should enable the students for:

- The students are exposed to various types and techniques of Aerodynamic data generation on aerospace vehicle configurations in the aerospace industry.
- They will learn to design and conduct experiments in wind tunnels, including model preparation, instrumentation, and data acquisition techniques to measure aerodynamic forces, pressures, and flow characteristics.
- Students will develop skills in analyzing and interpreting wind tunnel data, applying dimensional analysis and similarity principles to ensure the validity of experimental results and their correlation to real-world conditions.
- They will explore advanced techniques in flow visualization, such as smoke, laser-induced fluorescence, and particle image velocimetry (PIV), to study flow patterns and phenomena around models.
- Students will enhance their ability to communicate experimental findings effectively, preparing comprehensive reports and presentations that detail methodologies, results, and implications for aerodynamic design and analysis.

Unit 1 **(8 Hrs)**

Principles of Model Testing: Buckingham Theorem – Non dimensional numbers – Scale effect – Geometric Kinematic and Dynamic similarities.

Unit 2 **(8 Hrs)**

Types and Functions of Wind Tunnels: Classification and types – special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions – Layouts – sizing and design parameters

Unit 3 **(8 Hrs)**

Calibration of Wind Tunnels: Test section speed – Horizontal buoyancy – Flow angularities – Flow uniformity & turbulence measurements – Associated instrumentation – Calibration of subsonic & supersonic tunnels.

Unit 4 **(8 Hrs)**

Conventional Measurement Techniques: Force measurements and measuring systems – Multi component internal and external balances –Pressure measurement system - Steady and Unsteady Pressure- single and multiple measurements - Velocity measurements – Intrusive and Non-intrusive methods – Flow visualization techniques surface flow, oil and tuft - flow field visualization, smoke and other optical and nonintrusive techniques

Unit 5 **(8 Hrs)**

Special Wind Tunnel Techniques: Intake tests – store carriage and separation tests - Unsteady force and pressure measurements –wind tunnel model design

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.

REFERENCE BOOKS:

1. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.
2. Bradsaw "Experimental Fluid Mechanics".
3. Short term course on Flow visualization techniques, NAL , 2009
4. Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008 NAL, Bangalore.

Course Outcomes:

At the end of this course, the students:

CO1: Ability to use various techniques of Aerodynamic data generation.
CO2: Students will enhance their ability to apply wind tunnel testing results to real-world engineering problems in aerospace, automotive, and other industries.
CO3: They will become proficient in using visualization techniques to analyze flow patterns and identify areas for design improvement.
CO4: Students will learn to interpret aerodynamic data, including lift, drag, and pressure distributions, to evaluate the performance of different designs.
CO5: They will develop skills in designing and conducting wind tunnel experiments, including model preparation, data collection, and analysis.

Unmanned Air Vehicles (ANT-018)

L T P: 3 0 0

Course Objectives:

The course should enable the students for:

- Introduce to the student about the basic ideas of Unmanned Air Vehicles.
- Familiarize the students about the aerodynamics and airframe configurations.
- Accustom the student to the wide variety of unmanned air vehicles.
- Acquaint the student about the various communication and navigation systems of unmanned air vehicles.
- Students will develop skills in analyzing the performance and mission capabilities of UAVs, including payload considerations, endurance, range, and operational limitations.

Unit 1 **(8 Hrs)**

Introduction to Unmanned Aircraft Systems: The systemic basis of UAS-system composition; Conceptual phase; Preliminary design; Selection of the system; Some applications of UAS.

Unit 2 **(8 Hrs)**

Aerodynamics and Airframe Configurations: Lift-induced Drag; Parasitic Drag; Rotary-wing aerodynamics; Response to air turbulence; Airframe configurations scale effects; Packaging density; Aerodynamics; Structures and mechanisms; Selection of power-plants; Modular construction; Ancillary equipment.

Unit 3 **(8 Hrs)**

Characteristics of Aircraft Types: Long-endurance, long-range role aircraft; Medium-range, tactical aircraft; Close-range / battlefield aircraft; MUAV types; MAV and NAV types; UCAV; Novel hybrid aircraft configurations; Research UAV.

Unit 4 **(8 Hrs)**

Communications Navigation: Communication media; Radio communication; Mid-air collision (MAC) avoidance; communications data rate and bandwidth usage; Antenna Types NAVSTAR Global Positioning System (GPS) - TACAN - LORAN C - Inertial Navigation - Radio Tracking - Way-point Navigation.

Unit 5 **(8 Hrs)**

Control and Stability: HTOL Aircraft - Helicopters - OTE/OTE/SPH - Convertible Rotor Aircraft - Payload Control -Sensors –culmon filter- Autonomy.

TEXT BOOKS:

1. Reg Austin., Unmanned Aircraft Systems, John Wiley and Sons., 2010.

REFERENCE BOOKS:

1. Milman & Halkias, ―Integrated Electronics, McGraw Hill, 1999.
2. Malvino & Leach, ―Digital Principles & Applications, McGraw Hill, 1986.
3. Collinson R.P.G, ―Introduction to Avionics, Chapman and Hall, India, 1996.
4. Bernad Etikin, "Dynamic of flight stability and control, John Wiley, 1972.

Course Outcomes:

At the end of this course, the students:

CO1: Types of UAV configuration.
CO2: Working principles of UAV, Stability and control and avionics system of UAV.
CO3: Students will gain a thorough understanding of the design, operation, and applications of unmanned aerial vehicles (UAVs), including their components and systems.
CO4: They will learn about the principles of flight, control systems, and navigation techniques specific to UAVs, enabling them to analyze and optimize UAV performance.
CO5: They will explore regulatory and safety considerations related to UAV operations, including airspace management and compliance with aviation regulations.

Computer Aided Aircraft Engineering Drawing (ANT-019)

L T P: 3 0 0

Course Objectives:

The course should enable the students for:

- Understand the concepts and various tools used in design module
- Understand the design of typical structural components.
- Understand the design of typical aircraft components.
- Understand the design of three view diagram of a typical aircraft.
- Students will develop skills in producing technical drawings, including orthographic projections, isometric views, and section views, ensuring that all necessary dimensions and annotations are included for manufacturing and assembly.

LIST OF EXPERIMENTS

Week-l: SKETCHER; Interface, Sketch Tools, View Tool bar, Profile Tool bar, Operation Tool bar, Tools, Constrain tool bar, Transformation Tool bar, User Selection Filter, Standards, Visualizations.
Week-2: PART DESIGN; Sketch Based Features, Dress up Features, Transformation Features, Reference Elements, Measure, Thickness, Boolean Operations.
Week-3: SHEET METAL DESIGN; Walls, Cutting and Stamping, Bending, Rolled Walls,
Week-4: SURFACE DESIGN; Surfacer, Operations, Wireframe, Replication.
Week-5: ASSEMBLY; Product Structure Tools, Constrains.
Week-6: GD&T ; Introduction to Geometric Dimensioning and Tolerance, Weld Symbols, GD&T Symbols, Types of Tolerances, Types of views, Roughness Symbols.
Week-7: DRAFTING; Views, Annotations, Sheet Background.
Week-8: DESIGN OF AIRCRAFT WING; Design of any two types of Aircraft structures
Week-9: DESIGN OF FUSELAGE; Design of fuselage with internal components
Week-10: DESIGN OF NOSE CONE; Design of Nose cone structures
Week-11: DESIGN OF LANDING GEAR; Design of Main landing gear and nose landing gear

REFERENCE BOOKS:

1. http://www.ehu.eus/asignaturasKO/DibujoInd/Manuales/R12_manual_catia_v5.pdf
2. http://www.engr.psu.edu/xinli/edsgn497k/TeaPotAssignment.pdf
3. http://file1.engineering.com/pdf/PartDesign.pdf

Course Outcomes:

At the end of this course, the students:

CO1: Exposure to computer aided design and drafting software.
CO2:Learn part design and assembly by design tool.
CO3:Students will enhance their ability to prepare comprehensive documentation and shop floor drawings essential for aircraft manufacturing and maintenance.

CO4: They will understand the integration of 3D modeling and drafting techniques to enhance design visualization and modification.

CO5:Students will gain skills in drafting various aircraft components and assemblies with accurate dimensions, tolerances, and annotations.

FLIGHT CONTROL LAB (ANP-008)

L T P: 0 0 2

Course Objective

The course should enable the students to:

- Understand the basics simulation of unaccelerated and accelerated level flight for climb and descend
- Analyse the take-off and landing performance and ground roll for different modes of aircraft.
- Identify the basic controls and manoeuvre of in complex flight Path
- They will explore the design and tuning of control algorithms, such as PID controllers, to achieve desired performance characteristics in flight control systems, including response time, stability, and robustness.
- Students will develop skills in modeling and simulating aircraft dynamics, using software tools to predict the behavior of flight control systems under various conditions and disturbances.

Particulars

List of Experiments

LIST OF EXPERIMENTS
Week-1: SIMULATION OF UNACCELERATED AND ACCELERATED LEVEL FLIGHT
1. Simulation of steady flight
Week-2: SIMULATION OF UNACCELERATED AND ACCELERATED CLIMB
1. Simulation of steady climb
Week-3: SIMULATION OF UNACCELERATED AND ACCELERATED DESCENT
1. Simulation of steady descent
Week-4: SIMULATION OF TAKE-OFF PERFORMANCE
1 Estimation of takeoff velocity
Week-5: SIMULATION OF LANDING PERFORMANCE
1. Estimation of ground roll distance
2. Estimation of total landing distance
Week-6: SIMULATION OF CONVENTIONAL FLIGHT PATH
1. Perform the given mission profiles
Week-7: STABILIZATION OF LONGITUDINAL PERTURBED AIRCRAFT
1. Perform the operation from disturbed flight to trim flight
Week-8: STABILIZATION OF LATERAL PERTURBED AIRCRAFT
1. Simulate lateral directional modes.
Week-9: SIMULATION OF SPIN RECOVERY
1. Perform the operation of spin recovery
Week-10: SIMULATION OF COORDINATED LEVEL TURN
1. Perform the level turn at given turn rate.
2. Perform the level turn at given turn radius.
Week-11: SIMULATION OF BARREL ROLL MANOEUVRE
1. Perform the barrel roll manoeuvre

REFERENCE BOOKS:

1. Peter John Davison. "A summary of studies conducted on the effect of motion in flight simulator pilot training".

2. Beard, Steven; et al. "Space Shuttle Landing and Rollout Training at the Vertical Motion Simulator" (PDF). AIAA. Retrieved 5 February 2014.

WEB REFERENCE:

2. https://ch.mathworks.com/help/aeroblks/flight-simulator-interfaces.html.

Course Outcomes

At the end of this course, student will be able to:

CO1: Exposure to flight simulation.
CO2: Exposure to MATLAB.
CO3: Students will enhance their ability to record, analyze, and interpret flight control system data to diagnose issues and improve aircraft handling characteristics.
CO4: They will understand the principles of autopilot and automatic flight control systems through practical experiments.
CO5: Students will develop skills in conducting stability and control tests using flight simulators and control system models.

AIRCRAFT PROPULSION LAB (ANP-009)

L T P: 0 0 2

Course Objective

The course should enable the students to:

- To familiarise the students to the working of jet engines and its different working conditions
- Students will gain hands-on experience with various aircraft propulsion systems, including jet engines, turbofans, turboprops, and piston engines, understanding their operational principles and performance characteristics.
- They will learn to conduct experiments to measure key performance parameters of propulsion systems, such as thrust, fuel efficiency, and specific fuel consumption, using appropriate instrumentation and data acquisition techniques.
- Students will develop skills in analyzing and interpreting experimental data, applying thermodynamic and fluid dynamic principles to evaluate engine performance and efficiency under different operating conditions.
- They will explore the effects of design variables, such as nozzle design, compressor and turbine efficiency, and combustion chamber performance, on overall propulsion system effectiveness.

Particulars

List of Experiments

Minimum 10 experiments out of the following (or similar experiments).

Week-1: Study of jet engines parts.
Week-2: Study of free convective heat transfer over a flat plate
Week-3: Study of forced convective heat transfer over a flat plate
Week-4: Ignition studies of solid and liquid propellants
Week-5: Operation of a ramjet engine
Week-6: Velocity Profile Study of Free Jet
Week-7: Velocity Profile Study of Wall Jet
Week-8: Study of Thrust of hybrid propulsion system with oxidiser-fuel mixing ratio
Week-9: Preparation of fuel grain for hybrid rocket
Week-10: Burning rate measurement of solid propellants in a strand burner

Course Outcomes

At the end of this course, student will be able to:

CO1: To understand how to do the heat transfer analysis over the surface of the aircraft structure, the working of different jet engines.
CO2: Students will enhance their ability to troubleshoot and diagnose issues in propulsion systems, preparing them for real-world engineering challenges in the aerospace industry.
CO3: They will explore the principles of thermodynamics and fluid mechanics as they apply to propulsion systems through hands-on experiments.
CO4: Students will develop skills in analyzing engine performance data and understanding the effects of different operating conditions on propulsion efficiency.
CO5: They will learn to conduct performance evaluations of propulsion systems, measuring parameters such as thrust, fuel efficiency, and specific impulse.

Internship II/ Mini Project II (ANP-010)

Course Objectives

The course should enable the students to:

- Create an Industrial environment and culture within the institution.
- Identify the issues and challenges of an industry.
- Prepare report on the application of emerging technologies in the selected industry.
- Learn and understand the concept of entrepreneurship.
- Inculcate innovative thinking.

Course Outcomes:

On completion of the course, student will be able to–

CO1: Develop his abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project or Internship.

CO2: Understand the importance of document design by compiling Technical Report on the Mini Project or Internship work carried out.

CO3: Comment and evaluate other students research questions and internship proposals.

CO4: Students will gain exposure to professional engineering practices, teamwork, and ethical considerations relevant to aerospace engineering projects.

CO5: Students will gain exposure to professional engineering practices, teamwork, and ethical considerations relevant to aerospace engineering projects.

Constitution of India (AHT-009)

L T P: 2 0 0

Course Objectives

The course should enable the students to:

- Acquaint them with legacies of constitutional development in India and help to understand the most diversified legal document of India and philosophy behind
- Make them aware of the theoretical and functional aspects of the Indian Parliamentary System.
- Channelize their thinking towards basic understanding of the legal concepts and its implications for engineers
- Students will develop skills in analyzing landmark Supreme Court judgments and constitutional amendments, understanding their impact on Indian law and society.
- They will explore the significance of federalism in India, including the distribution of powers between the central and state governments, and the role of local self-governments.

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Particulars

Unit 1 **(8 Hrs)**

Constitutional Framework Meaning of Terms and Phrases frequently used in political system like constitution, constitutionalism, Rule of Law, Federal system, Government and so on. Historical Background of Indian Constitution, Making of Indian Constitution, Salient features of Indian Constitution, Preamble of Indian Constitution.

Unit 2 **(8 Hrs)**

Different Parts, Articles, and their Significance Part I to IVA (Union and its territories w.r.t. Indian States, Citizenship, Fundamental Rights conferred to citizens and foreigners, Directive Principles of State Policy– Its importance and implementation and Fundamental Duties and its legal status), Article 1 to 51A and their significance.

Unit 3 **(8 Hrs)**

System of Government Parliamentary Form of Government in India – The constitution powers and status of the President of India, Federal structure and distribution of legislative and financial powers between the Union and the States, Emergency Provisions: National Emergency, President Rule, Financial Emergency and Amendment of the Constitutional Powers and Procedure and the significance of basic structure in Indian Judicial system.

Unit 4 **(8 Hrs)**

Working of Central, State & Local Self Government as per Constitution Framework for central government (President, Vice president, Prime Minister, Central council of ministers, Parliament, Supreme court and so on), Framework for state government (Governor, Chief Minister, state legislature, High court and so on) and Framework for local self government (Panchayatiraj, Municipalities) and Union Territories.

Unit 5 **(8 Hrs)**

Constitutional, Non-Constitutional and other bodies Discussion on Various constitutional bodies like Election Commission, UPSC, SPSC, Finance commission, NCSC, NCST, NCBC, CAG and AGI. Discussion on Various non-constitutional bodies like NITI Aayog, NHRC, CIC, CVC, CBI, Lokpal and Lokayukta. Discussion on Various other constitutional bodies like Co- operative societies, Official Language, Tribunals etc.

Text/Reference Books-

1-M. Laxmikanth, “Indian Polity”, McGraw- Hill, 6th edition, 2020
2-D.D. Basu, “Introduction to the Indian Constitution”, LexisNexis, 21st edition, 2020
3-S.C. Kashyap, “ Constitution of India”, Vitasta publishing Pvt. Ltd., 2019

Course Outcomes

The course should enable the students to:
CO1: Understand the basic knowledge and salient features of Indian Constitution.
CO2: Identify and explore the basic features and modalities about Indian constitution.
CO3: Discusses the essence of Union and its territories, Citizenship, Fundamental Rights, DPSP and Fundamental Duties.
CO4: Differentiate and relate the functioning of Indian parliamentary system at the center and state level.
CO5: Differentiate different aspects of Indian Legal System and its related bodies.

Essence of Indian Traditional Knowledge (AHT-010)

L T P: 2 0 0

Course Objectives

The course should enable the students:

- With the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
- To understand the traditional knowledge and analyse it and apply it to their day to day life.
- To know the need and importance of protecting traditional knowledge.
- To understand the concepts of Intellectual property to protect the traditional knowledge.
- For concentrating on various acts in protecting the environment and Knowledge management impact on various sectors in the economy development of the country.

Particulars

Unit 1 **(8 Hrs)**

Introduction to Traditional and Culture Knowledge Define culture, traditional, civilization and heritage knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK). Indigenous traditional knowledge Vs western traditional knowledge vis-à-vis formal knowledge.

Unit 2 **(8 Hrs)**

Protection of Traditional Knowledge Protection of traditional knowledge: The need for protecting traditional knowledge Significance of traditional knowledge Protection, value of traditional knowledge in global economy, Role of Government to harness traditional knowledge.

Unit 3 **(8 Hrs)**

Traditional Knowledge and Intellectual Property Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Global legal forums for increasing protection of Indian Traditional Knowledge.

Unit 4 **(8 Hrs)**

Traditional Knowledge in Different Sectors Traditional knowledge in engineering, biotechnology and agriculture, traditional medicine system, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of traditional knowledge.

