Semester:	7				
Course Code:	ME5130				
Course Name:	Optical Flow Diagnostics for Fluid and Combustion				
Credits Value:	2 (Notional hours: 100)				
Pre-requisites:	ME3040 and ME5070				
Core/ Optional:	Optional				
Hourly Breakdown	Lectures (hours)	Tutorials (hours)	Practical classes (hours)	Assignments (hours)	Independent Learning & Assessment (hours)
	24	04		04	68

Course Aim: This course is aimed at providing a general understanding of experimental based flow visualization methods while a major emphasis is placed to provide a comprehensive knowledge on Particle Image Velocimetry (PIV). Students will be able to gain the required knowledge and skills to plan flow visualization experiments to analyze a wide range of natural and industrial flows as well as to perform appropriate post-processing with acquired images.

Intended Learning Outcomes:

At the end of this course, students should be able to;

- **compare** experimental flow visualization techniques used in modern day research, and current state of art devices that are available in the industry,
- **examine** principles of planar, stereoscopic, and volumetric PIV along with their applications,
- **analyze** experimental flow data using PIV post-processing techniques commonly used in experimental fluids,
- **assess** how a PIV experiment can be set up according to an intended application.

Course Content:

- **Introduction:** A broad overview to the experimental flow visualization techniques
- **Fluid Diagnostics:** Constant Temperature Anemometer (CTA), Laser Doppler Anemometry (LDA), Laser Induced Fluorescence (LIF), Particle Image Velocimetry (PIV)
- **Combustion Diagnostics:** Laser-Induced Fluorescence (C-LIF), Rayleigh thermometry, Laser induced Incandescence (LII), Time-Resolved LIF (TR LIF)
- **Mathematical Background of Statistical PIV:** Image intensity field, cross-correlation of image pairs, particle displacement, optimization of correlation
- **PIV Hardware:** State of art devices currently available in the industry, standard PIV lasers and cameras, lasers and cameras for time-resolved measurements, timing devices
- **Advances in PIV:** Stereoscopic PIV, scanning PIV systems, techniques for 3D - PIV, micro PIV

(μPIV)

- **PIV recipe:** Selecting hardware devices for a given application, setting up an experimental rig, rules of thumb for obtaining quality PIV data
- **Post-processing of PIV data:** Data validation, replacement schemes, data assimilation techniques, vector field operators, estimation of integral quantities, vortex detection
- **Review of selected applications:** Aero-acoustic and pressure measurements, helicopter aerodynamics, flows at different temperatures, biomedical engineering, automotive industry, microfluidics, mixing, combustions

Teaching/ Learning Methods:
Classroom lectures, tutorials, in-class exercises and assignments

Assessment Strategy:

Continuous Assessment 50%		**Final Assessment** 50%		
Details:		Theory (%)	Practical (%)	Other (%) (Project)
Assignments/Quizzes	20%	50%		
Mini class project	30%			

Recommended Reading:

- Adrian, L., Adrian, R. J., & Westerweel, J. (2011). *Particle image velocimetry (No. 30).* Cambridge university press.
- Merzkirch, W. (2012). *Flow visualization*. Elsevier.
- Smits, A. J. (2012). *Flow visualization: techniques and examples*. World Scientific.
- Bradshaw, P. (2016). *Experimental Fluid Mechanics*: The Commonwealth and International Library: Thermodynamics and Fluid Mechanics Division. Elsevier.
- Raffel, M., Willert, C. E., Scarano, F., Kähler, C. J., Wereley, S. T., & Kompenhans, J. (2018).*Particle image velocimetry: a practical guide*. Springer.