Fall 2014

OPTI 526: Optical Design in Multi-scale Photonic System

(2 units)

Dynamically dated course: 09/29/2014-12/10/2014
Tuesday/Thursday 8:00-9:15am
Optical Science RM 305
Note: students enrolling in OPTI 526 must also enroll in OPTI 600A

Instructor:

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Course Website: D2L

Contents:

Modern complex optical system consists of subsystems having various characteristic length scales, which extend from nanometer to macroscopic range. Future optical engineers are required to design, analyze, and characterize such multi-scale optical systems by using appropriate theory, framework and modalities. This course provides students opportunities to understand basic theories, learn procedures and software to design and analyze multi-scale and nano-photonic optical system such as nano aperture scanning microscope, grating sensors, photonic crystals, holographic data storage employing volume grating as well as a complex lens system. In the first part class we emphasize understanding basic theory. In the second part of the class, critical reviewing of relevant papers and design project by using software such as CodeV, OptiScan, COMSOL, and FDTD will be assigned.

Prerequisites*:

Co-requisite: OPTI 600A: Photonics in Lens Design (will be completed during first 5 weeks of semester)
OPTI 502, 505R, 512R or equivalent.

Required Textbooks and References:

Goodman, J.W. (2005). Introduction to Fourier Optics (3rd Ed.). Roberts and Company Publishers. ISBN-10: 0974707724.

Recommended Textbooks and References:

Joannopoulos, John D (2008). Photonic Crystals: Molding the Flow of Light (2nd Ed.). Princeton University Press. ISBN-10: 0691124566.

Smith, Howard M. (1976). Principles of Holography. John Wiley & Sons Inc. ISBN-10: 0471803413.
Class notes. Selected reading materials will be distributed.

Schedule:

Covered in OPTI 600A (co-	1	Aug. 26	Introduction		Course introduction, CodeV, Optical Design
		Aug. 28	Holography I	Goodman 9.1, 9.2,	Basic Description of Holography, Gabor, Leith-Upatnieks Hologram
	2	Sep. 2	Holography II	Goodman 9.3, 9.4, 9.5	Image formation by holography
		Sep. 4	Holography III	Smith, Goodman 4.4.3	Amplitude grating, theoretical max of diffraction efficiency
	3	Sep. 9	Holography IV	Smith, Goodman 4.4.4	Phase grating and theoretical max of diffraction efficiency
		Sep. 11	Coupled wave analysis I	Goodman 9.7.1-4	Kogelnik's Coupled Wave Analysis
	4	Sep. 16	Coupled wave analysis II		Goodman 9.7.5/ Kogelnik
		Sep. 18	Coupled wave analysis III	Goodman 9.7.5/ Kogelnik	Kogelnik's Coupled Wave Analysis (Continued)
	5	Sep. 23	**CodeV HOE modeling**	CodeV Manual	Modeling of Volume Hologram by CodeV
		Sep. 25	**RCWA analysis I**	OPTISCAN Manual	OPTI Scan Software Demo
OPTI 526 (2 credit course material)	6	Sep. 30	Application of Holography	Review Paper Provided	Fiber Bragg Grating, Holographic Memory
		Oct. 2	RCWA analysis II	M&G Paper	Introduction to Rigorous CWA
	7	Oct. 7	RCWA analysis III	M&G Paper	Introduction to Rigorous CWA
		Oct. 9	RCWA analysis IV	M&G Paper	Introduction to Rigorous CWA
	8	Oct. 14	Photonic band gap materials I	Joannopoulos	Master Equations
		Oct. 16	Photonic band gap materials II	Joannopoulos	Master Equations
	9	Oct. 21	Photonic band gap materials III	Joannopoulos	Band diagram
		Oct. 23	Photonic band gap materials IV	Joannopoulos	Transfer matrix
	10	Oct. 28	Photonic band gap materials V	Joannopoulos	2D Photonic Crystal
		Oct. 30	**Volume Holography Lab**		
	11	Nov. 4	FDTD analysis I	Class Note	Introduction to FDTD
		Nov. 6	**FDTD analysis II**	Class Note	FDTD Practice
	12	Nov. 11	**FDTD analysis III**	Class Note	FDTD Practice
		Nov. 13	50% Presentation (~3rd order analysis)		
	13	Nov. 18	Fundamentals of Plasmonics I	Class Note	Basic Equations
		Nov. 20	Fundamentals of Plasmonics II	Class Note	Basic Equations
	14	Nov. 25	Fundamentals of Plasmonics III	Class Note	Dispersion
		Dec. 2	Fundamentals of Plasmonics IV	Class Note	Applications
	15	Dec. 4	Fundamentals of Plasmonics V	Class Note	Applications
		Dec. 9	Photonic antenna and resonant apertures	Class Note	Resonant nano apertures
	16	TBA	Final Presentation		

Software Demo/Practice in class
Lab/Demo in class

Computing Environment:

CodeV, RCWA (Optiscan): Windows operating system, Matlab on local PC

FDTD (MIT Meep), FEM (COMSOL): Access to Linux server is provided. Students use PC/MAC to remotely login to the server.

Grading:

Homework 20%, Midterm Assignment 20%, Final Project/Report 60%

The class grades will depend on the class score statistics. However, nominally the following score ranges will be used to assign grades:

100%-90%: A | 75%-89%: B | 65%-74%: C | 55%-64%: D | 0%-54%: E

Academic Integrity:

According to the Arizona Code of Academic Integrity, “Integrity is expected of every student in all academic work. The guiding principle of academic integrity is that a student’s submitted work must be the student’s own.” Unless otherwise noted by the instructor, work for all assignments in this course must be conducted independently by each student. Co-authored work of any kind is unacceptable. Misappropriation of exams before or after they are given will be considered academics misconduct.

Misconduct of any kind will be prosecuted and may result in any or all of the following:

- Reduction of grade
- Failing grade
- Referral to the Dean of Students for consideration of additional penalty, i.e., notation on a student’s transcript re: academic integrity violation, etc.

Students with Learning Disabilities

If a student is registered with the Disability Resource Center, he/she must submit appropriate documentation to the instructor if he/she is requesting reasonable accommodations.