Unit 5 **(8 Hrs)**

Education System in India Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

Text/Reference Books:

1.Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2.”Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.
3.Traditional Knowledge System in India, by Amit Jha, 2009.
4. Satya Prakash, “Founders of Sciences in Ancient India”, Vijay Kumar Publisher, 1989
5. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh Pratibha Prakashan 2012.

Course Outcomes

The course should enable the students to:

CO1: Understand the concept of Traditional knowledge and its importance.
CO2: Know the need and importance of protecting traditional knowledge.
CO3: Know the various enactments related to the protection of traditional knowledge.
CO4: Understand the concepts of Intellectual property to protect the traditional knowledge.
CO5: Know the contribution of scientists of different areas.

B.Tech. (Aeronautical Engineering) SEMESTER-VI													
Sl.No.		Category	Subject	Periods			Evaluation Scheme					Subject Total	Credit
							Sessional Exam			ESE			
	Subject Codes			L	T	P	CT	TA	Total	TE	PE		
1	ANT-020	DC	High Speed Aerodynamics	3	1	0	30	20	50	100		150	4
2	ANT-021	DC	Space Propulsion	3	1	0	30	20	50	100		150	4
3	ANT-022	DC	Computational Aerodynamics	3	1	0	30	20	50	100		150	4
4	ANT-XXX	DE	Departmental Elective - 3	3	0	0	30	20	50	100		150	3
5	ANT-027	HSC	Open Elective-1	3	0	0	30	20	50	100		150	3
	ANT-011	DLC	Aerospace Propulsion Lab	0	0	2		25	25		25	50	1
6	ANP-012	DLC	CFD Lab	0	0	2		25	25		25	50	1
7	ANP-013	DLC	Project Stage -I	2	0	0	15	10	25	50		75	
8	AHT-010/AHT-009	NC	Essence of Indian Traditional Knowledge / Constitution of India						50			50	
9	GP-06	NC	General Proficiency	**17**	**3**	**6**						**900**	**21**
10			**Total**	3	1	0	30	20	50	100		150	4
11			Open Elective (Optional)										

Mini Project-III or Internship-III*
To be completed at the end of sixth semester (during Summer Break) & its evaluation/credit to be added in seventh semester.

	Departmental Elective - 3
ANT-023	Experimental Aerodynamics
ANT-024	Hypersonic Aerodynamics
ANT-025	Advanced Computational Aerodynamics
ANT-026	Helicopter Aerodynamics

High Speed Aerodynamics (ANT-020)

L T P: 3 1 0

Course Objectives :

The course should enable the students to:

- Understand the effect of compressibility at high-speeds and the ability to make intelligent design decisions.
- Explain the dynamics in subsonic, transonic and supersonic flow regimes in both internal and external geometries.
- Analyze the airfoils at subsonic, transonic and supersonic flight conditions using the perturbed flow theory assumption.
- Formulate appropriate aerodynamic models to predict the forces and performance of realistict three-dimensional configurations.
- They will explore the design considerations for high-speed vehicles, including drag reduction techniques, thermal management, and structural integrity under extreme aerodynamic loads.

Particulars

Unit 1 **(8 Hrs)**

INTRODUCTION TO COMPRESSIBLE FLOWS: Basic concepts: Introduction to compressible flow, brief review of thermodynamics and fluid mechanics, integral forms of conservation equations, differential conservation equations, continuum postulates, acoustic speed and mach number, governing equations for compressible flows.

Unit 2 **(8 Hrs)**

SHOCK AND EXPANSION WAVES: Shocks and expansion waves: Development of governing equations for normal shock, stationery and moving normal shock waves, applications to aircrafts, supersonic wind tunnel, shock tubes, shock polars, supersonic pitot probes; oblique shocks, governing equations, reflection of shock, Prandtl-Meyer expansion flow, shock expansion method for flow over airfoil, introduction to shock wave boundary layer interaction.

Unit 3 **(8 Hrs)**

ONE DIMENSIONAL AND QUASI ONE-DIMENSIONAL FLOW: Quasi one-dimensional flow: Isentropic flow in nozzles, area Mach relations, choked flow, under and over expanded nozzles, slip stream line. One dimensional flow: Flow in constant area duct with friction and heat transfer, Fanno flow and Rayleigh flow, flow tables and charts for Fanno flow and Rayleigh flow.

Unit 4 **(8 Hrs)**

APPLICATIONS OF COMPRESSIBLE FLOWS AND NUMERICAL TECHNIQUES: Small perturbation equations for subsonic, transonic, supersonic and hypersonic flow; Experimental characteristics of airfoils in compressible flow, supercritical airfoils, area rule; Theory of characteristics, determination of the characteristic lines and compatibility equations, supersonic nozzle design using method of characteristics.

Unit 5 **(8 Hrs)**

EXPERIMENTAL METHODS IN COMPRESSIBLE FLOWS: Experimental methods: Subsonic wind tunnels, supersonic wind tunnels, shock tunnels, free-piston shock tunnel, detonation-driven shock tunnels, and expansion tubes and characteristic features, their operation and performance, flow visualization techniques for compressible flows.

TEXT BOOKS:

1. John D. Anderson, ―Modern Compressible flow with historical perspective, McGraw-Hill Education, 3rd Edition, 2002.
2. John D. Anderson, ―Fundamentals of Aerodynamics, McGraw-Hill Education, 6th Edition, 2016.

REFERENCE BOOKS:

1. Ascher H. Shapiro, ―The Dynamics and Thermodynamics of Compressible Fluid Flow John Wiley & Sons; Volume 1 ed. Edition, 1977.
2. Radhakrishnan Ethirajan, ―Gas Dynamics, John Wiley & Sons, 2nd edition 2010.
3. H W Liepmann and A Roshko, ―Elements of Gas Dynamics, John Wiley & Sons, 4th edition, 2003.

Course Outcomes:
CO1: Air compressibility and isentropic relations inform of speed
CO2: Shock and expansion waves,
CO3: Supersonic wind tunnel, nozzle design, flow visualisation technique
CO4: Students will develop critical thinking skills to solve complex problems related to high-speed aerodynamics and apply theoretical concepts to real-world aerospace applications.
CO5: They will learn to assess the impact of design modifications on drag, lift, and overall stability in high-speed flight conditions.

Space Propulsion (ANT-021)

L T P: 3 1 0

Course Objectives:

The course should enable the students to:

- Evaluate various space missions, parameters to be considered for designing trajectories and rocket mission profiles
- Understand the fundamentals of chemical rocket propulsion, types of igniters and performance considerations of rockets.
- Discuss the working principle of solid and liquid propellant rockets and gain basic knowledge of hybrid rocket propulsion.
- Illustrate electric propulsion techniques, ion and nuclear rocket and the performances of different advanced propulsion systems.
- They will explore the principles of orbital mechanics and trajectory analysis, understanding how propulsion systems are used to achieve desired orbits, interplanetary transfers, and rendezvous maneuvers.

Particulars

Unit 1 **(8 Hrs)**

Principles of Rocket Propulsion: History of rockets, Newtons third law, orbits and space flight, types of orbits, basic orbital equations, elliptical transfer orbits, launch trajectories, the velocity increment needed for launch, the thermal rocket engine, concepts of vertical takeoff and landing, SSTO and TSTO, launch assists.

Unit 2 **(8 Hrs)**

Fundamentals of Rocket Propulsion: Operating principle, Rocket equation, Specific impulse of a rocket, internal ballistics, Rocket nozzle classification, Rocket performance considerations of rockets, types of igniters, preliminary concepts in nozzle less propulsion, air augmented rockets, pulse rocket motors, static testing of rockets and instrumentation, safety considerations.

Unit 3 **(8 Hrs)**

Solid Rocket Propulsion: Salient features of solid propellant rockets, selection criteria of solid propellants, estimation of solid propellant adiabatic flame temperature, propellant grain design considerations. Erosive burning in solid propellant rockets, combustion instability, strand burner and T- burner, applications and advantages of solid propellant rockets.

Unit 4 **(8 Hrs)**

Liquid and Hybrid Rocket Propulsion: Salient features of liquid propellant rockets, selection of liquid propellants, various feed systems and injectors for liquid propellant rockets, thrust control cooling in liquid propellant rockets and the associated heat transfer problems, combustion instability in liquid propellant

rockets, peculiar problems associated with operation of cryogenic engines, introduction to hybrid rocket propulsion, standard and reverse hybrid systems, combustion mechanism in hybrid propellant rockets, applications and limitations.

Unit 5 **(8 Hrs)**

Advanced Propulsion Techniques: Electric rocket propulsion, types of electric propulsion techniques, Ion propulsion, Nuclear rocket, comparison of performance of these propulsion systems with chemical rocket propulsion systems, future applications of electric propulsion systems, Solar sail.

TEXT BOOKS:

1. Hill, P.G. and Peterson, C.R., ―Mechanics and Thermodynamics of Propulsion, 2nd Edition, Addison Wesley, 1992.
2. Turner, M. J. L., ―Rocket and Spacecraft Propulsion, 2nd Edition, MIT Press, 1922.
3. Hieter and Pratt, ―Hypersonic Air breathing propulsion 5th Edition, 1993.

REFERENCE BOOKS:

1. Sutton, G.P., ―Rocket Propulsion Elements John Wiley & Sons Inc., New York, 5th Edition, 1993.
2. Mathur, M. L., and Sharma, R.P., ―Gas Turbine, Jet and Rocket Propulsion, Standard Publishers and Distributors, Delhi, 1988.
3. Tajmar, M., Advanced Space Propulsion Systems, Springer 2003

Course Outcomes

At the end of this course, the students will be:

CO1: Propulsion system in rockets and missiles.
CO2: Type of trajectory and orbits.
CO3: Students will enhance their ability to apply theoretical concepts to real-world propulsion challenges in space exploration.
CO4: They will develop hands-on experience with propulsion technologies and hypersonic aerodynamics through practical lab work.
CO5: Students will learn to evaluate and analyze propulsion cycles and their effectiveness in different space scenarios.

Computational Aerodynamics (ANT-022)

L T P: 3 0 0

Course Objectives:

The course should enable the students for:

- Discuss the fundamental aspects of numerical discretization and the major theories, approaches and methodologies used in computational aerodynamics.
- Analyze to build up the skills in the actual implementation of computational aerodynamics methods boundary conditions, turbulence modelling etc by using commercial CFD codes.
- Demonstrate the applications of CFD for classic fluid dynamics problems and basic thoughts and philosophy associated with CFD.
- Understand the various grids used in practice, including some recommendations related to grid quality and choose appropriate data structure to solve problems in real world.
- They will explore the validation and verification processes in computational aerodynamics, learning how to compare simulation results with experimental data and refine models for improved accuracy.

Particulars

Unit 1 **(8 Hrs)**

Introduction to Computational Aerodynamics: Need of computational fluid dynamics, philosophy of CFD, CFD as a research tool as a design tool, applications in various branches of engineering, models of fluid flow finite control volume, infinitesimal fluid element, substantial derivative physical meaning of divergence of velocity, derivation of continuity, momentum and energy equations, physical boundary conditions significance of conservation and non-conservation forms and their implication on CFD applications strong and weak conservation forms shock capturing and shock fitting approaches.

Unit 2 **(8 Hrs)**

Mathematical Behavior of Partial Differential Equations and Their Impact On Computational Aerodynamics: Classification of quasi-linear partial differential equations by Cramer‘s rule and Eigen value method, general behavior of different classes of partial differential equations and their importance in understanding physical and CFD aspects of aerodynamic problems at different Mach numbers involving hyperbolic, parabolic and elliptic equations: domain of dependence and range of influence for hyperbolic equations, well-posed problems

Unit 3 **(8 Hrs)**

Basic Aspects of Discretization: Introduction to finite difference: finite difference approximation for first order, second order and mixed derivatives, explicit and implicit approaches, truncation and round- off errors, consistency, stability, accuracy, convergence, efficiency of numerical solutions. Von Neumann stability analysis, physical significance of CFL stability condition. Need for grid generation, structured grids artesian grids, stretched (compressed) grids, body fitted structured grids, H-mesh, C- mesh, O-mesh, I-mesh, multi-

block grids, C-H mesh, H-O-H mesh, overset grids, adaptive grids, unstructured grids: triangular, tetrahedral cells, hybrid grids, quadrilateral, hexahedral cells

Unit 4 **(8 Hrs)**

CFD Techniques: Lax-Wendroff technique, MacCormack's technique, Crank Nicholson technique, Relaxation technique, aspects of numerical dissipation and dispersion. Alternating-Direction-Implicit (ADI) Technique, pressure correction technique: application to incompressible viscous flow, need for staggered grid. Philosophy of pressure correction method, pressure correction formula. Numerical procedures: SIMPLE, SIMPLER, SIMPLEC and PISO algorithms, boundary conditions for the pressure correction method.

Unit 5 **(8 Hrs)**

Finite Volume Methods: Basis of finite volume method, conditions on the finite volume selections, cell-centered and cell vertex approaches. Definition of finite volume discretization, general formulation of a numerical scheme, two-dimensional finite volume method with example.

Text Books:

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

REFERENCE BOOKS:

1. Hirsch, C., ―Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics, Vol. I, Butter worth-Heinemann, 2nd edition, 2007.
2. Hoffmann, K. A. and Chiang, S. T., ―Computational Fluid Dynamics for Engineers, Engineering Education Systems, 4th edition, 2000.
3. Patankar, S.V., ―Numerical Heat Transfer and Fluid Flow, Hemisphere Pub. Corporation, 1st edition, 1980.

Course Outcomes:

At the end of this course, the students:

CO1: Mesh creation technique.
CO2: Solving PDF by using numerical technique.
CO3: Students will develop skills in grid generation and mesh refinement to ensure accurate and efficient simulations of complex geometries.
CO4: They will understand the principles of turbulence modeling and its impact on aerodynamic predictions in various flight conditions.
CO5: Students will enhance their ability to interpret simulation results and apply them to optimize aircraft designs and improve performance in real-world applications.

Experimental Aerodynamics (ANT-023)

L T P: 3 0 0

Course Objectives :

The course should enable the students to learn:

- To provide details, operating principles and limitations of forces, pressure, velocity andtemperature measurements. To describe flow visualization techniques and to highlight in depth discussion of Analog methods.
- They will learn to design and conduct wind tunnel experiments, including the selection of appropriate test models, instrumentation, and measurement techniques to capture aerodynamic forces and flow characteristics.
- Students will develop skills in data acquisition and analysis, using tools such as force balances, pressure taps, and flow visualization techniques (e.g., smoke, tufts, and laser Doppler velocimetry) to assess lift, drag, and flow patterns.
- They will explore the effects of various parameters, such as Reynolds number, angle of attack, and surface roughness, on aerodynamic performance, and how to interpret these effects in the context of real-world applications.
- Students will enhance their ability to communicate experimental findings effectively, preparing comprehensive lab reports and presentations that detail methodologies, results, and implications for aerodynamic design and optimization in aerospace engineering.

Particulars

Unit 1: **(8 Hrs)**

Basic Measurements in Fluid Mechanics: 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.

Unit 2: **(8 Hrs)**

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

Unit 3: **(8 Hrs)**

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

Unit 4: **(8 Hrs)**

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

Unit 5: **(8 Hrs)**

Special Flows and Uncertainty Analysis: Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers - Data acquisition and processing – Signal conditioning - Uncertainty analysis – Estimation of measurement errors – External estimate of the error – Internal estimate of the error – Uncertainty calculation - Uses of uncertainty analysis.

TEXT BOOKS:

1. Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids," CRC Press –Taylor & Francis, 2007.

2. Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press, Taylor & Francis, 2006.

REFERENCE BOOKS:

1. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.Bradsaw Experimental Fluid Mechanics.
2. NAL-UNI Lecture Series 12: Experimental Aerodynamics, NAL SP 98 01 April 1998
3. Lecture cours on "Advanced Flow diagnostic techniques" 17-19 September 2008 NAL, Bangalore

Course Outcomes:

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

CO1: Knowledge on measurement techniques in aerodynamic flow.
CO2: Acquiring basics of wind tunnel measurement systems.
CO3: Specific instruments for flow parameter measurement like pressure, velocity, temperature etc.
CO4: Students will enhance their ability to apply experimental results to improve aircraft design, performance, and stability.
CO5: They will explore flow visualization methods, such as smoke trails and Particle Image Velocimetry (PIV), to study complex flow phenomena.

Hypersonic Aerodynamics (ANT-024)

L T P: 3 0 0

Course Objectives:

The course should enable the students to learn:

- Knowledge in basics of hypersonic and supersonic aerodynamics
- Acquiring knowledge in theory of hypersonic flow.
- Understanding of boundary layers of hypersonic flow and viscous interaction
- Role of chemical and temperature effects in hypersonic flow.
- Students will develop skills in analyzing and modeling hypersonic flows using both analytical and computational methods, including the application of the Navier-Stokes equations and relevant turbulence models for high-speed conditions.

Particulars

Unit 1: **(8 Hrs)**

Fundamentals Of Hypersonic Aerodynamics: 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 2: **(8 Hrs)**

Simple Solution Methods For Hypersonic Inviscid Flows: 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 3: **(8 Hrs)**

Viscous Hypersonic Flow Theory: 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 4: **(8 Hrs)**

Viscous Interactions In Hypersonic Flows: 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 5: **(8 Hrs)**

high temperature effects in hypersonic flows: 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.

TEXT BOOKS:

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

REFERENCE BOOKS:

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

Course Outcomes:

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

CO1: To introduce fundamental concepts and features peculiar to hypersonic flow to students to familiarize them with the aerodynamical aspects of hypersonic vehicles and the general hypersonic flow theory.
CO2: Students will enhance their ability to apply theoretical knowledge to real-world hypersonic applications, such as space re-entry vehicles and advanced missile systems.
CO3: They will explore the challenges associated with hypersonic flight, including stability, control, and material selection for high-temperature environments.
CO4: Students will develop skills in using computational tools and experimental methods to study hypersonic flows and assess vehicle performance in extreme conditions.
CO5: They will learn to analyze the effects of high-speed aerodynamics on vehicle design, including shock waves, thermal loads, and aerodynamic heating.

