VEHICLE AERODYNAMICS (SG2211/SG3128), 6 ECTS,

TEACHERS:

Alessandro Talamelli Course responsible, Teacher

Jens Fransson, Examiner

Philipp Schlatter, Assistant

Ramis Örlü, Assistant

Aidan Rinehart, Assistant

Yushi Murai, Assistant

LITERATURE

Lecture Notes provided by the teacher and available on CANVAS

Barnard, R.H., Road Vehicle Aerodynamic Design - An introduction, 2:nd edition 2001, MechAero Publishing, ISBN 0-9540734-0-1.

EXAMINATION AND GRADING

- LAB1 - Laboratory Work, 0.8 credits, Grading scale: P, F
- PRO1 - Project, 3.0 credits, Grading scale: P, F
- TEN1 - Examination, 2.2 credits, Grading scale: A, B, C, D, E, F

COURSE PLAN

REGULAR LECTURES

1st Lecture-17th of March
Introduction - Course layout - Importance of Vehicle Aerodynamics

2nd Lecture-18th of March
Historical review

3rd Lecture-19th of March
Introduction to fluid mechanics - The fluid particle - Kinematic, thermodynamic and transport properties - Viscosity of fluids – Thermal conductivity - Pathlines, streamlines and streaklines

4th Lecture-20th of March
Streamtube and Vortextube – Helmoltz theorems - Steady flow - Compressibility - The principles of

fluid mechanics – The continuity equation - The momentum balance- The energy equation

5th Lecture-23rd of March
Uncoupled system - The initial and boundary conditions- The Navier-Stokes equations – SG2211 Project Presentation

6th Lecture-24th of March
Main problems Boundary conditions - Simplified problem- Equations for incompressible irrotational flows - Effect of viscosity in irrotational flow - The solution of incompressible irrotational viscous flow – The generalised Bernoulli theorem – Bernoulli theorem for rotational flows - Genesis of vorticity on a flat plate - Generalization to more complex geometries - Wu theorem

7th Lecture- 25th of March
Dynamics of vorticity on a flat plate - Vorticity thickness on a flat plate - Definition of boundary layer – The Prandtl theory – The iterative procedure

8th Lecture-1th of April
Boundary layer representation - Boundary layer thickness -Displacement and momentum thickness - Boundary layer evolution – Boundary layer separation - Effects of geometry on separation - Reynolds number dependency

9th Lecture-2nd of April
Transition Main parameters in transition - Turbulence Separation bubbles - Definition of Aerodynamic and Bluff bodies - Aerodynamic forces on vehicles - Force coefficients - Pressures - Shear stresses - Lift and Drag of vehicles - Aerodynamic bodies - The iterative procedure- The potential flow results (thin airfoil, conformal mapping, panel methods) - The Kutta condition

10th Lecture-3th of April
The potential flow results (thin airfoil, conformal mapping, panel methods) - The Kutta condition - Lift on wings for vehicle application

11th Lecture-6th of April
Boundary layer corrections - Effect of thickness - Effect of curvature - Separation and stall on thick, medium and thin airfoil - Wing profiles interactions

12th Lecture-7th of April
Control of lift - Gurney flap – Second Iteration (Boundary layer corrections) - Classification of Drag - Drag on aerodynamic bodies Friction drag - Importance of friction drag in vehicle aerodynamics - The Prandtl equations - Flat plate analogy - Solution for Laminar flow - Solution for Turbulent flow - Solution with transition

13th Lecture-8th of April
Integral methods - Friction drag control - Laminar profiles - Form drag - Estimation by iterative procedure

14th Lecture-9th of April
Energy interpretation of drag - Forces on bluff bodies - Potential flow around bodies - Flow around

a cylinder - Potential flow around a car - Application of the iterative procedure to a ground vehicle – The solution around a cylinder- Pressures on a hemi-cylinder

15th Lecture-28th of April
The Helmoltz model - Approximate procedure for bluff bodies (Potential flow with regions of separated flow) - Drag for bluff bodies - Form drag - Drag coefficient of a cylinder

16th Lecture-29th of April
Laminar separation - Turbulent separation - Critical region - Energy in the wake and the role of vorticity - Intensity, spacing and concentration effects - Form drag in different geometries - Effects of aspect ratio and corners

17th Lecture-6th of May
Methods to reduce form drag - Effects of roughness - Use of vortex generators - Splitter plates- Interference effects on 2D bodies - Ground effects

18th Lecture-11th of May
Aerodynamics of 3D aero bodies - Lift of finite wings – Drag of finite wing – Friction on 3D bodies - The induced drag – Control of induced drag - Influence of the end plates - The Delta wing - Lift and drag of a delta wing - Wing in ground effect – Aerodynamics of 3D bluff bodies - Fore body and after body drag - Form drag in 3D bodies - - Drag due to streamwise vortices - The Morel body – Drafting

19th Lecture-12th of May
The aerodynamic of a family car

EXTERNAL LECTURES

1th External Lecture-7th of May
Aerodynamics of Bicycles

2nd External Lecture-8th of May
Aerodynamics of Rail Vehicles