Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(*An Autonomous Institute affiliated to Savitribai Phule Pune University formerly University of Pune*)

Structure and Syllabus of

Honors in Aerospace Engineering

Effective from Academic Year 2015-16

Prepared by: - Board of Studies in Mechanical Engineering

Approved by: - Academic Board, Vishwakarma Institute of Technology, Pune

Signed by

Chairman – BOS **Chairman – Academic Board**

Mechanical Engineering Department
Structure for Honors in Aerospace Engineering (4 Semesters)

Structure Third Year B.Tech Semester I

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs/week)			Credits
			Lect.	Tutorial	Practical	
T1	ME38121	Introduction to Flight and Flight Mechanics	2	0	0	2
		Total	**2**	**0**	**0**	**2**

Structure Third Year B.Tech Semester II

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs/week)			Credits
			Lect.	Tutorial	Practical	
T2	ME38122	Aerodynamics & Aero Structures	2	0	0	2
	ME38321	Aero Simulation lab	0	0	2	1
		Total	2	0	2	**3**

Structure Final Year B.Tech Semester I

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs/week)			Credits
			Lect.	Tutorial	Practical	
T3	ME48123	Aircraft Propulsion and Aircraft Design	2	0	0	2
	ME38322	Aircraft Design and Modeling Lab	0	0	2	1
		Total	2	0	2	**3**

Structure Final Year B.Tech Semester II

Subject No.	Subject Code	Subject Name	Teaching Scheme (Hrs/week)			Credits
			Lect.	Tutorial	Practical	
	ME48423	Seminar	0	0	0	2

ME38121 Introduction to Flight and Flight Mechanics

Credits: 02	**Teaching Scheme:-** Theory 02 Hrs/week

Course Outcomes: On successful completion of the course, the student will be able -	**UNIT Linking**
1. To understand the standard atmospheric condition and history of human flight	Unit I
2. To identify different types of aircrafts and different parts of aircrafts	Unit I & II
3. To understand the functioning of different parts of an aircraft	Unit II
4. To understand the mechanism of generation of different aerodynamic forces and to solve the fundamental problems related to these forces	Unit III & Unit IV
5. To use and incorporate fundamental principles from mathematics, basic science and physics to solve general problems associated with different flight conditions and flight stability.	Unit IV & Unit V

Unit I Introduction **4 hours**

Part A: Introduction to airplanes and space vehicles, History of Flight, Types of Aircrafts, Fundamentals of flight, Standard Atmosphere

Part B: Lighter than air aircrafts, available and required power and effect of altitude on both

Unit II Aircraft: Parts and Configuration **6 hours**

Part A: Fuselage, Wings, Tailplanes, Control Surfaces, High Lift devices, Aircraft Configurations: Military and Civil

Part B: Landing gear, cockpit, auxiliary power unit

Unit III Airfoils, Wings, and Other Aerodynamic Shapes: **7 hours**

Part A: Introduction to Airfoils, Airfoil Nomenclature, Lift, Drag, and Moment Coefficients, Infinite versus Finite Wings, Pressure Coefficient,

Part B: Delta wing configuration, forward swept wing

Unit IV Elements of Airplane Performance **6 hours**

Part A: Drag Polar, Level Unaccelerated Flight, Gliding Flight, flight conditions for best Range and best Endurance

Part B: Lift Vs. Drag behavior, aircraft stall

Unit V Principles of Stability and Control **5 hours**

Part A: Pitch, Roll & Yaw, Static Stability, Dynamic Stability, Control Moments on the Airplane, Angle of Attack, Concept of Static Longitudinal
Part B: Lateral Stability, gyroscopic effect

Text Books:

1. Anderson, J. D., Jr., Introduction to Flight, McGraw Hill 2001.

Reference Books:

1. Introduction to Aircraft Flight Mechanics, Thomas R. Yechout, AIAA Educational series

ME38321 Aero Simulation Lab

Credits: 01 **Teaching Scheme:**- Practical 02 Hrs/week

Prerequisite: Nil

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

1. simulate and analyse a simple flow over a body to calculate forces
2. simulate and analyse a simple structure for stresses and strains

Students are expected to perform following practicals with the use of a software package like STAR CCM or similar

List of Practicals:

1. Study of Flow simulation of Techniques.
2. Stress analysis of Trusses.
3. Measurement of drag on simple shapes.
4. Effect of Shape on Aerodynamic Drag.
5. Pressure distribution on an Airfoil and Cylinder.
6. Airfoil Drag from a Wake Traverse
7. Boundary Layer Study
8. Beam Deflection simulation.