Advanced Computational Aerodynamics (ANT-025)

L T P: 3 0 0

Course Objectives :

The course should enable the students to learn:

- Explain the concept of panel methods, analyze various boundary conditions applied and demonstrate several searching and sorting algorithms.
- Describe the initial methods applied in the process of CFD tools development their advantages and disadvantages over modern developed methods.
- Demonstrate different methods evolved in analyzing numerical stability of solutions and evaluate the parameters over which the stability depends and their range of values.
- Understand advanced techniques and methods in time marching steps and identify different boundary conditions for different cases in CFD techniques.
- Students will develop skills in the use of high-performance computing resources and parallel processing techniques to enhance the efficiency and accuracy of CFD simulations, enabling the analysis of large-scale and time-dependent aerodynamic problems.

Particulars

Unit 1: **(8 Hrs)**

Numerical Solutions: Euler equations: Flux approach, Lax-Wendroff method, basic principles of upwind schemes, flux vector splitting, Steger Warming flux vector splitting, Van Leer flux vector splitting, Upwind reconstruction, evolution, Godunov‘s first order upwind method, Roe‘s first order upwind method.

Unit 2: **(8 Hrs)**

Time Dependent Methods: Stability of solution, explicit methods, FTFS, FTCS, FTBS, Leapfrog method, Lax method. Implicit methods: Euler‘s FTCS, Crank Nicolson method, description of Lax- Wendroff scheme, McCormack two step predictor-corrector method, description of time split methods, approximate factorization schemes.

Unit 3 **(8 Hrs)**

Boundary Conditions: Boundary Layer Equations: Setting up the boundary layer equations, flat plate boundary layer solution, boundary layer transformations, explicit and implicit discretization, solution of the implicit difference equations, integration of the continuity equation, boundary layer edge and wall shear stress, Keller-box scheme. Concept of dummy cells, solid wall inviscid flow, viscous flow, farfield concept of characteristic variables, modifications for lifting bodies inlet outlet boundary, injection boundary, symmetry plane, coordinate cut, periodic boundaries, interface between grid blocks, flow gradients at boundaries of unstructured grids.

Unit 4: **(8 Hrs)**

Method of Characteristics: Philosophy of method of characteristics, determination of characteristic lines, two dimensional irrotational flow, determination of compatibility equations, unit processes, supersonic nozzle design by the method of characteristics, supersonic wind tunnel nozzle, minimum length nozzles, domain of dependence and range of influence.

Unit 5: **(8 Hrs)**

Panel Methods: Basic formulation, boundary conditions, physical considerations, reduction of a problem to a set of linear algebraic equations, aerodynamic loads, preliminary considerations prior to establishing numerical solution, steps toward constructing a numerical solution, solution of thin airfoil with lumped vortex filament, accounting for effects of compressibility and viscosity.

TEXT BOOKS:

1. Tannehill John C, Anderson Dale A, Pletcher Richard H, ―Computational Fluid Mechanics and Heat Transfer, Taylor & Francis, 2nd Edition, 1997.
2. Chung T G, ―Computational Fluid Dynamics, Cambridge University Press, 2nd Edition, 2010.
3. Katz Joseph and Plotkin Allen, ―Low-Speed Aerodynamics, Cambridge University Press, 2nd Edition, 2006.

REFERENCE BOOKS:

1. Anderson J D, ―Modern Compressible Fluid Flow, 2nd Edition, McGraw Hill, 1990.
2. Anderson J D, ―Fundamentals of Aerodynamics, Tata McGraw Hill, 5th Edition, 2010.
3. Anderson J D, ―Computational Fluid Dynamics, McGraw Hill, 1995.

Course Outcomes:

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

CO1: Different techniques to solve the complex fluid dynamics problem numerical.
CO2: Students will deepen their understanding of advanced computational fluid dynamics (CFD) techniques, including unsteady and compressible flow simulations for complex aerodynamic applications.
CO3: They will learn to implement and utilize advanced turbulence models, such as Large Eddy Simulation (LES) and Detached Eddy Simulation (DES), to capture intricate flow phenomena.
CO4: Students will develop skills in high-performance computing and parallel processing to optimize CFD simulations for large-scale aerodynamic problems.
CO5: Students will enhance their ability to critically evaluate and validate CFD results against experimental data, applying findings to inform and improve aerodynamic design processes.

Helicopter Aerodynamics (ANT-026)

L T P: 3 0 0

Course Objectives :

The course should enable the students to learn:

- Understand the elements of helicopter aerodynamics and ground effect machines, their components and methods of control.
- Formulate the mathematical model using simple blade element theory, analyze its figure of merit and evaluate power estimations.
- Evaluate performance and its effect on altitude and understand the preliminary stability aspects of helicopters.
- Apply the aerodynamics, propulsion and control concepts for various VTOL and STOL aircraft and ground effect machines.
- Students will develop skills in analyzing rotor performance through the application of momentum theory, blade element theory, and computational fluid dynamics (CFD) to predict aerodynamic forces and moments during different flight maneuvers.

Particulars

Unit 1: **(8 Hrs)**

Elements of Helicopter Aerodynamics: Configurations based on torque reaction, jet rotors and compound helicopters, methods of control, collective and cyclic pitch changes, lead and lag, flapping hinges.

Unit 2: **(8 Hrs)**

Ideal Rotor Theory: Hovering performance, momentum and simple blade element theories, figure of merit, profile and induced power estimation, constant chord and ideal twist rotors.

Unit 3 **(8 Hrs)**

Power Estimates: Induced, profile and parasite power requirements in forward flight. Performance curves with effects of altitude, preliminary ideas on helicopter stability.

Unit 4: **(8 Hrs)**

Lift, Propulsion and Control of VSTOL Aircraft: Various configurations: propeller, rotor, ducted fan and jet lift, tilt wing and vectored thrust, performance of VTOL and STOL aircraft in hover, transition and forward motion.

Unit 5: **(8 Hrs)**

Ground Effect Machines: Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machine, drag of hovercraft on land and water, applications of hovercraft.

TEXT BOOKS:

1. Gessow A, and Myers G C, ―Aerodynamics of Helicopter, Macmillan &Co., 1st Edition 1987.
2. McCormick B W, ―Aerodynamics of V/STOL Flight, Academic Press, 1st Edition, 1987.

REFERENCE BOOKS:

1. Johnson W, ―Helicopter Theory, Princeton University Press, 1st Edition, 1980.
2. McCormick BW, ―Aerodynamics, Aeronautics and Flight Mechanics John Wiley, 1st Edition, 1995.
3. Gupta L, ―Helicopter Engineering, Himalayan Books, 1st Edition, 1996.

Course Outcomes:

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

CO1: Working principle of helicopter.
CO2: Types of helicopter.
CO3: They will gain insights into advanced rotor design and materials that enhance performance and efficiency.
CO4: Students will apply theoretical knowledge to real-world scenarios, improving their ability to assess and optimize helicopter performance in various flight conditions.
CO5: Students will develop skills in evaluating the effects of unsteady aerodynamics and dynamic stall on helicopter operations.

AEROSPACE PROPULSION LAB (ANP-011)

L T P: 0 0 2

Course Objective

The course should enable the students to:

- Understand the basics of propulsion, working principles of reciprocating engines, performance estimation based on rotation angles, and components of engine and their functions
- Knowledge about the operation of valves, ports and their functioning in four stroke and two stroke engines.
- Calculation of percentage of carbon residue and flash and fire point temperatures of a Lubricating Oil.
- Understand the basic characteristics and range of performance of axial flow gas turbine. Perform parametric jet engine performance analysis and turbo machinery and basic combustion calculations.
- They will explore the principles of combustion and thermodynamics as they relate to propulsion, conducting experiments to study combustion efficiency, emissions, and the effects of different fuel types and mixtures on engine performance

Particulars

List of Experiments

Minimum 10 experiments out of the following (or similar experiments).

Week-1 ENGINE DISASSEMBLY AND ASSEMBLY

1. To understand the working mechanism and identifying various components to build an IC engine.

2. Brief description about Components of engine and their functions.

Week-2 FLASH POINT AND FIRE POINT TEST

1. Determination of flash point and fire point for a sample using pen sky martin‘s test.

Week-3 DETERMINATION OF DYNAMIC VISCOSITY OF A GIVEN SAMPLE USING REDWOOD VISCOMETER

1. Determine kinematic viscosity and dynamic viscosity of given sample using a viscometer.

2. Order fluctuating temperature is measured in terms of viscosity.

Week-4 MECHANICAL EFFICIENCY OF AXIAL COMPRESSOR

1. Calculation of the Mechanical efficiency of axial compressor- power required, power Available, Compression Ratio.

Week-5 GAS TURBINE PARAMETERS CALCULATION

1. Calculation of work, power and Thrust requirement in gas turbine- combustion power input, work heat relationship.

Week-6 GAS TURBINE EFFICIENCY AND PERFORMANCE DIAGRAMS

1. Elucidate T-S, H-S diagrams for the gas turbine and compare efficiencies of non-ideal engine components.

Week-7 GAS TURBINE EFFICIENCY CALCULATIONS

1. Calculation of thermal, propulsive and overall efficiency of turbo jet cycle.

Week-8 WORK OUTPUT OF AXIAL TURBINE

1. Calculation of total work output of axial turbine- out put work necessary, Available output.

Week-9 NOZZLE PERFORMANCE

1. Calculation of various nozzle performance with airflow

Week-10 CALORIFIC VALUE OF DIFFERENT FUELS

1. Calculation of calorific value of different fuels and materials using digital bomb calorimeter and optimizing astute fuels

Week-11 FREE AND FORCED CONVECTION

1. Estimation of convection coefficient of air using forced jet or free convection apparatus

Week-12 PROPELLER TEST RIG

1. Calculation of propeller efficiency and thrust availability using propeller test rig at various blade pitch angles.

REFERENCE BOOKS:

1. https://www.cast-safety.org/pdf/3_engine_fundamentals.pdf
2. https://en.wikipedia.org/wiki/Reciprocating_engine.

Course Outcomes

At the end of this course, student will be able to:

CO1: Working principle of IC engine, compressor.
CO2: Turbine efficiency.
CO3: Students will enhance their ability to work collaboratively in teams, applying theoretical knowledge to solve real-world propulsion challenges and improve design processes.
CO4: They will explore the principles of combustion and thermodynamics as they relate to propulsion systems, enhancing their understanding of energy conversion processes.
CO5: Students will develop skills in data acquisition and analysis, interpreting results to evaluate the effectiveness of different propulsion technologies.

CFD Lab (ANP-012)

L T P: 0 0 2

Course Objective

The course should enable the students to:

- Experience in computing aerodynamic problems and understanding flow physics over the objects.
- Knowledge in estimating flow analysis for different mach numbers.
- Determining the aerodynamic forces like mainly lift and drag.
- Analyze the errors and cause of errors in computational analysis.
- They will explore the validation and verification processes in CFD, comparing simulation results with experimental data or analytical solutions to assess the accuracy and reliability of their models.

Particulars

List of Experiments

Minimum 10 experiments out of the following (or similar experiments).

Week-1: INTRODUCTION
Introduction to computational aerodynamics, the major theories, approaches and methodologies used. in computational aerodynamics. Applications of computational aerodynamics for classical aerodynamic‘s problems.

Week-2: INTRODUCTION TO GAMBIT
Introduction to gambit, geometry creation, suitable meshing types and boundary conditions.

Week-3: INTRODUCTION TO FLUENT.
Introduction to fluent, boundary conditions, solver conditions and post processing results.

Week-4: FLOW OVER A FLAT PLATE
Flow over a flat plate at low Reynolds numbers, observe the boundary layer phenomena, no slip condition and velocity profile inside the boundary layer.

Week-5: FLOW THROUGH PIPE
Flow through pipe at different Reynolds numbers; observe the velocity changes for laminar and turbulent flows.

Week-6: FLOW OVER A CIRCULAR CYLINDER
Flow over a circular cylinder at different Reynolds numbers, observe the properties at separation region and wake region.

Week-7: FLOW OVER A CAMBERED AEROFOIL
Flow over a cambered aerofoil at different velocities, observe flow properties and compare the computation results with experimental results (consider the model from aerodynamics laboratory).

Week-8: FLOW OVER A SYMMETRIC AEROFOIL
Flow over a symmetric aerofoil at different velocities, observe flow properties and compare the computation results with experimental results (consider the model from aerodynamics laboratory).

Week-9: FLOW OVER WEDGE
Flow over wedge body at supersonic mach number; observe the shock wave phenomena and change of properties across the shock wave.

Week-10: FLOW OVER A CONE
Flow over a cone at supersonic mach number; observe the shock waves and 3D relieving effect.

Week-11: CODE DEVELOPMENT
Solution for the following equations using finite difference method
I. One dimensional wave equation using explicit method of lax.
II. One dimensional heat conduction equation using explicit method.

Week-12: CODE DEVELOPMENT
Generation of the following grids
I. Algebraic grids.
II. Elliptic grids.

REFERENCE BOOKS:
1. Anderson, J.D., Jr., Computational Fluid Dynamics The Basics with Applications, McGraw-Hill Inc, 1st Edition 1998.
2. Hoffmann, K. A. and Chiang, S. T., ―Computational Fluid Dynamics for Engineers, 4th Edition, Engineering Education Systems (2000).
3. Hirsch, C., ―Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics, Vol. I, 2nd Edition., Butterworth-Heinemann (2007).
4. JAF. Thompson, Bharat K. Soni, Nigel P. Weatherill ―Grid generation, 1st Edition 2000.

Course Outcomes
At the end of this course, student will be able to:

CO1: Numerical Simulation of Aerodynamic problem.
CO2: Hands on experience on various solving technique with boundary conditions.
CO3: Students will develop practical skills in setting up and running computational fluid dynamics (CFD) simulations using industry-standard software.
CO4: They will learn to create and refine computational meshes to ensure accurate and efficient simulation results for various aerodynamic problems.
CO5: Students will enhance their ability to integrate CFD results into engineering design processes, improving optimization and decision-making in aerospace applications.

Project Stage - I (ANP-013)

Course Objectives

The course should enable the students:

- To allow students to demonstrate a wide range of the skills learned during their course of study
- To encourage multidisciplinary research through the integration learned in a number of courses.
- To allow students to develop problem solving, analysis, synthesis and evaluation skills.
- To encourage teamwork.
- To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation

Course Outcomes

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

CO1: Demonstrate a sound technical knowledge of their selected project topic.
CO2: Undertake problem identification, formulation and solution.
CO3: Combine the theoretical and practical concepts studied in his / her academics.
CO4: Communicate with engineers and the community at large in written and oral forms.
CO5: Demonstrate the knowledge, skills and attitudes of a professional engineer.

Essence of Indian Traditional Knowledge (AHT-010)

L T P: 2 0 0

Course Objectives

The course should enable the students:

- With the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
- To understand the traditional knowledge and analyse it and apply it to their day to day life.
- To know the need and importance of protecting traditional knowledge.
- To understand the concepts of Intellectual property to protect the traditional knowledge.
- For concentrating on various acts in protecting the environment and Knowledge management impact on various sectors in the economy development of the country.

Particulars

Unit 1 **(8 Hrs)**

Introduction to Traditional and Culture Knowledge Define culture, traditional, civilization and heritage knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK). Indigenous traditional knowledge Vs western traditional knowledge vis-à-vis formal knowledge.

Unit 2 **(8 Hrs)**

Protection of Traditional Knowledge Protection of traditional knowledge: The need for protecting traditional knowledge Significance of traditional knowledge Protection, value of traditional knowledge in global economy, Role of Government to harness traditional knowledge.

Unit 3 **(8 Hrs)**

Traditional Knowledge and Intellectual Property Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Global legal forums for increasing protection of Indian Traditional Knowledge.

Unit 4 **(8 Hrs)**

Traditional Knowledge in Different Sectors Traditional knowledge in engineering, biotechnology and agriculture, traditional medicine system, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of traditional knowledge.

Unit 5 **(8 Hrs)**

Education System in India Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

Text/Reference Books:

1.Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2.”Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.
3.Traditional Knowledge System in India, by Amit Jha, 2009.
4.Satya Prakash, “Founders of Sciences in Ancient India”, Vijay Kumar Publisher, 1989

5. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh Pratibha Prakashan 2012.

Course Outcomes

The course should enable the students to:

CO1: Understand the concept of Traditional knowledge and its importance.
CO2: Know the need and importance of protecting traditional knowledge.
CO3: Know the various enactments related to the protection of traditional knowledge.
CO4: Understand the concepts of Intellectual property to protect the traditional knowledge.
CO5: Know the contribution of scientists of different areas.

Constitution of India (AHT-009)

L T P: 2 0 0

Course Objectives

The course should enable the students to:

- Acquaint them with legacies of constitutional development in India and help to understand the most diversified legal document of India and philosophy behind.
- Make them aware of the theoretical and functional aspects of the Indian Parliamentary System.
- Channelize their thinking towards basic understanding of the legal concepts and its implications for engineers. Students will gain a comprehensive understanding of the structure, principles, and provisions of the Constitution of India, including its historical context and significance.
- They will explore the fundamental rights and duties enshrined in the Constitution, emphasizing their importance in safeguarding individual liberties and promoting social justice.
- Students will analyze the roles and functions of various government institutions established by the Constitution, including the Executive, Legislature, and Judiciary.

Particulars

Unit 1 **(8 Hrs)**

Constitutional Framework Meaning of Terms and Phrases frequently used in political system like constitution, constitutionalism, Rule of Law, Federal system, Government and so on. Historical Background of Indian Constitution, Making of Indian Constitution, Salient features of Indian Constitution, Preamble of Indian Constitution.

Unit 2 **(8 Hrs)**

Different Parts, Articles, and their Significance Part I to IVA (Union and its territories w.r.t. Indian States, Citizenship, Fundamental Rights conferred to citizens and foreigners, Directive Principles of State Policy– Its importance and implementation and Fundamental Duties and its legal status), Article 1 to 51A and their significance.

Unit 3 **(8 Hrs)**

System of Government Parliamentary Form of Government in India – The constitution powers and status of the President of India, Federal structure and distribution of legislative and financial powers between the Union and the States, Emergency Provisions: National Emergency, President Rule, Financial Emergency and Amendment of the Constitutional Powers and Procedure and the significance of basic structure in Indian Judicial system.

Unit 4 **(8 Hrs)**

Working of Central, State & Local Self Government as per Constitution Framework for central government (President, Vice president, Prime Minister, Central council of ministers, Parliament, Supreme court and so on), Framework for state government (Governor, Chief Minister, state legislature, High court and so on) and Framework for local self government (Panchayatiraj, Municipalities) and Union Territories.

