Subject Description Form

Subject Code	ME45001
Subject Title	Aerodynamics
Credit Value	3
Level	4
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisite: ME34004 Fluid Mechanics
Objectives	To equip students with necessary knowledge of flow physics, analytical and numerical techniques for the prediction of forces acting on and performance analysis of aerodynamic bodies.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Formulate and solve problems relating to low-speed flow past two-dimensional airfoils and aerodynamic bodies by applying inviscid and incompressible flow theories. b. Formulate and solve problems relating to downwash and induced drag phenomena for finite wings by applying the techniques derived from laws of vortex motion. c. Formulate and solve problems relating to compressible flow through nozzles/diffusers and supersonic flow past aerodynamic bodies by applying one-dimensional compressible flow equations and knowledge of flow compressibility and wave phenomena in aerodynamics. d. Analyze and interpret data obtained from experiments in incompressible and compressible aerodynamics. e. Present effectively in completing written reports of laboratory work and the given task.
Subject Synopsis/ Indicative Syllabus	***Fundamental Principles and Equations* -** Control volume concept for fluid. Continuity equation. Momentum equation. Energy equation. Substantial derivative. Angular velocity, vorticity and strain. Dimensional analysis. ***Inviscid and Incompressible Flow* -** Stream function and velocity potential. Potential flow. Laplace's equation and its elementary solutions. ***Incompressible Flow over Two-Dimensional Airfoils* -** Airfoil nomenclature and characteristics. The Kutta condition. Circulation and lift. Kelvin's circulation theorem and starting vortex. General thin airfoil theory. Symmetric and cambered airfoils. Aerodynamic Center. Panel method for arbitrary lifting bodies. Viscous airfoil drag. ***Finite Wings* -** Downwash and induced drag. Vortex system on finite wing. Law of vortex motion. Prantdl's lifting line theory. Lifting-surface theory and vortex lattice numerical method.

***Inviscid and Compressible Flow* -** Definition of compressibility and total conditions. Governing equations. One-dimensional flow: weak waves and plane normal shock waves. Two-dimensional supersonic flow: oblique shock and expansion waves. Flow through nozzles and diffusers.

***Compressible Flow over Airfoils* -** Velocity potential equation and its linearized form. Prandtl-Glauert compressibility correction. Critical Mach number. The sound barrier. Supersonic pressure coefficients. Application to supersonic airfoils.

Teaching/Learning Methodology

Lectures are used to deliver the fundamental principles and equations of aerodynamics as well as solution techniques (outcomes a to d).

Tutorials are used to illustrate the application of fundamental principles to practical engineering situations (outcomes a to c).

Projects, in the form of design problems or case studies, are used to allow students to deepen their knowledge on a selected topic through search of information, analysis of data and report writing (outcomes a, b and e).

Experiment(s) on evaluating the effects of configurations of an airfoil on its flow field and aerodynamic characteristics, either in laboratory or numerical setup, is (are) provided for bridging the knowledge of fluid mechanics with current subject. Students are exposed to proper use of knowledge taught and analysis skills on evaluating their experimental results (outcomes a, d and e).

Teaching/Learning Methodology	Outcomes				
	a	b	c	d	e
Lecture	√	√	√	√	
Tutorial	√	√	√		
Project/Laboratory	√	√			√
Experiment	√			√	√

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)				
		a	b	c	d	e
1. Assignment	20%	√	√	√		
2. Project/Laboratory report	15%		√	√	√	√
3. Test	15%	√	√			
4. Examination	50%	√	√	√		
Total	100%					

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Overall Assessment:

0.50 × End of Subject Examination + 0.50 × Continuous Assessment

	Examination is adopted to assess students on the overall understanding and the ability of applying the concepts. It is supplemented by continuous assessment including assignments projects and test(s), which provide timely feedback to both lecturers and students on various topics of the syllabus. Assigned homework and test are designed to enhance the students' learning of fundamental principles in aerodynamics. The projects provide students an opportunity to capitalize on the knowledge they learn for tackling practical aerodynamic problems arising from real practice. Written report and oral presentation on a specific project or case study is used to assess the students' knowledge in contemporary aircraft maintenance engineering.	
Student Study Effort Expected	Class contact:	
	▪ Lecture	33 Hrs.
	▪ Tutorial	6 Hrs.
	Other student study effort:	
	▪ Self-study	45 Hrs.
	▪ Homework assignment	12 Hrs.
	▪ Project/case study	12 Hrs.
	Total student study effort	108 Hrs.
Reading List and References	1. Anderson Jr., J. D., Fundamentals of Aerodynamics, McGraw-Hill, latest edition. 2. Houghton, E. L., and Carpenter, P. W., Aerodynamics for Engineering Students, Butterworth & Heinemann, latest edition. 3. Bertin, J. J. and Cummings, R. M., Aerodynamics for Engineers, Pearson Prentice-Hall, latest edition. 4. Anderson Jr., J. D., Aircraft Performance and Design, McGraw-Hill, latest edition.	

Revised July 2014