Text Books:

1. Anderson, J. D., Jr., Fundamentals of Aerodynamics, McGraw Hill 2001.
2. Houghton, E. L. and Carpenter, P. W., Aerodynamics for Engineers, Butterworth-Heinemann, 2001.
3. Nash William, Strength of Materials, TMH, 1998
4. H. Versteeg (Author), W. Malalasekera, An Introduction to Computational Fluid Dynamics

Reference Books:

1. Anderson J.D. Jr, Computational Fluid Dynamics, McGraw Hill

ME38122 Aerodynamics and Aero structure

Credits: 02	**Teaching Scheme: 02 Hours / Week**

Course Outcomes: On successful completion of the course, the student will be able -	
1. To understand the basic nature of aerodynamic and structural forces & its generation.	ALL
2. To learn the effect of compressibility and its effect on Aircraft.	Unit II
3. To calculate the lift and drag forces developed over simple bodies like flat plate, cylinder, airfoil with known geometry	Unit I & II
4. To perform stress and strain analysis of simple aerospace structures	Unit IV
5. To set up a numerical solution for a simple aerodynamics or structures related problem	Unit V

Unit 1: General introduction to Aerodynamics: **(5 Hours)**
Part A: Airfoils, wings and their nomenclature; lift, drag and pitching moment coefficients; centre of pressure and aerodynamic centre.
Potential flow, circulation and lift generation, Kutta-Joukovskii theorem.
Part B: Starting vortex, Kutta condition, symmetric and cambered airfoil sections

Unit 2: **(6 Hours)**
Part A: Subsonic incompressible flow past airfoils, Critical Mach number, drag divergence Mach number, supercritical airfoils, effect of sweep, area rule
Supersonic flow past airfoils, shock and expansion waves
Part B: Supersonic flow over airfoils and wings; subsonic/supersonic leading edge.

Unit 3: **(6 Hours)**
Part A: Introduction: semi-monocoque aerospace structures - Loads and Design considerations; construction concepts, layout, nomenclature and structural function of parts, strength vs. stiffness based design,
Part B: Torsion of non-circular prismatic beams: importance of warping

Unit 4: **(5 Hours)**
Part A: Thin plate theory – subjected to pure bending, bending and torsion and transverse loading and buckling
Part B: ultimate load carrying capacity of a typical semi-monocoque TW box-section

Unit 5: Computational Methods in Aerospace **(6 Hours)**
Part A: Panel Methods Incompressible Flow, Finite Volume Method,
Introduction to FE Modeling: Axially loaded slender body, Virtual work, Construction of element stiffness matrix and load vector, Assembly of global stiffness matrix and global load vector, Determination of displacement and stress

Part B: Finite difference solution of Laplace's equation for flow over an airfoil,

Text Books:

1. Anderson, J. D., Jr., Fundamentals of Aerodynamics, McGraw Hill 2001.
2. Houghton, E. L. and Carpenter, P. W., Aerodynamics for Engineers, Butterworth-Heinemann, 2001.
3. Nash William, Strength of Materials, TMH, 1998

Reference Books:

1. Bertin, J. J., Aerodynamics for Engineers, Pearson Education, 2002.
2. Timoshenko.S. and Young D.H., Elements of strength materials Vol I and Vol. II., T. Van Nostrand Co-Inc Princeton-N.J. 1990

ME38322 Aircraft Design and Modeling Lab

Credits: 02	**Teaching Scheme:**- Theory 02 Hrs/week

Course Outcomes: On successful completion of the course, the student will be able -	
1. make a simple model of the aircraft	
2. analyse and predict the performance of the modelled aircraft based on basic parameters like range, speed, etc	

Practical includes two design projects:

One design project shall consist of modeling of a subsonic wing cross-section and its performance estimation on basic parameters like lift & drag coefficients and their changes with angle of attack, etc.

Second design project shall consist of basic modeling of a subsonic aircraft and its performance estimation on basic parameters like range, speed, etc.

The above exercise can be performed using software packages like OpenVSP, ADS, XFoil, etc.

