Modulbezeichnung:	**Optical Manufacturing Metrology (OMM)** (Optical Manufacturing Metrology)	**5 ECTS**
Modulverantwortliche/r:	Tino Hausotte	
Lehrende:	Tino Hausotte	

Startsemester: SS 2015	Dauer: 1 Semester	Turnus: jährlich (SS)
Präsenzzeit: 60 Std.	Eigenstudium: 90 Std.	Sprache: Englisch

Lehrveranstaltungen:

Optical Manufacturing Metrology (SS 2015, Vorlesung, 2 SWS, Tino Hausotte)
Optical Manufacturing Metrology - Übung (SS 2015, Übung, 2 SWS, Tino Hausotte et al.)

Inhalt:

- **Introduction:** manufacturing metrology and main task: fields of industrial metrology, main tasks (control the conformity, readjusting/correcting of process parameters), objectives and aims (ensure the function, interchangeability, correction parameters for manufacturing processes) - measuring, testing, monitoring - equipment in manufacturing metrology - optics (theories: quantum, wave, ray), effects, properties and principles of measurement
- **Geometrical tolerances:** basic (GPS) Framework, duality principle and operations (partition, extraction, filtration, association, collection, construction) - definitions of geometric elements, standard geometrical elements - geometrical parameters of workpieces, classification system for form deviations - linear and angular dimensions (terms and definitions) - ISO-system for tolerances of linear sizes (terms and definitions, types of fits, code system) - symbols and drawing indication of geometrical tolerances - definition of form tolerances - datums - orientation, location and run-out tolerances - several essential specifications for GPS (CT, E, M, F) - surface texture parameters (determination, types)
- **Measurement and Evaluation Strategies:** determination of measurement strategy, probing strategy and evaluation strategy (Minimum and recommended number of probing points, Nyquist's Criterion, probing of feature segments, evaluation criteria) - influences on the uncertainty of measurement results (uncertainty of measurement, Golden Rule)
- **Optical Principles and Components:** Theories of optics - Geometrical optics (reflection, refraction, fibre optic components, ray tracing, lenses, aberration, beam splitter, mirrors, prisms, reflectors) - Wave optics (wave equations, polarisation, polarisers, beam-splitting polarisers, coherence and interference, diffraction) - Quantum optics (spontaneous emission, light-emitting-diodes and detectors, stimulated emission, laser, photoelectric effect and detectors)
- **Tolerances of optical Components:** reference wavelengths - testing areas and volumes - dimensioning of lenses and of edges, dimension and protective chamfers - specification of angle - material specification (stress birefringence, bubbles and other inclusions, inhomogeneities and striae) - surface treatment and coating
- **Scales and Encoders:** Abbe comparator principal (traceability, 1th order and 2nd order error, Abbe comparator) - linear encoder (principle, Moiré-effect and reticle, detection of motion direction) - output signals and demodulation of encoder signals (counting and resolution enhancement) - reading head of encoders (imaging and interferential measuring principle, transmitted and reflected light) - reference marks - absolute encoders (U- and V-scanning and Gray code)
- **Interferometer for length measurements:** interference and interferometer - Michelson-Interferometer - superposition of waves, Basics of the interference, Interference of light waves - homodyne and heterodyne principal - interference at a Michelson-Interferometer - interference of a homodyne interferometer - demodulation at a homodyne interferometer (dead path) - demodulation at a heterodyne Interferometer - refractive index of air (dependency, measurement) - coherence (spatial and temporal, interferograms with two monochromatic light, white light) - He-Ne-Laser (modes and mode distances, stability) - interferometer setups and adjustment
- **Interferometer for surface measurements:** interference of equal inclination - interference of equal thickness - multiple beam interference - demodulation with phase shifting (principle, generation of phase shift, unwrapping) - application of Fizeau Interferometry - interference microscopes (setups,

evaluation)
- **Optical Surface Measurements:** microscope designs, measuring microscope - numerical aperture and resolution - focus variation - confocal microscope (principle, setups, laser-scanning microscope) - chromatic white-light sensor - laser autofocus method (characteristic curve, principles with astigmatic lens and Foucault knife) - summary: optical probing

Lernziele und Kompetenzen:

Learning targets and competences:

Remembering
- The students have knowledge about the objectives, main tasks, and quantities of manufacturing metrology
- The students have knowledge about inspection equipment in manufacturing metrology

Applying
- The students are able to analyze the GPS concept and geometrical tolerances.
- The students are able to compare optical measurement procedures and its applications.

Literatur:

- Yoshizawa, T.: Handbook of optical Metrology: Principles and Applications. Boca Raton, CRC Press, 2009
- Gåsvik, K. J.: Optical metrology. New York, Wiley, 2002
- Benteley, J. P.: Principles of Measurement Systems. Essex, Prentice Hall, 1995
- International Vocabulary of Metrology - Basic and General Concepts and Associated Terms, VIM, 3rd edition, JCGM 200:2008

Verwendbarkeit des Moduls / Einpassung in den Musterstudienplan:

Das Modul ist im Kontext der folgenden Studienfächer/Vertiefungsrichtungen verwendbar:

[1] **International Production Engineering and Management (Bachelor of Science): 5. Semester**
(Po-Vers. 2010 | Bachelorprüfung | International Elective Moduls | International Elective Modules | Optical Manufacturing Metrology)

[2] **International Production Engineering and Management (Bachelor of Science): 5. Semester**
(Po-Vers. 2011 | Bachelorprüfung | International Elective Moduls | International Elective Modules | Optical Manufacturing Metrology)

[3] **Maschinenbau (Bachelor of Science): ab 3. Semester**
(Po-Vers. 2009w | Wahlmodule | Technische Wahlmodule)

[4] **Maschinenbau (Master of Science)**
(Po-Vers. 2007 | Studienrichtungen Allgemeiner Maschinenbau, Fertigungstechnik, und Rechnergestützte Produktentwicklung | Masterprüfung | Wahlmodule | Technische Wahlmodule)

[5] **Maschinenbau (Master of Science): 2. Semester**
(Po-Vers. 2013 | Studienrichtung International Production Engineering and Management | Masterprüfung | International Elective Modules)

[6] **Mechatronik (Master of Science): 1-3. Semester**
(Po-Vers. 2012 | M3 Technische Wahlmodule)

[7] **Wirtschaftsingenieurwesen (Master of Science)**
(Po-Vers. 2009 | Ingenieurwissenschaftliche Studienrichtungen | Technische Wahlmodule | Technische Wahlmodule)

Studien-/Prüfungsleistungen:

Optical Manufacturing Metrology (Prüfungsnummer: 49003)
(englische Bezeichnung: Optical Manufacturing Metrology)

Prüfungsleistung, Klausur, Dauer (in Minuten): 90
Anteil an der Berechnung der Modulnote: 100%
weitere Erläuterungen:
Prüfungstermine, eine **allgemeine Regel der Prüfungstagvergabe** und **Termine der Klausureinsicht** finden Sie auf StudOn: Prüfungstermine und Termine der Klausureinsicht

Erstablegung: SS 2015, 1. Wdh.: WS 2015/2016
1. Prüfer: Tino Hausotte

Organisatorisches:

- Vortragssprache: Englisch
- Unterlagen zur Lehrveranstaltung werden auf der Lernplattform StudOn (www.studon.uni-erlangen.de) bereitgestellt. Das Passwort wird in der ersten Vorlesung bekannt gegeben.