Unit 5 **(8 Hrs)**

Constitutional, Non-Constitutional and other bodies Discussion on Various constitutional bodies like Election Commission, UPSC, SPSC, Finance commission, NCSC, NCST, NCBC, CAG and AGI. Discussion on Various non-constitutional bodies like NITI Aayog, NHRC, CIC, CVC, CBI, Lokpal and Lokayukta. Discussion on Various other constitutional bodies like Co- operative societies, Official Language, Tribunals etc.

Text/Reference Books-

1-M. Laxmikanth, “Indian Polity”, McGraw- Hill, 6th edition, 2020
2-D.D. Basu, “Introduction to the Indian Constitution”, LexisNexis, 21st edition, 2020
3-S.C. Kashyap, “ Constitution of India”, Vitasta publishing Pvt. Ltd., 2019

Course Outcomes

The course should enable the students to:

CO1: Understand the basic knowledge and salient features of Indian Constitution.
CO2: Identify and explore the basic features and modalities about Indian constitution.
CO3: Discusses the essence of Union and its territories, Citizenship, Fundamental Rights, DPSP and Fundamental Duties.
CO4: Differentiate and relate the functioning of Indian parliamentary system at the center and state level.
CO5: Differentiate different aspects of Indian Legal System and its related bodies.

B.Tech. (Aeronautical Engineering) SEMESTER-VII

Sl. No.	Subject Codes	Category	Subject	Periods			Evaluation Scheme					Subject Total	Credit
							Sessional Exam			ESE			
				L	T	P	CT	TA	Total	TE	PE		
1	AHT- 016/ AHT-015	HSC	HSMC-2 / HSMC-1	3	1	0	30	20	50	100		150	3
2	ANT-XXX	DE	Departmental Elective-4	3	0	0	30	20	50	100		150	3
3	ANT-XXX	DE	Departmental Elective-5	3	0	0	30	20	50	100		150	3
4		OE*	Open Elective-2	3	0	0	30	20	50	100		150	3
5	ANP-014	DLC	Project Seminar	0	0	2			50			50	1
6	ANP-015	DLC	Project Stage -II	0	0	4			100			100	2
7	ANP-016	DLC	Mini Project-III or Internship-III*	0	0	2			50			50	1
8	AHT-017	MC	Disaster Management	3	0	0	30	20	50	100		150	3
9	AHT-018	NC	Innovations and Problem Solving (Audit Course)	2	1	0	15	10	25	50		75	0
10	GP-07	NC	General Proficiency						50			50	0
			Total	**17**	**1**	**8**						**950**	**19**
11	Minor Course (Optional)			3	1	0	30	20	50	50		150	4

*The Internship-III (4-6 weeks) conducted during summer break after VI semester and will be assessed during VII semester

*Aeronautical Engineering student shall opt open elective offered by other departments

	Departmental Elective - 4		**Departmental Elective - 5**
ANT-027	Industrial Aerodynamics	ANT-030	Heat Transfer
ANT-028	Turbo Machinery	ANT-031	Cryogenics
ANT-029	Theory of Combustion	ANT-032	Aero Engine Design
ANT-033	Aircraft Maintenance Engineering	ANT-034	Heat Transfer in Space Applications

HSMC-1
Rural Development: Administration and Planning (AHT-015)

L T P: 3 0 0

Course Objectives

This course enables the students to:

- Gain knowledge on the concepts related to administration, its importance and various approaches of Development Administration.
- Gain skills on New Public Management, Public Grievances and redressal Mechanisms, Accountability and Transparency in Administration and e-governance in the rural development sector.
- Develop their competency on the role of Bureaucracy in Rural Development.
- Students will gain a comprehensive understanding of the concepts, theories, and practices of rural development, including the socio-economic challenges faced by rural communities and the importance of sustainable development.
- They will explore the role of various government and non-governmental organizations in rural development, analyzing their strategies for planning, implementing, and evaluating rural development programs and policies.

Particulars

Unit 1 **(8 Hrs)**

Rural Planning & Development: Concepts of Rural Development, Basic elements of rural Development, and Importance of Rural Development for creation of Sustainable Livelihoods, An overview of Policies and Programmes for Rural Development- Programmes in the agricultural sector, Programmes in the Social Security, Programmes in area of Social Sector.

Unit 2 **(8 Hrs)**

Rural Development Programmes: Sriniketan experiment, Gurgaon experiment, Marthandam experiment, Baroda experiment, Firkha development scheme, Etawapilot project, Nilokheri experiment, approaches to rural community development: Tagore, Gandhi etc.

Unit 3 **(8 Hrs)**

Panchayati Raj & Rural Administration: Administrative Structure: bureaucracy, structure of administration; Panchayati Raj Institutions Emergence and Growth of Panchayati Raj Institutions in India; People and Panchayati Raj; Financial Organizations in Panchayati Raj Institutions, Structure of rural finance, Government & Non-Government Organizations / Community Based Organizations, Concept of Self help group.

Unit 4 **(8 Hrs)**

Human Resource Development in Rural Sector: Need for Human Resource Development, Elements of Human Resource Development in Rural Sector Dimensions of HRD for rural development-Health, Education, Energy, Skill Development, Training, Nutritional Status access to basic amenities – Population composition.

Unit 5 **(8 Hrs)**

Rural Industrialization and Entrepreneurship: Concept of Rural Industrialization, Gandhian approach to Rural Industrialization, Appropriate Technology for Rural Industries, Entrepreneurship and Rural Industrialization- Problems and diagnosis of Rural Entrepreneurship in India, with special reference to Women Entrepreneurship; Development of Small Entrepreneurs in India, need for and scope of entrepreneurship in Rural area.

Text Books/References:

1. Corporate Social Responsibility: An Ethical Approach - Mark S. Schwartz.
2. Katar Singh: Rural Development in India – Theory History and Policy.
3. Todaro M.P. Economic Development in III World war.
4. Arora R.C – Integrated Rural Development in India.
5. Dhandekar V.M and Rath N poverty in India.
6. A.N.Agarwal and Kundana Lal: Rural Economy of India.
7. B.K.Prasad: Rural Development-Sarup& Son's Publications.

Course Outcomes

After completion of the course student will be able to:

CO1: Understand the definitions, concepts and components of Rural Development.
CO2: Students will know the importance, structure, significance, resources of Indian rural economy.
CO3: Students will have a clear idea about the area development programmes and its impact.
CO4: Students will be able to acquire knowledge about rural entrepreneurship.
CO5: Students will be able to understand about the using of different methods for human resource planning.

HSMC-2

Project Management & Entrepreneurship (AHT-016)

L T P: 3 0 0

Course Objectives

The course should enable the students to:

- Understand the concepts of Project Management for planning to execution of projects.
- Understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
- Be capable to analyze, apply and appreciate contemporary project management tools. and methodologies in Indian context.
- Understand the concepts of Entrepreneurship, role of entrepreneur in economic development, steps for establishing an enterprise.
- Students will understand the fundamental principles and processes of project management, including planning, scheduling, resource allocation, and risk management.

Particulars

Unit 1 **(8 Hrs)**

Entrepreneurship: Entrepreneurship: need, scope , Entrepreneurial competencies & traits, Factors affecting entrepreneurial development, Entrepreneurial motivation (Mc Clellend's Achievement motivation theory), conceptual model of entrepreneurship , entrepreneur vs. intrapreneur; Classification of entrepreneurs; Entrepreneurial Development Programmes.

Unit 2 **(8 Hrs)**

Entrepreneurial Idea and Innovation: Introduction to Innovation, Entrepreneurial Idea Generation and Identifying Business Opportunities, Management skills for Entrepreneurs and managing for Value Creation, Creating and Sustaining Enterprising Model & Organizational Effectiveness.

Unit 3 **(8 Hrs)**

Project Management: Project management: meaning, scope & importance, role of project manager; project life-cycle Project appraisal: Preparation of a real time project feasibility report containing Technical appraisal, Environmental appraisal, Market appraisal (including market survey for forecasting future demand and sales) and Managerial appraisal.

Unit 4 **(8 Hrs)**

Project Financing: Project cost estimation & working capital requirements, sources of funds, capital budgeting, Risk & uncertainty in project evaluation , preparation of projected financial statements viz. Projected balance sheet, projected income statement, projected funds & cash flow statements, Preparation of detailed project report, Project finance.

Unit 5 **(8 Hrs)** Social

Entrepreneurship: Social Sector Perspectives and Social Entrepreneurship, Social Entrepreneurship Opportunities and Successful Models, Social Innovations and Sustainability, Marketing Management for Social Ventures, Risk Management in Social Enterprises, Legal Framework for Social Ventures. Case study

and presentations: Case study of successful and failed entrepreneurs. Power point presentation on current business opportunities.

Text Books

1. Innovation and Entrepreneurship by Drucker, P.F.; Harperand Row.
2. Business, Entrepreneurship and Management: Rao, V.S.P.;Vikas
3. Entrepreneurship: Roy Rajeev.
4. Text Book of Project Management: Gopal Krishnan ,P.and Ramamoorthy,V.E.; McMill.
5. Project Management for Engineering, Business and Technology: Nicholas, J.M., and Steyn, H.; PHI.
6. Project Management: The Managerial Process: Gray, C.F., Larson, E.W. and Desai, G.V.; MGH.

Course Outcomes

After completion of the course student will be able to:

CO1: Understand project characteristics and various stages of a project.

CO2: Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.

CO3: Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.

CO4: Describe Entrepreneurship, Examine role of entrepreneur in economic development.

CO5: Students will gain a comprehensive understanding of project management principles, including planning, execution, monitoring, and closing of projects in an aerospace context.

Industrial Aerodynamics (ANT-027)

L T P: 3 0 0

Course Objectives :

The course should enable the students to learn:

- To familiarize the learner with non-aeronautical uses of aerodynamics such as road vehicle, building aerodynamics and problems of flow induced vibrations.
- They will explore the impact of aerodynamic forces on the design and performance of various industrial products, such as automobiles, aircraft, wind turbines, and HVAC systems.
- Students will develop skills in using computational fluid dynamics (CFD) and wind tunnel testing to analyze and optimize aerodynamic performance in real-world industrial scenarios.
- They will examine the effects of environmental factors, such as turbulence and pressure variations, on industrial operations and how to mitigate these effects through design and engineering solutions.
- Students will enhance their ability to communicate technical findings effectively, preparing detailed reports and presentations that summarize their analyses, design recommendations, and implications for industrial applications.

Particulars

Unit 1: **(8 Hrs)**

Atmosphere: Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows.

Unit 2: **(8 Hrs)**

Wind Energy Collectors: Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.

Unit 3: **(8 Hrs)**

Vehicle Aerodynamics: Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft.

Unit 4: **(8 Hrs)**

Building Aerodynamics: 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 5: **(8 Hrs)**

Flow Induced Vibrations: Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

TEXT BOOKS:

1. M. Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and Road vehicles", Plenum press, New York, 1978.
2. Sachs. P., "Winds forces in Engineering", Pergamon Press, 1978.

REFERENCE BOOKS:

1. Blevins. R.D., "Flow Induced Vibrations", Van Nostrand, 1990.
2. Calvent. N.G., "Wind Power Principles", Charles Griffin & Co., London, 1979

Course Outcomes:

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

CO1: Use of aerodynamics for non- aerodynamics such as vehicle, building.
CO2: Solve the problems and able to analyse vibrations during.
CO3: Students will understand the fundamental principles of aerodynamics as they apply to industrial applications, including airflow around structures, vehicles, and machinery.
CO4: They will learn to analyze the effects of aerodynamic forces on performance, efficiency, and safety in various industrial contexts, such as automotive, aerospace, and wind energy.
CO5: Students will develop skills in using computational fluid dynamics (CFD) and experimental methods to study and optimize aerodynamic designs in real-world scenarios.

Turbo Machinery (ANT-028)

L T P: 2 1 0

Course Objectives :

The course should enable the students to:

- Provide students with opportunities to apply basic flow equations
- Train the students to acquire the knowledge and skill of analyzing different turbo machines.
- How to compare and chose machines for various operations
- Students will gain a comprehensive understanding of the principles and operation of turbomachinery, including the design, analysis, and performance of turbines, compressors, and pumps used in various engineering applications.
- They will explore the thermodynamic cycles and fluid dynamics governing turbomachinery, enabling them to analyze energy conversion processes and efficiency in different systems.

Particulars

Unit 1 **(8 Hrs)**

Introduction to Turbomachinery: Classification of turbo-machines, second law of thermodynamics applied to turbine and compressors work, nozzle, diffuser work, fluid equation, continuity, Euler's, Bernoulli's, equation and its applications, expansion and compression process, reheat factor, preheat factor

Unit 2 **(8 Hrs)**

Fundamental Concepts of Axial and Radial Machines: Euler's equation of energy transfer, vane congruent flow, influence of relative circulation, thickness of vanes, number of vanes on velocity triangles, slip factor, Stodola, Stanitz and Balje's slip factor, suction pressure and net positive suction head, phenomena of cavitation in pumps, concept of specific speed, shape number, axial, radial and mixed flow machines, similarity laws.

Unit 3 **(8 Hrs)**

Gas Dynamics: Fundamental thermodynamic concepts, isentropic conditions, mach numbers, and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Supersonic flow, oblique shock waves. Normal shock recoveries, detached shocks, Aerofoil theory. Centrifugal compressor: Types, Velocity triangles and efficiencies, Blade passage design, Diffuser and pressure recovery. Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance

Unit 4 **(8 Hrs)**

Axial Flow Compressors: Flow Analysis, Work, and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Degree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

Unit 5 **(8 Hrs)**

Axial Flow Gas Turbines: Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifels relation, Design cascade analysis, Soderberg, Hawthrone, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, off design performance.

TEXT BOOKS:

1. Principles of Turbo Machines/DG Shepherd / Macmillan
2. Turbines, Pumps, Compressors/Yahya/ Mc Graw Hill

REFERENCE BOOKS:

1. A Treatise on Turbo machines / G. Gopal Krishnan and D. Prithviraj/ SciTech
2. Gas Turbine Theory/ Saravanamuttoo/ Pearson
3. Turbo Machines/ A Valan Arasu/ Vikas Publishing House Pvt. Ltd.

Course Outcomes

At the end of this course, the students will be:

CO1: Ability to design and calculate different parameters for turbo machines.
CO2: Prerequisite to CFD and Industrial fluid power courses.
CO3: Ability to formulate design criteria.
CO4: Ability to understand thermodynamics and kinematics behind turbo machines.
CO5: Students will apply their knowledge to real-world engineering problems, preparing them for careers in industries such as aerospace, power generation, and HVAC systems.

Theory of Combustion (AHT-029)

L T P: 3 0 0

Course Objectives :

The course should enable the students for:

- Understand the concepts in combustion theory and illustrate students involved in combustion research with the required fundamental knowledge in combustion stoichiometry.
- Familiarize in the area of combustion in various engines, generalise stability limits and flame stabilization in diffusion flame.
- Calculate the combustion efficiency. Discuss fundamental combustion problems arising from gas turbine combustion or more generally from combustion in steady flowing premixed systems.
- Determine the supersonic combustion. Combustion in rocket engines and emission. Different types of combustion chambers in gas-turbine engines, primary requirements of the combustor, afterburners.
- Students will gain a comprehensive understanding of the fundamental principles of combustion, including the chemical reactions, thermodynamics, and fluid dynamics involved in the combustion process.

Unit 1 **(8 Hrs)**

Basics Of Combustion Theory: Combustion stoichiometry and thermo chemical calculation, chemical kinetics and equilibrium, transport phenomena, theory of viscosity, conductivity and diffusivity

Unit 2 **(8 Hrs)**

Pre-Mixed Flames: Description of premixed flames, burning velocity and parametric dependences, experimental methods of measuring burning velocity, simple one-dimensional thermal theory of flame, concepts of minimum ignition energy, quenching distance, stability limits and flame stabilization.

Unit 3 **(8 Hrs)**

Diffusion Flame: Jet flame physical description, theoretical analysis-Burke-Schumann‘s analysis, mechanism of soot formation, Defining of premixed, diffusion flames, liquid fuel combustion flames. Liquid fuel combustion, difference between premixed and diffusion flames, liquid fuel combustion-conservation equations, calculation of mass burning rate, droplet burning.

Unit 4 **(8 Hrs)**

Combustion In Reciprocating And Gas- Turbine Engines: Description of the combustion process in piston engines, Combustion efficiency and factors affecting it, Rankine - Hugoniot curves, deflagration and detonation in reciprocating engines and preventive methods; Description of different types of combustion chambers in gas-turbine engines, primary requirements of the combustor, afterburners.

Unit 5 **(8 Hrs)**

Combustion In Rocket Engines And Emission: Types of rockets based on combustion, solid fuel combustion, combustion of carbon particle, simplified analysis, boundary layer combustion, combustion of carbon sphere with co burning gas phase; Chemical emission from combustion and its effects, exhaust gas analysis, emission control.

TEXT BOOKS:

1. Stephen R Turns, ―An Introduction to combustion Concepts and Application, TMH Publication, 3rd Edition, 2011.
2. Fawzy El-Mahallawy, Saad El-Din Habik, Elsevier ―Fundamentals and Technology of combustion, 1st Edition, 2002.

REFERENCE BOOKS:

1. Charles E. Baukal, ―Heat Transfer in Industrial Combustion, CRC Press, 1st Edition, 2000.
2. G. Singer, ―Combustion, Fossil Power Systems Ed Publications, 4th Edition, 1966.
3. S. P. Sharma, Chandra Mohan ―Fuels and Combustion, Tata McGraw Hill Publishing Co., 1st Edition, 1987.

Course Outcomes:

At the end of this course, the students:

CO1: To familiarize the students in the area of combustion in various engines.
CO2: Students will apply their knowledge to real-world challenges in combustion systems, preparing them for careers in energy, aerospace, and environmental engineering sectors.
CO3: They will explore the impact of combustion parameters, such as temperature, pressure, and fuel composition, on efficiency, emissions, and overall performance.
CO4: Students will develop skills in modeling combustion processes using theoretical and computational methods, including the use of chemical kinetics and reaction mechanisms.
CO5: They will learn to analyze different types of combustion, such as premixed, diffusion, and explosive combustion, and their applications in various engineering contexts.

