AMITY UNIVERSITY
UTTAR PRADESH

Course Title: AERODYNAMICS – I

Credit Units: 5

L	T	P/S	SW/ FW	TOTAL CREDIT UNITS
3	1	2	-	5

Course Code: AERO202

Course Level : UG

Course Objectives

In this course, aerospace students are to learn the concepts of flow measurements, fluid motion and the governing equations for incompressible/compressible flows. The students are, thus, in a position to analyze the behaviour of various aerodynamic forces that act upon the bodies kept in the flow fields.

Pre-requisites: Mechanics of fluid, Thermodynamics and Mathematics.

Course Contents/Syllabus:

	Weightage (%)
Module I : Introduction	**10**
Descriptors/Topics Continuum and free molecular flows, inviscid and viscous flows, incompressible and compressible flows. Newtonian and Non-Newtonian flows. Pitot static tube, measurement of air-speed, pressure coefficient. Aerodynamic force and moments. Dimensional analysis, non-dimensional parameters, M, Re, Fr etc., flow similarity.	
Module II : Description of Fluid Motion	**15**
Descriptors/Topics: Lagrangian and Eulerian methods, Description of properties in a moving fluid, local and material rate of change. Equation of conservation of mass for control volume, special form of equation of conservation of mass, differential form of conservation equation. Streamline, Path-line, Streak-line, Vorticity and circulation. Laws of vortex motion. Translation, rotation and rate of deformation of fluid particles.	
Module III : Equation of Fluid Motion	**10**
Descriptors/Topics : Euler's and Navier-Stoke equations. Derivation of Bernoulli’s equation for in-viscid and viscous flow fields. Momentum equation and angular momentum equation in integral form, Boundary Layer Theory.	

Module IV : Incompressible Flow	**35**
Descriptors/Topics : Condition on velocity for incompressible flow. Laplace's equations. Potential function, stream function. Basic elementary flows: Uniform flows, source flow, Doublet flow and Vortex flow. Superimposition of elementary flows. Non lifting and lifting flow over a circular cylinder, comparison with real flow over circular cylinder. Kutta-Jaukowski theorem, generation of lift.	
Module V : Elements of Compressible Flow	**30**
Descriptors/Topics: Compressible flow properties: Total Enthalpy, Total Temperature, Temperature and Pressure ratios as a function of Mach No., Mass Flow Parameter (MFP). Isentropic Area ratio (A/A*), Velocity-Area variations, 2D small amplitude wave propagation. Adiabatic Steady Flow Ellipse, description of Flow Regimes. Introduction to Normal and Oblique Shock waves. Working out solutions through gas tables/charts.	

Student Learning Outcomes:

- Differentiate between various types of flows.
- Calculate aerodynamic characteristics over the lifting bodies.
- Recognize flow behaviors over the lifting bodies.
- Describe importance of theory of circulation for generation of lift.
- Define compressible flow properties and formation of shockwares.

Pedagogy for Course Delivery: Session Plan / course-material uploading, Class-room teaching associated with assignments**,** aerodynamics Lab experiments & Report preparation, quiz, viva-voce and evaluation.

Lab/ Practicals details

List of Experiments:

- Wind tunnel as a tool, their classification, uses and applications.
- Experiments on Reynold's apparatus.
- Use of Pitot - static tube and Anemometer for measuring velocity.
- Measurement of pressure gradient along a wind tunnel.
- Measurement of velocity profile in favourable and adverse pressure gradient.
- Smoke visualization over cylinder / airfoils.
- Pressure distribution over a 2D cylinder.
- Experiments on potential flow Analogy (Hele-Shaw flow).
- Setting up of liquid paraffin smoke wire for flow visualization.

- Measurement of Drag of a 2D cylinder by Jone's Wake Survey method.

Assessment/ Examination Scheme:

Theory L/T (%)	Lab/Practical/Studio (%)	Total
80	20	100

Theory Assessment (L&T):

Continuous Assessment/Internal Assessment - 30					End Term Examination
Components (Drop down)	**A**	**CT**	**S/V/Q**	**HA**	**70**
Weightage (%)	5	10	8	7	70

Lab/ Practical/ Studio Assessment:

	Continuous Assessment/Internal Assessment				End Term Examination	
Components (Drop down	**PR**	**LR**	**V**	**A**	**EXP**	**V**
Weightage (%)	10	10	5	5	35	35

Text & References:

- John D. Anderson Jr., "Fundamentals of Aerodynamics", 2nd Ed., McGraw Hill.
- Jack D. Mattingly, "Principles of Gas Turbine"' 1st Ed., McGraw Hill, 1996.
- H. Schlichting, "Boundary Layer Theory", 6th Ed., McGraw Hill, 1986.
- Frank M. White, "Fluid Mechanics", 2nd Ed., McGraw Hill, 1986.
- S.W. Yuan, "Foundations of Fluid Mechanics", Prentice Hall.
- E. Rathakrishnan, "Gas Dynamics", Prentice Hall.
- Gupta and Gupta, "Fluid Mechanics and its Applications", Wiley Eastern, 1960.

Any other Study Material:

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