Text Books:

1. Aircraft Design and Performance, Anderson John D., Tata McGrawHill

Reference Books:

1. Raymer Daniel P, Aircraft Design: A conceptual approach, AIAA Educational Series

ME48123 Aircraft Propulsion and Aircraft Design

Credits: 02	**Teaching Scheme:**- Theory 02 Hrs/week

Course Outcomes: On successful completion of the course, the student will be able -	
1. learn basic aspects of Propulsion system and design of an aircraft	ALL
2. Identify the types of jet engine and its components.	Unit I & II
3. Understand the working principle of jet engine & its governing thermodynamic cycle.	Unit I & II
4. Decide the configuration of the aircraft for a given mission and design the aircraft at a conceptual level	Unit III
5. Estimate the weight of the aircraft at a primary level	Unit III
6. Understand the concept of working of Helicopters and Safety regulations in Aircraft Industry.	Unit IV & V

Unit I Aircraft Propulsion **5 hours**

Part A: Jet propulsion principal, thrust produced, basic jet engine construction and parts of a jet engine, air intake, compressor, combustion chamber, exhaust nozzle,

Part B: Effect on the performance of jet engine of atmospheric conditions: temperature, pressure, humidity, altitude

Unit II Jet Engine Types **6 hours**

Part A: Thermodynamic cycle of jet engine - Brayton cycle, Efficiency of a jet engine, Bypass ratio, Types of Jet Engines, Bypass Turbojet, Turbofan, Turboprop and Turboshaft, modified Brayton cycle for different type of jet engines

Part B: Effect of bypass airflow on engine performance, use of bypass air other than propulsion, prop-fan concept

Unit III Aircraft Design **7 hours**

Part A: Various stages in aircraft design, conceptual design, preliminary design, Aircraft configurations, aircraft weights - empty weight, maximum take-off weight, payload, pay load - range diagram, Weight Estimation process

Part B: configurations of small aircrafts, private jets, fighter aircrafts, military cargo aircrafts, reconnaissance aircrafts and their common mission profiles, blended wing-body configuration

Unit IV Helicopters **5 hours**

Part A: Helicopter, Vertical take-off and hovering, main rotor construction and working, tail rotor construction and working, gyrocopters

Part B: Helicopter parts, contra-rotating main rotor

Unit V: Aircraft Safety **5 hours**

Part A: Overview of regulations, basic flight certification requirements, Twin Engine Operations (ETOPS) regulations, air crash case study

Part B: Jet engine testing, Bird hits, Regulations for noise and emissions

Text Books:

1. Nicolas Cumptsy, Jet Propulsion: A Simple Guide to the Aerodynamic and Thermodynamic Design and Performance of Jet Engines

2. Aircraft Design and Performance, Anderson John D., Tata McGrawHill

Reference Books:

1. Raymer Daniel P, Aircraft Design: A conceptual approach, AIAA Educational Series
2. JAA Powerplant Manual

ME48423 **: SEMINAR**

Credits: 02
Prerequisite: None

Course outcomes:
1. Students will able to perform literature survey with the available resources.
2. Students will be able to communicate and present the technical data gathered, in logical and organized manner using the appropriate technical jargon.

The seminar topic may be related to -

- Aerospace Engineering and Technology
- Interdisciplinary topics in close relation with Aerospace Engineering
- Recent Trends and Future scope in Aerospace Engineering field.

The topics should be based on recent research paper published in International Conference/ Reviewed Engineering Journals of International Repute in print media.
Each student should have different seminar topic and its presentation. In case more than one student is working on the same topic, then their scope of seminar must be distinct.

Instructions for Seminar Report Writing

1. Prepare minimum one copy of manuscript of Seminar report for the submission. The report should be printed on both sides of the paper, except the cover page, front page and Certificate.
2. The manuscript of the seminar report should be preferably 15-20 pages.
3. The Seminar report must be spiral bound.
4. Following will be the order of the report-
    - Cover page and front page as per the standard specimen (**as described by the Department**) on separate sheet.
    - Certificate from the institute as per the standard specimen (**as described by the Department**).
    - Acknowledgement
    - Table of Contents
    - Abstract (A brief abstract of the report not more than 250 words. The heading of abstract i.e. word "Abstract" should be **bold, Times New Roman, 12 pt** and should be typed at the **centre**. The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on motive, method, key-results and conclusion in the Abstract)
    - List of Figures
    - List of Tables
    - Nomenclature (**Symbols and abbreviations** used in the manuscript should be included in Nomenclature section)

- Chapters: Introduction, Theory/Literature Review, Theoretical Analysis, Design Methodology, Experimental/Numerical scheme, Manufacturing and Experimental details (if any), Results and Discussion, Conclusions.
- References.