Aircraft Maintenance Engineering (ANT-030)

L T P: 3 0 0

Course Objectives :

The course should enable the students to learn:

- To introduce the knowledge of the maintenance and repair procedures followed for overhaul of aero engines.
- To impart the standards of FAA for documentation. They will explore the various systems and components of aircraft, including airframe, powerplant, avionics, and landing gear, and understand their maintenance, inspection, and repair procedures.
- Students will develop skills in troubleshooting and diagnosing aircraft issues, utilizing technical manuals, maintenance logs, and diagnostic tools to ensure airworthiness and compliance with aviation regulations.
- They will examine the importance of quality assurance and management in aircraft maintenance, including the implementation of maintenance programs, record-keeping, and adherence to safety protocols.
- Students will enhance their ability to communicate effectively within a team environment, preparing reports and presentations that detail maintenance activities, findings, and recommendations for improving aircraft reliability and performance.

Particulars

Unit 1: **(8 Hrs)**

NECESSITY & DEVELOPMENT OF MAINTENANCE PROGRAMS Definition of maintenance, role of the engineer, role of the mechanic, two types of maintenance, reliability, establishing a maintenance program. Goals and objectives of maintenance. Maintenance steering group(MSG) Approach, process – Oriented maintenance, task- oriented maintenance, current MSG process – MSG – 3, maintenance program documents.

Unit 2: **(8 Hrs)**

AVIATION CERTIFICATION REQUIREMENTS AND DOCUMENTATION FOR MAINTENANCE & ENGINEERING Aircraft certification, delivery inspection, operator certification, certification of personnel, aviation industry interaction; types of documentation. Manufacturer`s documentation, regulatory documentation. Airline generated documentation. ATA document standards. Objectives of a maintenance program, outline of aviation maintenance program, summary of FAA requirements, additional maintenance program requirements; organization of maintenance and engineering, organization structure, M&E organization chart, general groupings, managerial level functions-
technical services, aircraft maintence, overhaul shops, material.

Unit 3: **(8 Hrs)**

TECHNICAL SERVICES Engineering: makeup of engineering, mechanics and engineers, engineering department functions, engineering order preparation; production planning & control – forecasting, production planning, production control , Organization of PP&C; technical publications- functions of technical publications, airline libraries, control of publications,; Technical Training-organization, training for aviation maintenance, airframe manufacturer`s training courses,

Unit 4: **(8 Hrs)**

MAINTENANCE AND MATERIAL SUPPORT Line maintenance(on – aircraft), functions that control maintenance, MCC responsibilities, general line maintenance operations, aircraft logbook, ramp and terminal operations, maintenance crew requirement, morning meeting; Hangar Maintenance (on-aircraft)-organization of hangar maintenance, problem areas in hangar maintenance, maintenance support shops, ground support equipment, typical C – check: Shop data collection; Material support –organization and function of material. Material directorate, M&E support functions

Unit 5: **(8 Hrs)**

OVERSIGHT FUNCTIONS, ART & SCIENCE OF TROUBLE SHOOTING Quality Assurance , quality audits, ISO 9000 quality standard, technical records, Quality control- quality control organization, FAA and JAA QC inspector qualifications. Basic inspection policies,; Reliability – definition and types of reliability, elements of a reliability program, Maintenance safety – safety regulations, maintenance safety program, general safety rules, accident and injury reporting . Human factors in maintenance, Trouble shooting, knowledge of malfunctions, Basic concepts of trouble shooting.

Text Books:

1. Kinnison, H.A , Aviation Maintenance Manageent, Mc Graw – Hill – 2004.
2. Mc Kinley, J.L. Bent, R.D ., Maintenance and Repair of Aerospace Vehicles, Northrop Institute of Technology, Mc Graw Hill, 1967.

Reference Books:

1. Friend, C.H., Aircraft maintence Management . Longman, 1992.
2. Kroes, M., Watkins. W., and Delp. F. Aircraft Maintenance and Repair, Tata Mc Graw – Hill. 2010

Course Outcomes

CO1: Ability to maintain and repair the areo engines.
CO2: Ability to prepare aircraft maintenance manuals.
CO3: Ability to know the standards of quality, FAA
CO4: Students will gain a comprehensive understanding of aircraft systems, including airframe, powerplant, avionics, and electrical systems, essential for effective maintenance and troubleshooting.
CO5: Students will develop practical skills in performing inspections, repairs, and overhauls on various aircraft components, using industry-standard tools and techniques.

Heat Transfer (ANT-031)

L T P: 3 0 0

Course Objectives :

- To provide knowledge about application of conduction, convection and radiation heat transfer concepts to different practical applications
- Students will gain a comprehensive understanding of the fundamental principles of heat transfer, including conduction, convection, and radiation, and their applications in various engineering contexts.
- They will explore the mathematical formulations and physical laws governing heat transfer processes, enabling them to analyze and solve heat transfer problems in real-world scenarios.
- Students will develop skills in using analytical and numerical methods to model heat transfer phenomena, including the application of software tools for simulations and calculations.
- They will examine the role of heat exchangers, insulation, and thermal management systems in optimizing energy efficiency and performance in engineering applications.

Particulars

Unit 1: **(8 Hrs)**

Introduction: Modes and mechanisms of heat transfer – Basic laws of heat transfer –General discussion about applications of heat transfer. Conduction Heat Transfer: Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates – simplification and forms of the field equation – steady, unsteady, and periodic heat transfer – Initial and boundary conditions One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders, and spheres- Composite system- overall heat transfer coefficient- Electrical analogy -Critical radius insulation

Unit 2: **(8 Hrs)**

One Dimensional Steady State Conduction Heat Transfer: Variable Thermal conductivity – systems with heat sources or Heat generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature One Dimensional Transient Conduction Heat Transfer: Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi infinite body.

Unit 3: **(8 Hrs)**

Convective Heat Transfer: Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham P Theorem and method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations – Integral Method as approximate method -Application of Von Karman Integral Momentum Equation for flat plate with different velocity profiles. Forced convection: External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.

Unit 4: **(8 Hrs)**

Internal Flows: Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this –Use of empirical relations for Horizontal Pipe Flow and annulus flow. Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes. Heat Exchangers: Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

Unit 5: **(8 Hrs)**

Heat Transfer with Phase Change: Boiling: – Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling. Condensation: Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations. Radiation Heat Transfer: Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.

TEXT BOOKS:

1. Heat and Mass Transfer – Dixit /Mc Graw Hill
2. Heat and Mass Transfer / Altamush Siddiqui/ Cengage

REFERENCE BOOKS:

1. Essential Heat Transfer - Christopher A Long / Pearson
2. Heat Transfer –Ghoshdastidar / Oxford

Course Outcomes:

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

CO1: Understand the basic modes of heat transfer..
CO2: Compute one dimensional steady state heat transfer with and without heat generation.
CO3: Understand and analyze heat transfer through extended surfaces.
CO4: Understand one dimensional transient conduction heat transfer.
CO5: Understand concepts of continuity, momentum and energy equations.
CO6: Interpret and analyze forced and free convective heat transfer.

Cryogenics (ANT-032)

L T P: 3 1 0

Course Objectives :

The course should enable the students to learn:

- Understand the behavior of fluids at cryogenic temperatures and utilize the feature for cryogenic application in aerospace propulsion.
- Analyze the behavior of solids at cryogenic temperatures and develop systems used in hybrid rocket propulsion systems.
- Estimate thermodynamically gas liquefaction systems and elucidate the application of liquefied gas in aerospace propulsion.
- Create thermodynamically gas separation systems and experiment in a sustained environment for possible synthesis of rarefied gases for testing.
- They will explore the various methods of producing and maintaining cryogenic temperatures, including refrigeration cycles, cryogenic fluids, and insulation techniques.

Particulars

Unit 1: **(8 Hrs)**

Introduction to Cryogenics: Thermo physical and fluid dynamic properties of liquid and gas hydrogen, Thermo physical and fluid dynamic properties of liquid and gas helium, Liquefaction systems of hydrogen and helium gases, Liquefaction systems of hydrogen and helium gases, Refrigeration and liquefaction principals; Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison.

Unit 2: **(8 Hrs)**

Properties of Cryogenic Substance: Cryogenic fluids, Solids at cryogenic temperatures; Superconductivity, Recuperative – Linde – Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon; Regenerative – Stirling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas.

Unit 3: **(8 Hrs)**

Cryogenic Insulations: Vacuum insulation, Evacuated porous insulation, Gas filled Powders and fibrous materials. Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations.

Unit 4: **(8 Hrs)**

Storage and Instrumentation of Cryogenic Liquids: Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems, Measurement of strain, pressure, flow, liquid level and Temperature in cryogenic environment; Cryostats.

Unit 5: **(8 Hrs)**

Cryogenic Equipments: Cryogenic heat exchangers – recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization, Magneto-caloric refrigerator; 3He- 4He Dilution refrigerator; Cryopumping; Cryogenic Engineering applications in energy, aeronautics, space, industry, biology, preservation Application of Cryogenic Engineering in Transport.

TEXT BOOKS:

1. Flynn, T.M., Dekker, Marcel ―Cryogenic Engineering, Plenum Press, USA, 2009.
2. Timmerhaus, K.D, Flynn, T.M, ―Cryogenic Process Engineering, Plenum Press, USA, 2009.

REFERENCE BOOKS:

1. Bose A. and Sengupta P.―Cryogenics: Applications and Progress, Tata McGraw Hill, 2010.
2. Barron R., ―Cryogenic Systems, Oxford University Press, 2012.
3. Haselden, G.G., Cryogenic Fundamentals, Academic Press, 2012.

Course Outcomes:

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

CO1: Cryogenic propulsion system.
CO2: Students will gain a fundamental understanding of cryogenic principles, including the behavior of materials and fluids at extremely low temperatures, and the thermodynamic processes involved in cryogenic systems.
CO3: Students will develop skills in designing and operating cryogenic systems, including cryogenic storage, liquefaction processes, and insulation techniques to minimize heat transfer.
CO4: Students will apply their knowledge to real-world problems in cryogenics, preparing them for careers in industries such as aerospace, energy, and advanced manufacturing.
CO5: They will explore the challenges associated with cryogenic materials, including thermal contraction, brittleness, and the effects of low temperatures on material properties.

Aero Engine Design (ANT-033)

L T P: 3 1 0

Course Objectives:

The course should enable the students to learn:

- Perform parametric and performance analysis of aircraft engines to achieve engine performance requirements identified in constraint and mission analysis.
- Describe the fundamental thermodynamic and gas dynamic principles used in the parametric analysis and performance analysis of aero engines.
- Explain the fundamental design tools used for analysis and preliminary design of main burner and afterburner, fundamental design tools used for analysis and preliminary design of inlet and nozzle.
- Demonstrate, Analyze and choose appropriate materials used in rockets& missiles, mission and weight requirements.
- They will explore the various components of aero engines, such as compressors, combustion chambers, turbines, and nozzles, and understand their functions, design considerations, and performance characteristics

Particulars

Unit 1: **(8 Hrs)**

Fundamentals Of Engine Design: Engine design roadmap, preliminary propulsion design sequence, basic definitions, unit conversions, standard atmosphere, compressible flow equations, mission profile, performance requirements and constraints, desired capabilities.

Unit 2: **(8 Hrs)**

Constraint Analysis And Mission Analysis: Concept, design tools, preliminary estimates for constraint analysis, examples of constraint analysis, selection of preliminary design point, complete constraint boundary conditions, constant speed climb, horizontal acceleration, climb and acceleration, takeoff acceleration, constant altitude and speed cruise, constant altitude and speed turn, best subsonic cruise Mach number and altitude, liter, warm-up, takeoff rotation, constant energy height maneuver, general determination of takeoff weight, example and sample mission analysis

Unit 3: **(8 Hrs)**

Engine Selection: Parametric cycle analysis, station numbering, gas model, component efficiencies, engine performance analysis, computational inputs and outputs, finding plausible solutions. Parametric and performance behaviors, examples, integrated results, design choices, performance cycle analysis, component performance analysis, iterative solution scheme, component behavior.

Unit 4: **(8 Hrs)**

Engine Sizing: Subsonic inlets, supersonic inlets, nozzles, drag, sizing, constraints, selecting number of engines, final reprise, engine system design, engine static structure, starting, overall operation

Unit 5: **(8 Hrs)**

Engine Component Operation: Operation lines, fan and compressor aerodynamics, turbine aerodynamics, engine life, high pressure and low-pressure turbine design, combustion system components, combustion process, fuels, and ignition, afterburners, sample inlet and exhaust nozzle design.

TEXT BOOK:

1. Mattingly J.D., Heiser W.H., Pratt D.T., ―Aircraft Engine Design, AIAA ES, 2nd Edition, 2002.

REFERENCE BOOKS:

1. Mathur, M., and Sharma, R.P., ― Gas Turbines and Jet and Rocket Propulsion, Standard Publishers, New Delhi 1998
2. Cornelisse, J.W., ―Rocket Propulsion and Space Dynamics, J.W., Freeman & Co. Ltd., London, 1982
3. Parker, E.R., ―Materials for Missiles and Spacecraft, McGraw-Hill Book Co. Inc., 1982

Course Outcomes:

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

CO1: Engine design requirements and selection criteria.
CO2: Students will be able to integrate multidisciplinary design aspects, including materials selection and cooling techniques, to develop efficient and reliable aero engines.
CO3: They will gain proficiency in using computational tools to model and simulate aero engine behavior under various operating conditions.
CO4: Students will develop skills in applying aerodynamic and structural considerations to optimize engine components for performance and durability.
CO5: They will learn to analyze thermodynamic cycles and performance parameters critical to engine efficiency and thrust generation.

Heat Transfer in Space Applications (ANT-034)

L T P: 3 0 0

Course Objectives:

The course should enable the students to learn:

- Perform parametric and performance analysis of aircraft engines to achieve engine performance requirements identified in constraint and mission analysis.
- Describe the fundamental thermodynamic and gas dynamic principles used in the parametric analysis and performance analysis of aero engines.
- Explain the fundamental design tools used for analysis and preliminary design of main burner and afterburner, fundamental design tools used for analysis and preliminary design of inlet and nozzle.
- Demonstrate, Analyze and choose appropriate materials used in rockets& missiles, mission and weight requirements.
- Students will gain a comprehensive understanding of the principles of heat transfer as they apply to space environments, including conduction, convection, and radiation in the context of vacuum and microgravity conditions

Particulars

Unit 1: **(8 Hrs)**

Introduction Spacecraft Thermal Control: need of spacecraft thermal control – temperature specification – energy balance in a spacecraft – modes of heat transfer – factors that influence energy balance in a spacecraft – principles of spacecraft thermal control.

Unit 2: **(8 Hrs)**

Spacecraft Thermal Analysis: formulation of energy – momentum and continuity equations for problems in spacecraft heat transfer – development of discretized equation – treatment of ra- diative heat exchange (for non-participative media based on radiosity and Gebhart method) – incorporation of environmental heat flux in energy equation – numerical solution methods – input parameters required for analysis

Unit 3: **(8 Hrs)**

Spacecraft Thermal Environments: launch and ascent – earth bound orbits – interplanetary mission and reentry mission.

Unit 4: **(8 Hrs)**

Devices and Hardware for Spacecraft TCS (Principles & Operation): passive thermal control - mechanical joints – heat sinks and doublers – phase change materials – thermal louvers and switches – heat pipes – thermal coating materials – thermal insulation – ablative heat transfer – active thermal control techniques: electrical heaters, HPR fluid systems, space borne cooling systems.

Unit 5: **(8 Hrs)**

Design and Analysis of Spacecraft: application of principles described above for development of spacecraft TCS.

REFERENCE BOOKS:

1. Incropera, F. P. and DeWitt, D. P., Fundamentals of Heat and Mass Transfer, 7th ed., John Wiley (2011).
2. Chapra, S. C. and Canale, R. P., Numerical Methods for Engineers, 7th ed., McGraw-Hill (2014).
3. Pattan, B., Satellite Systems: Principles and Technologies, Chapman & Hall (1993).
4. Meyer, R. X., Elements of Space Technology, Academic Press (1999).
5. Gilmore, D. G. (Ed.), Spacecraft Thermal Control Handbook, Volume I: Fundamental Tech- nologies, 2nd ed., The Aerospace Press, AIAA (2002).

Course Outcomes:

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

CO1: Engine design requirements and selection criteria.
CO2: They will learn to design and analyze thermal management systems, including passive and active thermal control techniques, for spacecraft and satellite applications.
CO3: Students will develop skills in selecting appropriate materials and components to optimize thermal performance in extreme conditions.
CO4: They will gain experience in modeling and simulating thermal behavior using computational tools to predict system performance.
CO5: Students will apply their knowledge to solve real-world thermal challenges in space missions, preparing them for careers in aerospace engineering and related fields.

Project Stage - II (ANP-015)

Course Objectives

The course should enable the students:

- To allow students to demonstrate a wide range of the skills learned during their course of study
- To encourage multidisciplinary research through the integration learned in a number of courses.
- To allow students to develop problem solving, analysis, synthesis and evaluation skills.
- To encourage teamwork.
- To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation.

Course Outcomes

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

CO1: Demonstrate a sound technical knowledge of their selected project topic.
CO2: Undertake problem identification, formulation and solution.
CO3: Combine the theoretical and practical concepts studied in his / her academics.
CO4: Communicate with engineers and the community at large in written and oral forms.
CO5: Demonstrate the knowledge, skills and attitudes of a professional engineer.

Internship III/ Mini Project III (ANP-016)

Course Objectives

The course should enable the students to:

- Create an Industrial environment and culture within the institution.
- Identify the issues and challenges of an industry.
- Prepare report on the application of emerging technologies in the selected industry.
- Learn and understand the concept of entrepreneurship.
- Inculcate innovative thinking.

Course Outcomes:

On completion of the course, student will be able to–

CO1: Develop his abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project or Internship.

CO2: Understand the importance of document design by compiling Technical Report on the Mini Project or Internship work carried out.

CO3: Comment and evaluate other students research questions and internship proposals.

CO4: Students will reflect on their learning experiences, identifying areas for personal and professional growth, and preparing for future career opportunities in engineering.

CO5: They will improve their communication skills by preparing and presenting project reports, effectively conveying technical information to diverse audiences.

