海外学者短期讲学课程简介及教学大纲

<table>
<tr><td>课程中文名称</td><td colspan="3">干涉测量技术及应用</td><td rowspan="2">授课语言</td><td rowspan="2">英语</td></tr>
<tr><td>课程英文名称</td><td colspan="3">Optical Interferometry: Techniques and Applications</td></tr>
<tr><td rowspan="4"></td><td rowspan="4">16</td><td>讲课</td><td>14</td><td>开课学期</td><td>2014-2015 春</td></tr>
<tr><td>讨论</td><td>2</td><td>周学时数</td><td>16</td></tr>
<tr><td>实验</td><td>0</td><td rowspan="2">上课时间</td><td rowspan="2">2015 年 5 月 8 日至 15 日</td></tr>
<tr><td>其他</td><td>0</td></tr>
<tr><td>课外学时数</td><td></td><td>考核方式</td><td colspan="3">考试　　考查</td></tr>
<tr><td>课程简介</td><td colspan="5">本课程主要对光学精密测量中精密位移测量这一个领域分支展开探讨与研究。精密位移计量技术在传统的计量领域中一直发挥着重要作用，例如对精密位移及定位传感器的可溯源的校准等。目前，许多精密机械系统中，为了获得精确的位置信息，都利用光学干涉技术直接进行位移测量或者利用经过干涉仪校准过的其他定位测量系统获得。因此干涉精密测量技术在精密机械领域中占有非常重要的地位，是现代先进制造领域的关键核心技术所在。
本课程的目标是：系统阐述干涉位移计量技术的发展历程、测量理论，分析利用干涉仪在位移传感、折射率测量、多自由度测量和自由曲面计量测量等领域中的实际应用。并进一度结合实例探讨精密位移测量及精密机械设计中存在的一系列实际问题，以及这些问题会如何影响到其他传感器如电容传感器等的校准。</td></tr>
<tr><td>教学大纲</td><td colspan="5">第一讲：干涉位移测量技术的基本概念
包括：干涉，光程差，零差与外差，干涉仪的基本配置，干涉信号的处理方法等。
第二讲：零差干涉测量技术
包括：零差干涉仪，干涉仪的方向判定，激光编码器，相位检测，激光器的稳频等。
第三讲：外差干涉测量技术
包括：外差频率的产生，塞曼激光器，双纵模激光器，基本的外差干涉仪，多普勒频移，平面镜外差干涉仪，角度测量，直线度测量等。
第四讲：精密位移台与传感器的校准
包括：精密位移台设计，阿贝误差，余弦误差传感器（线性度仪，电容传感器）等。
第五讲：瓦特天平中的绝对折射率测量
包括：波长跟踪与折射率跟踪，Edlen 公式，NIST 原始空气折射率计，NIST 新一代空气折射率计设计与进展等。
第六讲：眼球手术定位应用的精密扫描位移台</td></tr>
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	包括：眼球折射率校准，LASIK，多光子吸收，精密扫描定位系统，初步测量结果分析等。 第七讲：差分波前干涉仪及激光多轴干涉仪 包括：基于光纤传导的干涉仪，差分波前探测，滚转轴的微小量测量，多轴测量和位移台校准技术等。 第八讲：自由光学曲面计量中的点对点测量方法 包括：CMMs，光学 CMMs，光学探针，光学自由曲面中的接触式与非接触式测量，OCT 技术，LIDAR，共焦显微干涉术等。
预备知识或先修课程要求	光学工程基础

Course description and syllabus

<table>
<tr><td>Chinese name</td><td colspan="3">干涉测量技术及应用</td><td rowspan="2">language</td><td rowspan="2">English</td></tr>
<tr><td>English name</td><td colspan="3">Optical Interferometry: Techniques and Applications</td></tr>
<tr><td rowspan="4">Total credit hours and distribution</td><td rowspan="4">16</td><td>Class</td><td>14</td><td>semester</td><td>2014-2015spring</td></tr>
<tr><td>Discussion</td><td>2</td><td>Credit hours per week</td><td>16</td></tr>
<tr><td>Experiment</td><td></td><td></td><td></td></tr>
<tr><td>Others</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="3"></td></tr>
<tr><td>Description</td><td colspan="5">This course delves into a sub-field of optical metrology, called Displacement Measuring Interferometry, which is a critical technology for providing traceable calibration for position sensors and equipment. Many precision systems that require accurate positioning knowledge use displacement measuring interferometry either through direct measurement or calibration of alternative metrology systems. Displacement measuring interferometry offers high accuracy measurements with a wide bandwidth and direct traceability to international length standards.

The scope of this course is to provide a fundamental background for displacement interferometry, explain some the theory, and provide practical examples of interferometry systems and how it is used as a sensing technology. In addition to displacement interferometry, this course will cover measurement uncertainty and how it affects the calibration of other sensors such as linescales and capacitance sensors.</td></tr>
<tr><td>syllabus</td><td colspan="5">Lecture 1. Basics of displacement interferometry
Topics covered: Interference, Optical Path Difference, Phase-to-Displacement, Homodyne vs Heterodyne, Basic Interferometer Configurations, Signal processing
Lecture 2. Homodyne Interferometry:
Topics covered: Homodyne interferometers, Direction sensitivity, Laser encoders, Phase detection, Laser stabilization
Lecture 3. Heterodyne Interferometry
Topics covered: Split frequency, Zeeman Lasers, Two-Mode lasers, Heterodyne Lasers, basic heterodyne interferometer, Doppler frequency shift, Plane Mirror, angular, straightness
Lecture 4: Stage and Sensor Calibration
Topics covered: stages, Abbe errors, cosine error, alignment, sensors (linescale, capacitance)
Lecture 5: Absolute Refractometry for the Watt Balance
Topics covered: Wavelength tracking vs refractive index tracking, Edlen equation, Original NIST Refractometer, Updated NIST Refractometer</td></tr>
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	Lecture 6: Precision Scanning Stage for Ophthalmic Applications Topics covered: Refractive correction, LASIK, Multi-Photon Absorption, Precision Scanning Systems, Preliminary results. *Lecture 7: Differential Wavefront Interferometry & Multi-DOF Interferometry* Topics covered: Fiber delivered interferometry, Differential Wavefront Sensing, Roll Axis Weak Measurements, Multi-DOF sensing, Stage Calibration *Lecture 8: Point-to-Point Metrology Methods for Freeform Optics Metrology* Topics covered: CMMs, Optical CMMs, Optical Probes, Contact vs. Non-Contact. Freeform Optics metrology, Interferometry, Optical Coherence Tomography, LIDAR, Confocal microscopy.
Prior knowledge or courses	