Aerospace Engineering

Course Title: Experimental Aerodynamics **Number of Credits: 3**

Course Topics:

- Introduction to Basic Concepts (different research methods, experimental aerodynamics, wind tunnel, free flight test, governing equations for fluid flow, dimensional analysis and similarity principles, characteristics of free stream)
- Low Speed Wind Tunnel (functions and basic parts of the wind tunnel, different types of wind tunnel based on application, open or closed circuit wind tunnel, suction or blowdown type, test section)
- Design of a Low Speed Wind Tunnel (energy ratio, loss coefficient of wind tunnel parts, design of different parts of wind tunnel: settling chamber, screen, honeycomb, nozzle, test section, diffuser, fans system, corner)
- Measurement Instruments in Wind Tunnel (range, resolution, and accuracy of instruments, frequency response, temperature measurement sensors, strain gauges and piezoelectric sensors, load cells and balances, velocimetry (Pitot static tube, hot-wire, Laser Doppler, particle image velocimetry (PIV)))
- Calibration (basics of calibration, calibration of free stream and measurement instruments, calibration curves and equations, calibration error)
- Measurement Principle and Data Acquisition Techniques (signal processing, data analysis, noise filtering, sampling specification, different error sources, measurement uncertainty, repeatability)
- Hot-wire Anemometry (operating principle, advantages and disadvantages, parts and electronic circuits, calibration, Hot-wire probes, and hot-film probes)
- Flow Visualization (Eulerian and Lagrangian views, stream, path, and streak lines, different visualization methods, determination of the separation point and transition location)
- High Speed Wind Tunnel (different types of supersonic wind tunnel, wind tunnel parts, design of wind tunnel and its different parts, measurement instruments, Schlieren technique, shock tube, hypersonic wind tunnel)

Reading Resources:

- Low-Speed Wind Tunnel Testing: J.B. Barlow, W.H. Rae, A .Pope, John Wiley & Sons, Edition 3, 1999.
- High-speed Wind Tunnel Testing: Alan Pope, Kennith L. Goin, John Wiley & Sons, New York, 1978
- Mechanical measurements: T.G. Beckwith, R.D. Marangoni, J.H. Lienhard, Pearson, Edition 6, 2009.
- Springer Handbook of Experimental Fluid Mechanics: Edited by C .Tropea, A.L. Yarin, J.F. Foss, 2007.
- Flow Visualization: Techniques & Example, A.J. Smits, T.T. Lim, Imperial College Press, Edition 2, 2012.
- Hot-wire Anemometry: Principles and Signal Analysis: H. H. Bruun, Oxford University Press, 1995.