Disaster Management (AHT-017)

L T P: 3 0 0

Course Objectives

The course should enable the students to:

- Introduce themselves to various types of natural and manmade disasters.
- Understand causes and impact of disasters.
- Understand approaches of Disaster Management.
- Build skills to respond to disaster.
- They will explore the different types of disasters (natural, technological, and human-made) and their impacts on communities, infrastructure, and the environment, enabling them to assess risks and vulnerabilities effectively.

Particulars

Unit 1 **(8 Hrs)**

Introduction to Disasters Concepts, and definitions (Disaster, Hazard, Vulnerability, Resilience, Risks). Disaster Types, Trends, Causes, Consequences and Control of Disasters, Geological Disasters; Hydro-Meteorological, Biological, Technological and Manmade Disasters.

Unit 2 **(8 Hrs)**

Disasters: Classification, Causes, Impacts (Including social, economic, political, environmental, health, psychosocial, etc.) Differential impacts-in terms of caste, class, gender, age, location, disability. Global trends in disasters urban disasters, pandemics, complex emergencies, Climate change.

Unit 3 **(8 Hrs)**

Approaches to Disaster Risk Reduction: Disaster cycle- its analysis, Phases, Culture of safety, prevention, mitigation and preparedness, community based DRR, Structural- nonstructural measures, roles and responsibilities of community, Panchayati Raj Institutions/ Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders.

Unit 4 **(8 Hrs)**

Inter-relationship between Disasters & Development Factors affecting Vulnerabilities, differential impacts, Impact of Development projects such as dams, embankments, changes in Land-use etc. Climate Change Adaptation. Relevance of indigenous knowledge, appropriate technology and local resources

Unit 5 **(8 Hrs)**

Disaster Risk Management in India: Hazard and Vulnerability profile of India. Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, DM Act and Policy, Other related policies, plans, programmes and legislation)

Text/Reference Books:

1. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)
2. Damon, P. Copola, (2006) Introduction to International Disaster Management, Butterworth Heineman.
3. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.

4. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.

5. Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India LTD.

Course Outcomes

At the end of the course, Student will be able to:

CO1: Have an exposure to disasters, their significance and types.

CO2: Understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.

CO3: Understand approaches of Disaster Management.

CO4: Build skills within themselves to respond to disasters.

CO5: Students will apply their knowledge to real-world scenarios, enhancing their problem-solving abilities and preparing them for careers in emergency management, public safety, and related fields.

Innovations and Problem Solving (AHT-018)

L T P: 2 1 0

Prerequisite:
Basic Engineering Aptitude

Course Objectives:

- Develop critical thinking skills essential for effective problem identification and solution.
- Apply acquired knowledge to solve both technical and non-technical problems.
- Learn simple methods and practices crucial for system development and problem formulation.
- Gain exposure to modern engineering tools and state-of-the-art design and analysis techniques.
- Enhance the ability to extract relevant information and address real-world challenges through practical problem-solving approaches.

Particulars

Unit 1 **8 Hrs**
Introduction to Critical Design Thinking
• Understanding critical thinking, creative thinking, and problem solving through examples.
• New ways to solve problems.

Unit 2 **8 Hrs**
Theory of Inventive Problem Solving
• Examples of inventive problem solving
• Era of technical systems
• Science of inventing
• Art of inventing
• Amazing world of tasks.

Unit 3 **8 Hrs**
Logic and Tools for Creativity and Clarity of Thought
• TRIZ tools for creativity and solutions
• World's known solutions
• Fundamentals of Problem solving
• Thinking in Time and Scale
• Uncovering and solving contradictions
• Fast Thinking with ideal outcome.

Unit 4 **8 Hrs**
Modeling for Problem Solving
• Moving from problem to ideal final result
• Tradeoffs and inherent contradictions
• Invisible reserves
• Law of increasing ideality
• Evaluation of solutions
• Enriching models for problem solving.

Unit 5 **8 Hrs**

Principles for Innovation
• General review
• Segmentation, Separation
• Local quality, symmetry change, merging and multi functionality
• Nested doll and weight compensation
• Preliminary counteraction, preliminary action, and beforehand compensation
• Equipotentiality, the other way around and curvature increase
• Dynamic parts, partial or excessive actions, dimensionality change, mechanical vibration
• Periodic action, continuity of useful action, and hurrying
• Blessing in disguise, feedback, and intermediary
• Self service, copying, cheap disposables, and mechanical interaction substitution
• Pneumatics and hydraulics, flexible shells and thin films, and porous materials
• Optical property changes, homogeneous, and discarding and recovering
• Parameter changes, phase transitions, and thermal expansion
• Strong oxidants, inert atmosphere, and composite materials
• How to select most suitable principle out of 40 ways to create good solutions

References:

1- ABC-TRIZ Introduction to Creative Design Thinking with Modern TRIZ Modeling by Michael A. Orloff
2- TRIZ And Suddenly the Inventor Appeared TRIZ, the Theory of Inventive Problem Solving by Genrich Altshuller
3- TRIZ for Engineers Enabling Inventive Problem Solving by Karen Gadd
4- Simplified TRIZ New Problem Solving Applications for Engineers and Manufacturing Professionals by Rantanen K., Domb E.
5- Simplified TRIZ New Problem Solving Applications for Engineers and Manufacturing Professionals by Rantanen K., Domb E.

Course Outcomes:

The course will enable students to:
CO1: Identify the market and value proposition.
CO2: Carry out rigorous and accessible formulation to problems.
CO3: Solutions via reducing the search space.
CO4: Eliminating tradeoffs to reduce dimension of optimization problems.
CO5: Execution through developing strategies for experiment, construction and monetization.
CO6: Simulate the work environment of the modern engineer or knowledge worker in general.

B.Tech. (Aeronautical Engineering) SEMESTER-VIII												
Sl. No.	**Subject Codes**	**Category**	**Subject**	**Periods**			**Evaluation Scheme**					**Subject Total**	**Credit**
							Sessional Exam			**ESE**			
				L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1	AHT-XXX	HSC	HSMC-2 /HSMC-1	3	0	0	30	20	50	100		150	3
2	ANT-XXX	DE	Departmental Elective-6	3	0	0	30	20	50	100		150	3
3		OE*	Open Elective-3	3	0	0	30	20	50	100		150	3
4		OE*	Open Elective-4	3	0	0	30	20	50	100		150	3
5	ANP-016	DLC	Project Stage -III	0	0	12			100		200	300	6
6	GP-08	NC	General Proficiency						50				
			Total	**12**	**0**	**14**						**900**	**18**
7	Minor Course (Optional)			3	1	0	30	20	50	50		150	4

*Aeronautical student shall opt open electives offered by other departments

	Departmental Elective - 6
ANT-035	Precision Engineering
ANT-036	Practical Non-Destructive Testing
ANT-037	CAD/CIM
ANT-038	Airframe Structural Design

HSMC-1
Rural Development: Administration and Planning (AHT-015)

L T P: 3 0 0

Course Objectives

This course enables the students to:

- Gain knowledge on the concepts related to administration, its importance and various approaches of Development Administration.
- Gain skills on New Public Management, Public Grievances and redressal Mechanisms,
- Accountability and Transparency in Administration and e-governance in the rural development sector.
- Develop their competency on the role of Bureaucracy in Rural Development.
- Evaluate rural development programs and policies to identify challenges and propose effective solutions.
- Develop practical skills in planning, implementation, and monitoring of rural development initiatives.

Particulars

Unit 1 **(8 Hrs)**

Rural Planning & Development: Concepts of Rural Development, Basic elements of rural Development, and Importance of Rural Development for creation of Sustainable Livelihoods, An overview of Policies and Programmes for Rural Development- Programmes in the agricultural sector, Programmes in the Social Security, Programmes in area of Social Sector.

Unit 2 **(8 Hrs)**

Rural Development Programmes: Sriniketan experiment, Gurgaon experiment, Marthandam experiment, Baroda experiment, Firkha development scheme, Etawapilot project, Nilokheri experiment, approaches to rural community development: Tagore, Gandhi etc.

Unit 3 **(8 Hrs)**

Panchayati Raj & Rural Administration: Administrative Structure: bureaucracy, structure of administration; Panchayati Raj Institutions Emergence and Growth of Panchayati Raj Institutions in India; People and Panchayati Raj; Financial Organizations in Panchayati Raj Institutions, Structure of rural finance, Government & Non-Government Organizations / Community Based Organizations, Concept of Self help group.

Unit 4 **(8 Hrs)**

Human Resource Development in Rural Sector: Need for Human Resource Development, Elements of Human Resource Development in Rural Sector Dimensions of HRD for rural development-Health, Education, Energy, Skill Development, Training, Nutritional Status access to basic amenities – Population composition.

Unit 5 **(8 Hrs)**

Rural Industrialization and Entrepreneurship: Concept of Rural Industrialization, Gandhian approach to Rural Industrialization, Appropriate Technology for Rural Industries, Entrepreneurship and Rural Industrialization- Problems and diagnosis of Rural Entrepreneurship in India, with special reference to Women Entrepreneurship; Development of Small Entrepreneurs in India, need for and scope of entrepreneurship in Rural area.

Text Books/References:

1. Corporate Social Responsibility: An Ethical Approach - Mark S. Schwartz.
2. Katar Singh: Rural Development in India – Theory History and Policy.
3. Todaro M.P. Economic Development in III World war.
4. Arora R.C – Integrated Rural Development in India.
5. Dhandekar V.M and Rath N poverty in India.
6. A.N.Agarwal and Kundana Lal: Rural Economy of India.
7. B.K.Prasad: Rural Development-Sarup& Son's Publications.

Course Outcomes

After completion of the course student will be able to:

CO1: Understand the definitions, concepts and components of Rural Development.
CO2: Students will know the importance, structure, significance, resources of Indian rural economy.
CO3: Students will have a clear idea about the area development programmes and its impact.
CO4: Students will be able to acquire knowledge about rural entrepreneurship.
CO5: Students will be able to understand about the using of different methods for human resource planning.

HSMC-2
Project Management & Entrepreneurship (AHT-016)

L T P: 3 0 0

Course Objectives

The course should enable the students to:

- Understand the concepts of Project Management for planning to execution of projects.
- Understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
- Be capable to analyze, apply and appreciate contemporary project management tools and methodologies in Indian context.
- Understand the concepts of Entrepreneurship, role of entrepreneur in economic development, steps for establishing an enterprise.
- Encourage innovation and risk-taking through the study of successful entrepreneurial practices and case studies.

Particulars

Unit 1 **(8 Hrs)**

Entrepreneurship: Entrepreneurship: need, scope , Entrepreneurial competencies & traits, Factors affecting entrepreneurial development, Entrepreneurial motivation (Mc Clellend's Achievement motivation theory), conceptual model of entrepreneurship , entrepreneur vs. intrapreneur; Classification of entrepreneurs; Entrepreneurial Development Programmes.

Unit 2 **(8 Hrs)**

Entrepreneurial Idea and Innovation: Introduction to Innovation, Entrepreneurial Idea Generation and Identifying Business Opportunities, Management skills for Entrepreneurs and managing for Value Creation, Creating and Sustaining Enterprising Model & Organizational Effectiveness.

Unit 3 **(8 Hrs)**

Project Management: Project management: meaning, scope & importance, role of project manager; project life-cycle Project appraisal: Preparation of a real time project feasibility report containing Technical appraisal, Environmental appraisal, Market appraisal (including market survey for forecasting future demand and sales) and Managerial appraisal.

Unit 4 **(8 Hrs)**

Project Financing: Project cost estimation & working capital requirements, sources of funds, capital budgeting, Risk & uncertainty in project evaluation , preparation of projected financial statements viz. Projected balance sheet, projected income statement, projected funds & cash flow statements, Preparation of detailed project report, Project finance.

Unit 5 **(8 Hrs)**

Social Entrepreneurship: Social Sector Perspectives and Social Entrepreneurship, Social Entrepreneurship Opportunities and Successful Models, Social Innovations and Sustainability, Marketing Management for Social Ventures, Risk Management in Social Enterprises, Legal Framework for Social Ventures. Case study and presentations: Case study of successful and failed entrepreneurs. Power point presentation on current business opportunities.

Text Books

1. Innovation and Entrepreneurship by Drucker, P.F.; Harperand Row.
2. Business, Entrepreneurship and Management: Rao, V.S.P.;Vikas
3. Entrepreneurship: Roy Rajeev.
4. Text Book of Project Management: Gopal Krishnan ,P.and Ramamoorthy,V.E.; McMill.
5. Project Management for Engineering, Business and Technology: Nicholas, J.M., and Steyn, H.; PHI.
6. Project Management: The Managerial Process: Gray, C.F., Larson, E.W. and Desai, G.V.; MGH.

Course Outcomes

After completion of the course student will be able to:

CO1: Understand project characteristics and various stages of a project.

CO2: Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.

CO3: Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.

CO4: Describe Entrepreneurship, Examine role of entrepreneur in economic development.

CO5: Apply project management principles to plan, execute, and monitor engineering and business projects effectively.

Precision Engineering (ANT-035)

L T P: 3 0 0

Course Objectives :

The course should enable the students to learn:

- Understand the BIS code fits and tolerances for geometrical dimensioning and tolerance (GD & T).
- Understand the principal application of different measuring instruments.
- Summarize the application of latest manufacturing techniques (nano).
- Understand the principles and significance of precision engineering in modern manufacturing and high-performance systems.
- Study advanced manufacturing techniques and metrology tools used for achieving high accuracy and tight tolerances.

Particulars

Unit 1: **(8 Hrs)**

Accuracy and Alignment Tests: Accuracy and alignment tests: General concept of accuracy, spindle rotation accuracy, test methods, displacement accuracy, dimensional wear of cutting tools, accuracy of NC systems, clamping errors, setting errors, location of rectangular prism, cylinder, basic type of tests, measuring instruments used for testing machine tools, alignment tests, straightness, flatness, parallelism, squareness, circularity, cylindricity.

Unit 2: **(8 Hrs)**

Influence of Static Stiffness, Thermal Effects: Influence of static stiffness, thermal effects: Static stiffness, nature of deformation in a machine tool, overall stiffness of a lathe, compliance of work piece, errors due to the variation of the cutting force and total compliance, accuracies due to thermal effects, methods of decreasing thermal effects-Influence of vibration on accuracy.

Unit 3: **(8 Hrs)**

Precision Machining: Top down and bottom up approach, development of nanotechnology, precision and micromachining, diamond turning of parts to nanometer accuracy. Stereo microlithography, machining of micro-sized components, mirror grinding of ceramics, ultra-precision block gauges.

Unit 4: **(8 Hrs)**

Nano Measuring Systems: In-process measurement of position of processing point, post process and online measurement of dimensional features, mechanical measuring systems, optical measuring systems, electron beam measuring systems, pattern recognition and inspection systems.

Unit 5: **(8 Hrs)**

Lithography: Nano Lithography, photolithography, nano lithography, photolithography, electron beam lithography, ion beam lithography, optical lithography, LIGA process, dip pen lithography, deep UV.

TEXT BOOKS:

1. Murthy R. L, ―Precision Engineering in Manufacturing, New Age International, New Delhi, 2005.
2. Norio Taniguchi, ―Nanotechnology, Oxford university press, Cambridge, 1996.

REFERENCE BOOKS:

1. Lee Tong Hong, ―Precision Motion control, Design and Implementation, Springer Verlag, UK, 2001.
2. Liangchi Zhang, ―Precision Machining of Advanced Materials, Trans Tech Publications Ltd., Switzerland, 2001.
3. Hiromu Nakazawa, ―Principles of precision engineering, Oxford university press, 1994.

Course Outcomes:

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

CO1: Tolerance and accuracy.
CO2: Nano measurements techniques.
CO3: Assess the role of precision engineering in high-tech industries such as aerospace, electronics, and medical devices.
CO4: Utilize modern tools and technologies in the fabrication, assembly, and testing of precision-engineered products.
CO5: Design and manufacture precision components using advanced materials, machining techniques, and equipment

Practical Non-Destructive Testing (ANT-036)

L T P: 2 1 0

Course Objectives:

The course should enable the students to:

- Understanding the basic principles of various non-destructive testing methods, fundamentals, discontinuities in different product forms.
- Differentiate various defect types and select the appropriate non-destructive testing methods for better evaluation of the specimen.
- Implement and document a written procedure paving the way for further training in specific techniques of nondestructive inspection of the experimental subject.
- Recognize the principles and operational techniques of the radiographic testing followed by its interpretation and evaluation.
- Analyze and evaluate flaws and discontinuities in materials without causing damage to the components.

Particulars

Unit 1 **(8 Hrs)**

Overview of Non-Destructive Testing: NDT versus mechanical testing, overview of the non- destructive testing methods for the detection of manufacturing defects as well as material characterization; Relative merits and limitations, various physical characteristics of materials and their applications in NDT, visual inspection, v unaided and aided.

Unit 2 **(8 Hrs)**

Surface Non-Destructive Examination Methods: Liquid Penetrant Testing: Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results; Magnetic particle testing: Theory of magnetism, inspection materials magnetisation methods, interpretation and evaluation of test indications, principles and methods of demagnetization, residual magnetism.

Unit 3 **(8 Hrs)**

Thermography and Eddy Current Testing (ET): Thermography: Principles, contact and non-contact inspection methods, Techniques for applying liquid crystals. Advantages and limitation, infrared radiation and infrared detectors, instrumentations and methods, applications; Eddy Current Testing: Generation of eddy currents, properties of eddy currents, Eddy current sensing elements, probes, instrumentation, types of arrangement, applications, advantages, limitations, interpretation/evaluation.

Unit 4 **(8 Hrs)**

Ultrasonic Testing (UT) and Acoustic Emission (AE): Ultrasonic Testing: Principle, transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A-scan, B-scan, C-scan; Phased array ultrasound, time of flight diffraction; Acoustic emission technique, V principle, AE parameters, applications.scription.

Unit 5 **(8 Hrs)**

Experimental Methods: Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, inverse square, law, characteristics of films, graininess, density, speed, contrast, characteristic curves, pentameters, exposure charts, radiographic equivalence. Fluoroscopy; Xerox; Radiography, computed radiography, computed tomography.

TEXT BOOKS:

1. Baldev Raj, T. Jayakumar, M. Thavasimuthu ―Practical Non-Destructive Testing, Narosa Publishing House, 2009.
2. Ravi Prakash, ―Non-Destructive Testing Techniques, 1st revised edition, New Age International Publishers, 2010.

REFERENCE BOOKS:

1. Paul E Mix, ―Introduction to Non-destructive testing: a training guide, Wiley, 2nd Edition New Jersey, 2005.
2. Charles, J. Hellier, ―Handbook of Non-destructive evaluation, McGraw Hill, New York 2001.

Course Outcomes

At the end of this course, the students will be:

CO1: Tolerance and accuracy.
CO2: Nano measurements techniques.
CO3: Apply NDT techniques to real-world scenarios, ensuring quality control and compliance with safety and regulatory standards in manufacturing and maintenance.
CO4: Understand industry standards and safety protocols in conducting NDT inspections for different engineering applications.
CO5: Select appropriate NDT techniques based on material type, component geometry, and defect detection requirements.

CAD/CIM (ANT-037)

L T P: 3 0 0

Course Objectives:

The course should enable the students for:

- Understand the basics of computer aided designing, computer aided manufacturing and computer integrated manufacturing.
- To study about group technology, computer aided process planning, material requirement planning (MRP) Enterprise resource planning (ERP).
- Gain knowledge about shop floor control and Flexible manufacturing systems (F.M.S).
- Emphasizes the integration of manufacturing enterprise using computer integrated manufacturing (CIM) technologies.
- Understand the principles and applications of CAD and CIM in modern manufacturing and product development.

Particulars

Unit 1 **(8 Hrs)**

Introduction: Computers in industrial manufacturing, product cycle, CAD/CAM hardware, basic structure, CPU, memory types, input devices, display devices, hard copy devices, and storage devices, computer graphics, raster scan graphics coordinate system, database structure for graphics modelling, transformation of geometry, three dimensional transformations, mathematics of projections, clipping, hidden surface removal.

Unit 2 **(8 Hrs)**

Geometric Modelling: Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, modelling facilities desired, drafting and modelling systems, basic geometric commands, layers, display control commands, editing, dimensioning and solid modelling.

Unit 3 **(8 Hrs)**

Group Technology Computer Aided Process Planning: History of group technology, role of G.T in CAD/CAM integration, part families, classification and coding, DCLASS and MCLASS and OPTIZ coding systems, facility design using G.T, benefits of G.T, cellular manufacturing. Process planning, role of process planning in CAD/CAM integration, approaches to computer aided process planning, variant approach and generative approaches, CAPP and CMPP systems.

Unit 4 **(8 Hrs)**

Computer Aided Planning and Control, Shop Floor Control And Introduction To FMS: Production planning and control, cost planning and control, inventory management, material requirements planning (ERP), control, phases, factory data collection system, automatic identification methods, bar code technology, automated data collection system; FMS, components of FMS, types, FMS workstation, material handling and storage system, FMS layout, computer control systems, applications and benefits.

Unit 5 **(8 Hrs)**

COMPUTER AIDED PLANNING AND CONTROL AND COMPUTER MONITORING Production planning and control, cost planning and control, inventory management, material requirements planning (MRP), shop floor control, lean and agile manufacturing, types of production monitoring systems, structure model of manufacturing, process control and strategies, direct digital control.

TEXT BOOKS:

1. Zimmers, P. Groover, ―CAD/ CAM, Prentice- Hall India, 2008.
2. Zeid, Ibrahim, ―CAD / CAM Theory and Practice, Tata McGraw-Hill, 1997.
3. Mikell. P. Groover ―Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education 2001.
4. Ranky, Paul G., ―Computer Integrated Manufacturing, Prentice hall of India Pvt. Ltd., 2005
5. Yorem Koren, ―Computer Integrated Manufacturing, McGraw Hill, 2005.

REFERENCE BOOKS:

1. P. Groover, Automation, ―Production Systems & Computer Integrated Manufacturing, Pearson Education. 2nd Edition 1989.
2. Lalit Narayan, ―Computer Aided Design and Manufacturing, Prentice-Hall India. 3rd Edition 2002.
3. Radhakrishnan, Subramanian, ―CAD / CAM / CIM, New Age.4th Edition 2016.
4. Jami J Shah, Martti Mantyla, ―Parametric and Feature-Based CAD/CAM: Concepts, Techniques, and Applications, John Wiley & Sons Inc, 1995.
5. Alavala, ―CAD/ CAM: Concepts and Applications, PHI Publications, 4th Edition, 2016.
6. W. S. Seames, ―Computer Numerical Control Concepts and Programming, 4th Edition 1999.

Course Outcomes:

At the end of this course, the students:

CO1: Industry need and manufacturing process.
CO2: Demonstrate understanding of CIM systems and their role in automated manufacturing.
CO3: Integrate CAD with CAM and CNC technologies for efficient product development and machining.
CO4: Analyze and simulate manufacturing processes using computer-integrated tools.
CO5: Work with industrial automation systems to improve productivity, quality, and operational efficiency.

Airframe Structural Design (ANT-038)

L T P: 3 0 0

Course Objectives:

The course should enable the students to learn:

- To know about detailed structural components present in aircraft.
- To acquire the knowledge about the design parameters how why and where they will be used in manufacturing.
- Students can acquire the knowledge about the loading conditions done on the structure.
- Study the design criteria and safety regulations governing aircraft structural components.
- Analyze structural elements such as fuselage, wings, and landing gear using analytical and computational methods.

Particulars

Unit 1: **(8 Hrs)**

INTRODUCTION
Principal structural components of aircraft. Design requirements- structural integrity, stiffness, service life. Baseline aerodynamic configuration, external loading, weight, operating conditions, conformity to government regulations. Design procedure- structural lay out, structural modeling, design criteria, load estimation, stress analysis, choice of materials, sizing- estimation of strength, stiffness, mass . optimization, trade-off. Structural index- use in design. Idealization of structures, materials- constitutive relations- equilibrium, compatibility conditions significance. Sizing of structural elements of given geometry and loading Analysis of box beams- single cell, multi cell- in bending, shear, torsion- normal stresses, shear flow, deformation- restraint against warping, secondary stresses.

Unit 2: **(8 Hrs)**

FASTENERS AND STRUCTURAL JOINTS Fasteners and fittings- role, significance, general design considerations, criteria for allowable strength. Margine of safety. Fastener systems, types, fastener information, dimensions, materials, allowable strength- tensile, shear, bending. Rivets, bolts and screws, nuts-detail design consideration. Fastener selection. fittings- lugs, bushings and bearings-loading design and analysis. Joints – splices, eccentric, gusset, welded, brazed, bonded- types, methods of joining, failure modes. Fatigue design considerations. Stress concentration- causes, methods of reduction. Fastener load distribution and by pass load-severity factor, structural joint life prediction. Shim control and requirement

Unit 3: **(8 Hrs)**

DESIGN OF WING AND TAIL STRUCTURES The wing- role- summary of wing loads, structural components- wing box, leading and trailing edges. Wing layout- location of spars, ailerons and flaps, rib spacing and direction, root rib bulkhead, span wise stiffeners, wing covers- skin-stringer panels, integrally stiffened panels, access holes, attachment of leading edge and trailing edge panels Spars- general rules of spar design. Ribs and bulkheads- rib spacing and arrangement .Wing root joints, carry through structure. Fighter wing design- problems with swept wings Wing box- loads, stress .Wing box,root bulkhead- estimation of loads, stress analysis, design parameters, optimization, sizing, margin of safety.. Leading and

trailing edge assembly- control surfaces, flaps- structure. Tail unit- horizontal, vertical tail, elevator, rudder- configuration, structural layout, design considerations.

Unit 4: **(8 Hrs)**

DESIGN OF FUSELAGE AND LANDING GEAR Function of fuselage- loading, general requirements. Ultimate strength of stiffened cylindrical structure. Principal structural components –skin and stringers, frame and floor beam, pressure bulkheads, wing & fuselage intersection- layout, stress analysis, sizing. Forward fuselage, aft, fuselage structures, fuselage openings- windows, doors- design considerations. Landing gear- purpose, types, general arrangement, loads- design considerations- ground handling, take-off, landing, braking, pavement loading, support structure. stowage and retraction, gear lock- kinematic design Shock absorbers- function, types, components, operation, loads, materials, design. Wheels and brakes, tire selection.

Unit 5: **(8 Hrs)**

FATIGUE LIFE, DAMAGE TOLERANCE, FAIL SAFE- SAFE DESIGN-WEIGHT CONTROL AND BALANCE Catastrophic effects of fatigue failure- examples- modes of failure- design criteria- fatigue stress, fatigue performance, fatigue life. Fatigue design philosophy- fail-safe, safe life. Service behaviour of aircraft structures- effect of physical and load environment design and of detail of fabrication Structural life- methods of estimation- the scatter factor- significanceFail-safe design- the concept, requirements, damage tolerance- estimation of fatigue strength.

Text Books:

1. NIU.M.C. Airframe Structural Design, second edition, Hongkong Conmlit Press, 1988, ISBN: 962-7128-09-0
2. NIU.M.C. Airframe Stress Analysis And Sizing, second edition, Hongkong Conmlit Press, 1987, ISBN: 962-7128-08-2

Course Outcomes:

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

CO1: Students will be acquainted with design criteria of aircraft component.
CO2: Students will be acquainted with manufacturing procedure from the design criteria.
CO3: Students will easily design their own components based on the design criteria they have learned.
CO4: Design structural elements of the airframe considering weight, strength, and safety requirements.
CO5: Use industry-relevant software tools for modeling and analysis of airframe structures.

Project Stage - III (ANP-016)

Course Objectives

The course should enable the students:

- To allow students to demonstrate a wide range of the skills learned during their course of study
- To encourage multidisciplinary research through the integration learned in a number of courses.
- To allow students to develop problem solving, analysis, synthesis and evaluation skills.
- To encourage teamwork.
- To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation

Course Outcomes

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

CO1: Demonstrate a sound technical knowledge of their selected project topic.
CO2: Undertake problem identification, formulation and solution.
CO3: Combine the theoretical and practical concepts studied in his / her academics.
CO4: Communicate with engineers and the community at large in written and oral forms.
CO5: Demonstrate the knowledge, skills and attitudes of a professional engineer.

INTRODUCTION TO AVIATION AND AEROSPACE TECHNOLOGY

COURSE OBJECTIVES:

1. To introduce students to the fundamental concepts of aviation and aerospace technology
2. To provide an overview of aircraft types, components, and systems
3. To familiarize students with basic aerodynamic principles
4. To explore the evolution of aviation and future trends
5. To create awareness about career opportunities in the aviation industry

SYLLABUS:

UNIT I: FUNDAMENTALS OF FLIGHT

History and evolution of aviation - from early attempts to modern aircraft, Classification of aircraft - fixed-wing, rotary-wing, lighter-than-air, Basic components of an aircraft - fuselage, wings, empennage, landing gear, Introduction to physics of flight - forces acting on an aircraft, Basic aerodynamic concepts - airfoils, lift, drag, thrust, and weight

UNIT II: AIRCRAFT SYSTEMS OVERVIEW

Flight control systems - primary and secondary controls, Aircraft propulsion systems - piston engines, jet engines, rockets, Aircraft instruments and avionics - navigation and communication, Environmental control systems - pressurization and air conditioning, Electrical and hydraulic systems in aircraft

UNIT III: AIRPORTS AND AIR TRAFFIC MANAGEMENT

Airport layout and infrastructure - runways, taxiways, terminals, Air traffic control systems and procedures, Navigation aids and communication systems, Flight planning and operations, Aviation regulations and safety standards

UNIT IV: SPACE TECHNOLOGY FUNDAMENTALS

Introduction to space and orbital mechanics, Types of spacecraft and launch vehicles, Satellite technology and applications, Space missions and exploration, International space programs and collaborations

UNIT V: CONTEMPORARY ISSUES AND FUTURE TRENDS

Sustainable aviation and green technologies, Unmanned aerial vehicles (UAVs) and drone technology, Advanced air mobility and urban air transportation, Digital transformation in aviation, Emerging careers and opportunities in aviation and aerospace

COURSE OUTCOMES:

After completion of the course student will be able to:

CO1: Explain the basic principles of flight and aircraft systems.

CO2: Identify different types of aircraft and their components.

CO3: Understand the fundamentals of airport operations and air traffic management.

CO4: Recognize the basic concepts of space technology and its applications.

CO5: Analyze current trends and future developments in aviation and aerospace.

REFERENCES:

TEXT BOOKS:

1. Anderson, J.D., "Introduction to Flight," McGraw-Hill Education, 8th Edition, 2016
2. Barnard, R.H. and Philpott, D.R., "Aircraft Flight," Pearson Education, 4th Edition, 2010
3. Sadraey, M.H., "Aircraft Design: A Systems Engineering Approach," Wiley, 2nd Edition, 2017

REFERENCE BOOKS:

1. Moir, I. and Seabridge, A., "Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration," Wiley, 3rd Edition, 2008
2. Wells, A.T. and Young, S.B., "Airport Planning & Management," McGraw-Hill Education, 6th Edition, 2011
3. Sutton, G.P. and Biblarz, O., "Rocket Propulsion Elements," Wiley, 9th Edition, 2016

DRONE TECHNOLOGY AND APPLICATIONS

COURSE OBJECTIVES:

1. To introduce students to unmanned aerial vehicles (UAVs) and their classifications
2. To provide an understanding of drone components, control systems, and operations
3. To explore various applications of drone technology across different industries
4. To familiarize students with regulations governing drone operations
5. To develop awareness of emerging trends in drone technology

SYLLABUS:

UNIT I: INTRODUCTION TO UNMANNED AERIAL VEHICLES

History and evolution of drone technology, Classification of UAVs - fixed-wing, multi-rotor, hybrid, designs, Components of a drone - frame, motors, propellers, power systems, Control systems and flight dynamics, Communication systems and data links

UNIT II: DRONE DESIGN AND OPERATION

Basic aerodynamics for drone flight, Power systems and propulsion - batteries, motors, ESCs, Flight controllers and stabilization systems, Navigation systems - GPS, IMU, sensors, Mission planning and autonomous operations

UNIT III: SENSORS AND PAYLOAD SYSTEMS

Camera systems and imaging technology, LiDAR and other remote sensing technologies, Thermal and multispectral imaging, Payload integration and management, Data acquisition and processing

UNIT IV: APPLICATIONS OF DRONE TECHNOLOGY

Aerial photography and videography, Precision agriculture and crop monitoring, Surveying, mapping, and geospatial applications, Infrastructure inspection and monitoring, Search and rescue, disaster management, and emergency response

UNIT V: REGULATIONS AND FUTURE TRENDS

National and international drone regulations, Airspace management and UTM (Unmanned Traffic Management), Privacy, security, and ethical considerations, Emerging technologies - AI, swarm intelligence, delivery drones, Future applications and career opportunities

COURSE OUTCOMES:

After completion of the course student will be able to:

CO1: Identify different types of drones and their components.

CO2: Understand the principles of drone flight and operation.

CO3: Recognize various sensors and payloads used in drone applications.

CO4: Analyze potential applications of drone technology across industries.

CO5: Evaluate regulatory frameworks and emerging trends in drone technology.

REFERENCES:

TEXT BOOKS:

1. Fahlstrom, P.G. and Gleason, T.J., "Introduction to UAV Systems," Wiley, 4th Edition, 2012
2. Valavanis, K.P. and Vachtsevanos, G.J., "Handbook of Unmanned Aerial Vehicles," Springer, 1st Edition, 2015
3. Nonami, K., et al., "Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Aerial Vehicles," Springer, 2010

REFERENCE BOOKS:

1. Austin, R., "Unmanned Aircraft Systems: UAVs Design, Development and Deployment," Wiley, 2010
2. Tziavou, O., Pytharouli, S., and Souter, J., "Unmanned Aerial Vehicles in Civilian Logistics and Supply Chain Management," IGI Global, 2019
3. Canis, B., "Unmanned Aircraft Systems (UAS): Commercial Outlook for a New Industry," Congressional Research Service, 2015

AIRCRAFT DESIGN APPRECIATION

COURSE OBJECTIVES:

1. To introduce students to the fundamentals of aircraft design philosophy
2. To develop an understanding of aerodynamic principles and their application in design
3. To explore the relationship between form and function in aircraft design
4. To familiarize students with various aircraft configurations and their purposes
5. To create awareness about aesthetics and innovation in aviation design

SYLLABUS:

UNIT I: FUNDAMENTALS OF AIRCRAFT DESIGN

Evolution of aircraft design - historical perspective, Aircraft design process - conceptual, preliminary, and detailed design, Requirements and specifications - mission profiles, Design constraints and trade-offs, Introduction to design tools and methodologies

UNIT II: AERODYNAMICS AND CONFIGURATION

Basic aerodynamic principles affecting design, Wing design - planform, airfoils, high-lift devices, Fuselage design considerations, Tail configurations and control surfaces, Engine integration and placement.

UNIT III: AIRCRAFT CONFIGURATIONS

Conventional configurations - tube and wing design, Canard configurations, Flying wing and blended wing-body designs, Unconventional and experimental configurations, Vertical/Short Take-Off and Landing (V/STOL) aircraft designs

UNIT IV: DESIGN FOR PERFORMANCE AND EFFICIENCY

Performance parameters and their influence on design, Weight and balance considerations, Aerodynamic efficiency and drag reduction, Structural efficiency and materials selection, Propulsion efficiency and integration

UNIT V: CONTEMPORARY AND FUTURE AIRCRAFT DESIGN

Commercial aircraft design trends, Business and general aviation design considerations, Sustainable and green aviation design concepts, Biomimicry and nature-inspired designs, Future aircraft concepts and innovations

COURSE OUTCOMES:

After completion of the course student will be able to:

CO1: Recognize the fundamental principles that govern aircraft design.

CO2: Identify different aircraft configurations and their design rationales.

CO3: Understand the relationship between form, function, and performance.

CO4: Analyze design trade-offs and their impact on aircraft capabilities.

CO5: Appreciate aesthetic and innovative aspects of aircraft design.

REFERENCES:

TEXT BOOKS:

1. Raymer, D.P., "Aircraft Design: A Conceptual Approach," AIAA Education Series, 6th Edition, 2018
2. Roskam, J., "Airplane Design," DARcorporation, 2nd Edition, 2003
3. Torenbeek, E., "Synthesis of Subsonic Airplane Design," Delft University Press, 1982

REFERENCE BOOKS:

1. Jenkinson, L.R., et al., "Civil Jet Aircraft Design," AIAA Education Series, 1999
2. Stinton, D., "The Design of the Aeroplane," Blackwell Science, 2nd Edition, 2001
3. Nicolai, L.M. and Carichner, G.E., "Fundamentals of Aircraft and Airship Design," AIAA Education Series, 2010

FUNDAMENTALS OF AIRCRAFT PROPULSION

COURSE OBJECTIVES:

1. To introduce students to various aircraft propulsion systems
2. To provide an understanding of the basic principles of jet engines
3. To familiarize students with propeller-based propulsion systems
4. To explore performance characteristics of different propulsion systems
5. To create awareness about emerging propulsion technologies

SYLLABUS:

UNIT I: INTRODUCTION TO AIRCRAFT PROPULSION

Historical development of aircraft propulsion, Classification of propulsion systems, Fundamentals of thrust generation, Basic thermodynamic principles for propulsion, Performance metrics and parameters

UNIT II: PISTON ENGINE AND PROPELLER SYSTEMS

Operating principles of aircraft piston engines, Propeller theory and performance, Propeller design considerations, Engine-propeller matching, Applications and limitations of piston-propeller systems

UNIT III: GAS TURBINE ENGINES

Operating principles of gas turbine engines, Components of jet engines - inlets, compressors, combustors, turbines, nozzles, Types of jet engines - turbojet, turbofan, turboprop, turboshaft, Engine performance parameters, Engine selection criteria for different aircraft

UNIT IV: ROCKET PROPULSION FUNDAMENTALS

Principles of rocket propulsion, Solid propellant rockets, Liquid propellant rockets, Hybrid propulsion systems, Applications in aviation and space

UNIT V: ADVANCED AND FUTURE PROPULSION CONCEPTS

Electric and hybrid-electric propulsion, Distributed propulsion systems, Hypersonic propulsion technologies, Sustainable aviation fuels and propulsion, Emerging technologies and future trends

COURSE OUTCOMES:

After completion of the course student will be able to:

CO1: Explain the basic principles of different aircraft propulsion systems.

CO2: Identify various engine types and their components.

CO3: Understand performance characteristics of propulsion systems.

CO4: Analyze the suitability of propulsion systems for different applications.

CO5: Recognize emerging trends in aircraft propulsion technology.

REFERENCES:

TEXT BOOKS:

1. Mattingly, J.D., et al., "Aircraft Engine Design," AIAA Education Series, 3rd Edition, 2018
2. Cumpsty, N. and Heyes, A., "Jet Propulsion," Cambridge University Press, 3rd Edition, 2015

3. Hill, P. and Peterson, C., "Mechanics and Thermodynamics of Propulsion," Addison-Wesley, 2nd Edition, 1992

REFERENCE BOOKS:

1. Rolls-Royce, "The Jet Engine," Wiley, 5th Edition, 2015
2. El-Sayed, A.F., "Aircraft Propulsion and Gas Turbine Engines," CRC Press, 2nd Edition, 2017
3. Walsh, P.P. and Fletcher, P., "Gas Turbine Performance," Blackwell Science, 2nd Edition, 2004

INTRODUCTION TO SATELLITES AND SPACE SYSTEMS

COURSE OBJECTIVES:

1. To introduce students to the fundamentals of satellite technology
2. To provide an understanding of orbital mechanics and space environment
3. To familiarize students with satellite subsystems and their functions
4. To explore various applications of satellite technology
5. To create awareness about space missions and launch systems

SYLLABUS:

UNIT I: INTRODUCTION TO SPACE SYSTEMS

History and evolution of satellite technology, Classification of satellites based on applications and orbits, Space environment and its effects on spacecraft, Fundamentals of rocket propulsion for space access, Launch vehicles and launch sites

UNIT II: ORBITAL MECHANICS FUNDAMENTALS

Kepler's laws and orbital elements, Types of orbits - LEO, MEO, GEO, HEO, sun-synchronous, Orbital maneuvers and transfers, Orbit perturbations and station keeping, Orbital determination and tracking

UNIT III: SATELLITE SUBSYSTEMS

Satellite structures and configurations, Power systems - solar arrays, batteries, Thermal control systems, Attitude determination and control, Communication systems and antennas

UNIT IV: SATELLITE APPLICATIONS

Communication satellites and networks, Remote sensing and Earth observation, Navigation and positioning systems (GNSS), Weather and environmental monitoring, Scientific research and space exploration

UNIT V: CURRENT TRENDS AND FUTURE DEVELOPMENTS

Small satellite technologies - CubeSats and nanosatellites, Satellite constellations and mega-constellations, On-orbit servicing and space debris management, Space tourism and commercialization, Future trends in satellite technology and space systems

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain the fundamentals of satellite technology and orbital mechanics

CO2: Identify different types of satellites and their applications

CO3: Understand the functions of various satellite subsystems

CO4: Analyze the relationship between satellite design and mission requirements

CO5:Recognize current trends and future developments in space technology

REFERENCES:

TEXT BOOKS:

1. Sellers, J.J., "Understanding Space: An Introduction to Astronautics," McGraw-Hill, 4th Edition, 2014

2. Fortescue, P., Swinerd, G., and Stark, J., "Spacecraft Systems Engineering," Wiley, 4th Edition, 2011
3. Wertz, J.R., Everett, D.F., and Puschell, J.J., "Space Mission Engineering: The New SMAD," Microcosm Press, 2011

REFERENCE BOOKS:

1. Maini, A.K. and Agrawal, V., "Satellite Technology: Principles and Applications," Wiley, 3rd Edition, 2014
2. Pisacane, V.L., "Fundamentals of Space Systems," Oxford University Press, 2nd Edition, 2005
3. Brown, C.D., "Elements of Spacecraft Design," AIAA Education Series, 2002

AVIATION SAFETY AND HUMAN FACTORS

COURSE OBJECTIVES:

1. To introduce students to the principles of aviation safety
2. To provide an understanding of human factors in aviation
3. To familiarize students with safety management systems
4. To explore accident investigation and prevention methods
5. To create awareness about regulatory frameworks for aviation safety

SYLLABUS:

UNIT I: FUNDAMENTALS OF AVIATION SAFETY

Evolution of aviation safety - historical perspective, Safety concepts and theories, Risk management principles in aviation, Safety culture and organizational factors, Safety statistics and performance indicators

UNIT II: HUMAN FACTORS IN AVIATION

Introduction to human factors - SHELL model, Human performance and limitations, Crew resource management (CRM), Fatigue, stress, and their management, Human error and error management

UNIT III: SAFETY MANAGEMENT SYSTEMS

Components of Safety Management Systems (SMS), Hazard identification and risk assessment, Safety reporting systems, Safety assurance and quality management, Emergency response planning

UNIT IV: ACCIDENT INVESTIGATION AND PREVENTION

Accident causation models, Investigation methodologies and procedures, Analysis techniques for accident investigation, Case studies of major aviation accidents, Lessons learned and preventive strategies

UNIT V: REGULATORY FRAMEWORK AND EMERGING TRENDS

ICAO standards and recommended practices, National regulatory frameworks, Safety oversight and auditing, Emerging challenges in aviation safety, Future trends in safety management and human factors

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

1. Explain the fundamental principles of aviation safety
2. Identify human factors issues affecting aviation safety
3. Understand the components and implementation of safety management systems
4. Analyze aviation accidents and contribute to prevention strategies
5. Recognize regulatory requirements and emerging trends in aviation safety

REFERENCES:

TEXT BOOKS:

1. Reason, J., "Human Error," Cambridge University Press, 1990
2. ICAO, "Safety Management Manual (SMM)," Doc 9859, 4th Edition, 2018
3. Wells, A.T. and Rodrigues, C.C., "Commercial Aviation Safety," McGraw-Hill Education, 6th Edition, 2017

REFERENCE BOOKS:

1. Dekker, S., "The Field Guide to Understanding Human Error," Ashgate Publishing, 3rd Edition, 2014
2. Stolzer, A.J., Halford, C.D., and Goglia, J.J., "Safety Management Systems in Aviation," Ashgate Publishing, 2nd Edition, 2015
3. Dismukes, R.K., Berman, B.A., and Loukopoulos, L.D., "The Limits of Expertise: Rethinking Pilot Error and the Causes of Airline Accidents," Ashgate Publishing, 2007

INTRODUCTION TO AIR TRAFFIC MANAGEMENT

COURSE OBJECTIVES:

1. To introduce students to the fundamentals of air traffic management
2. To provide an understanding of airspace structure and classification
3. To familiarize students with air traffic control procedures
4. To explore communication, navigation, and surveillance systems
5. To create awareness about emerging trends in air traffic management

SYLLABUS:

UNIT I: FUNDAMENTALS OF AIR TRAFFIC MANAGEMENT

History and evolution of air traffic management, Components of the air traffic management system, Air traffic services - objectives and functions, Regulatory framework - ICAO and national authorities, Stakeholders in the air transportation system

UNIT II: AIRSPACE STRUCTURE AND MANAGEMENT

Airspace classification and types, Flight information regions and control areas, Airways, routes, and navigation points, Special use airspace, Airspace capacity and flow management

UNIT III: AIR TRAFFIC CONTROL OPERATIONS

ATC facilities - towers, approach, en-route centers, ATC procedures and separation standards, Flight plans and flight data processing, Meteorological services for air navigation, Airport operations and ground movement control

UNIT IV: CNS/ATM SYSTEMS

Communication systems - voice and data link, Navigation systems - conventional and satellite-based, Surveillance systems - radar, ADS-B, multilateration, Automation tools and decision support systems, Integration of CNS systems for ATM

UNIT V: EMERGING TRENDS AND FUTURE DEVELOPMENTS

Next Generation Air Transportation System (NextGen), Single European Sky ATM Research (SESAR), Unmanned aircraft system traffic management (UTM), Performance-based navigation and operations, Artificial intelligence and automation in ATM

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

1. Explain the fundamental principles of air traffic management
2. Identify airspace structures and their management
3. Understand air traffic control procedures and operations
4. Analyze the role of CNS systems in air traffic management
5. Recognize emerging trends and future developments in ATM

REFERENCES:

TEXT BOOKS:

1. Nolan, M.S., "Fundamentals of Air Traffic Control," Cengage Learning, 5th Edition, 2010
2. ICAO, "Air Traffic Management," Doc 4444, 16th Edition, 2016

3. Cook, A., "European Air Traffic Management: Principles, Practice, and Research," Ashgate Publishing, 2007

REFERENCE BOOKS:

1. Belobaba, P., Odoni, A., and Barnhart, C., "The Global Airline Industry," Wiley, 2nd Edition, 2015
2. Fulton, N.L., Westcott, M., and Emery, S., "Fundamentals of Air Traffic Control: Automation," Springer, 2018
3. Ashford, N., Coutu, P., and Beasley, J., "Airport Operations," McGraw-Hill Education, 3rd Edition, 2012

AVIATION WEATHER AND METEOROLOGY

COURSE OBJECTIVES:

1. To introduce students to atmospheric science relevant to aviation
2. To provide an understanding of weather phenomena affecting flight
3. To familiarize students with aviation weather services and products
4. To explore weather hazards and their impact on flight operations
5. To create awareness about weather forecasting and decision-making

SYLLABUS:

UNIT I: FUNDAMENTALS OF AVIATION METEOROLOGY

Structure and composition of the atmosphere, Atmospheric pressure, temperature, and density, Wind - causes, measurement, and effects on flight, Atmospheric moisture and stability, Standard atmosphere and altimetry

UNIT II: WEATHER PHENOMENA

Cloud types, formation, and classification, Precipitation - types and effects on aviation, Air masses and frontal systems, Cyclones, anticyclones, and pressure systems, Local weather phenomena

UNIT III: AVIATION WEATHER HAZARDS

Thunderstorms and convective activity, Turbulence - clear air, mechanical, and convective, Icing - airframe and engine icing, Visibility restrictions - fog, haze, smoke, Wind shear, microbursts, and low-level wind effects

UNIT IV: AVIATION WEATHER SERVICES

Aviation weather reports - METAR, SPECI, Aviation forecasts - TAF, area forecasts, SIGMET, AIRMET, and other advisories, Weather charts and prognostic charts, Satellite and radar imagery for aviation

UNIT V: WEATHER DECISION-MAKING AND ADVANCED TOPICS

Weather briefing and interpretation, Weather information sources and technology, Weather radar and airborne weather systems, Weather and flight planning, Climate change and its impact on aviation

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

1. Explain the fundamentals of atmospheric science relevant to aviation
2. Identify various weather phenomena and their effects on flight
3. Understand aviation weather hazards and their operational implications
4. Analyze aviation weather reports, forecasts, and charts
5. Apply weather knowledge in operational decision-making

REFERENCES:

TEXT BOOKS:

1. Federal Aviation Administration, "Aviation Weather," FAA-H-8083-28, Latest Edition
2. Lankford, T., "Aviation Weather Handbook," McGraw-Hill Education, 2000
3. Oxford Aviation Academy, "Meteorology," ATPL Ground Training Series, Latest Edition

REFERENCE BOOKS:

1. Federal Aviation Administration, "Aviation Weather Services," AC 00-45, Latest Edition
2. Lester, P., "Aviation Weather," Jeppesen Sanderson, Latest Edition
3. Buck, R.N., "Weather Flying," McGraw-Hill Education, 5th Edition, 2013

SUSTAINABLE AVIATION AND GREEN TECHNOLOGIES

COURSE OBJECTIVES:

1. To introduce students to environmental challenges in aviation
2. To provide an understanding of sustainable aviation concepts
3. To familiarize students with green technologies for aircraft
4. To explore alternative fuels and propulsion systems
5. To create awareness about regulatory frameworks and future trends

SYLLABUS:

UNIT I: AVIATION ENVIRONMENTAL CHALLENGES

Aviation's environmental footprint – overview, Aircraft emissions and their effects, Aviation noise and its impacts, Climate change and aviation, Environmental regulations and policies

UNIT II: SUSTAINABLE AVIATION CONCEPTS

Principles of sustainability in aviation, Environmental performance metrics, Life cycle assessment for aviation, Sustainable aviation strategies, Economic aspects of environmental sustainability

UNIT III: GREEN TECHNOLOGIES FOR AIRCRAFT

Aerodynamic improvements for efficiency, Lightweight materials and structures, Advanced engine technologies, Electric and hybrid-electric propulsion, Aircraft systems optimization

UNIT IV: ALTERNATIVE FUELS AND ENERGY SOURCES

Conventional jet fuels and their properties, Sustainable aviation fuels (SAF) - types and production, Hydrogen as an aviation fuel, Biofuels for aviation, Energy storage technologies for electric aircraft

UNIT V: OPERATIONAL IMPROVEMENTS AND FUTURE TRENDS

Air traffic management for environmental benefits, Green airports and ground operations, Environmental certification and standards, Future aircraft concepts and technologies, Pathways to zero-emission aviation

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

1. Explain the environmental challenges associated with aviation
2. Identify sustainable aviation concepts and strategies
3. Understand green technologies for aircraft and their potential
4. Analyze alternative fuels and propulsion systems for aviation
5. Recognize operational improvements and future trends in sustainable aviation

REFERENCES:

TEXT BOOKS:

1. Daley, B., "Air Transport and the Environment," Routledge, 2010
2. Dincer, I., Colpan, C.O., and Kadioglu, F., "Causes, Impacts and Solutions to Global Warming," Springer, 2013
3. Epstein, A.H. and O'Flarity, S.M., "Greener Aviation with Virtual Design and Testing," AIAA, 2019

REFERENCE BOOKS:

1. ICAO, "Environmental Report," International Civil Aviation Organization, Latest Edition
2. Schafer, A., et al., "Technologies and Policies for the Transition to a Sustainable Energy System in Aviation," Transportation Research Record, 2016
3. Rindlisbacher, T. and Chittka, J., "Greener by Design - Sustainable Aviation," Elsevier, 2020

AIRPORT PLANNING AND MANAGEMENT

COURSE OBJECTIVES:

1. To introduce students to airport planning principles and processes
2. To provide an understanding of airport design and layout
3. To familiarize students with airport operations and management
4. To explore economic and environmental aspects of airports
5. To create awareness about future trends in airport development

SYLLABUS:

UNIT I: INTRODUCTION TO AIRPORT PLANNING

Evolution of airports and air transportation, Airport system planning - national and regional, Airport master planning process, Forecasting aviation demand, Site selection and evaluation

UNIT II: AIRPORT DESIGN AND LAYOUT

Runway configuration and geometric design, Taxiway and apron design, Terminal planning and design, Landside facilities - access roads, parking, Airport capacity analysis

UNIT III: AIRPORT OPERATIONS

Airside operations and management, Terminal operations and passenger processing, Ground handling and ramp operations, Wildlife hazard management, Emergency planning and response

UNIT IV: AIRPORT ECONOMICS AND MANAGEMENT

Airport ownership and governance models, Airport economics and financial management, Airport revenue sources and strategies, Airport charges and slot allocation, Performance measurement and benchmarking

UNIT V: CONTEMPORARY ISSUES AND FUTURE TRENDS

Environmental management at airports, Safety and security considerations, Smart airports and digital transformation, Sustainable airport development, Future trends in airport design and operations

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

1. Explain the principles and processes of airport planning
2. Identify key elements of airport design and layout
3. Understand airport operations and management practices
4. Analyze economic and environmental aspects of airports
5. Recognize contemporary issues and future trends in airport development

REFERENCES:

TEXT BOOKS:

1. Wells, A.T. and Young, S.B., "Airport Planning & Management," McGraw-Hill Education, 6th Edition, 2011
2. Horonjeff, R., et al., "Planning and Design of Airports," McGraw-Hill Education, 5th Edition, 2010
3. Ashford, N., Mumayiz, S., and Wright, P., "Airport Engineering: Planning, Design, and Development of 21st Century Airports," Wiley, 4th Edition, 2011

REFERENCE BOOKS:

1. ICAO, "Airport Planning Manual," Doc 9184, Latest Edition
2. de Neufville, R. and Odoni, A., "Airport Systems: Planning, Design, and Management," McGraw-Hill Education, 2nd Edition, 2013
3. Graham, A., "Managing Airports: An International Perspective," Routledge, 5th Edition, 2018