USC Viterbi School of Engineering

Ming Hsieh Department of Electrical Engineering

Course Announcement

EE 566: Optical Information Processing

Spring Semester 2010

This course covers the analysis, synthesis, and application of systems that use coherent or incoherent light.

Topics include:

- Scalar diffraction theory
- Diffraction from planar objects; light propagation (exact and approximate)
- Coherent and incoherent light (mathematical and physical descriptions)
- Imaging systems (including diffraction effects; incoherent and coherent systems)
- Optical Fourier transforming systems
- Introduction to information processing and computing systems using optics
- Introduction to holography

Sample applications will be selected from these and other topics, and will depend on student interest:

- Optics and diffraction effects in the eye
- Optical metamaterials and superlenses
- Computing, including optical memory and interconnections
- Biomedical, including optical coherence tomography for 3-D imaging of human tissue
- Ultrashort optical pulse processing for optical communications
- Optical imaging and sensing using compressive sampling
- Noninvasive testing and measurement
- Diffractive optical concentrators for solar cells

Prerequisite:	EE 401 or equivalent knowledge of Fourier transforms and linear systems
Time & Location:	Monday and Wednesday 12:30 - 1:50 PM, OHE 100B; and DEN locations.
Text:	Joseph W. Goodman, *Introduction to Fourier Optics, Third Ed.* (Roberts and Co., Englewood, Colorado, 2005)
Instructor:	Prof. B. Keith Jenkins, EEB 404A, jenkins@sipi.usc.edu, (213) 740-4149

USC

http://ee.usc.edu/academics/

EE 566 **Optical Information Processing** **Spring 2010**
B. K. Jenkins **Course Syllabus - DRAFT**
10/29/09

Class days and time: MW 12:30 - 1:50 PM PT
Class location: OHE 100B

Course prerequisites

Required: Knowledge of signals, linear systems, and Fourier transforms at the level of EE 301 and EE 401. Graduate standing in engineering or physics.

Helpful but not required: Familiarity with electromagnetic theory; familiarity with MATLAB.

Course text (required)

Joseph W. Goodman, *Introduction to Fourier Optics*, Third Edition (Roberts & Company, Englewood, Colorado, 2005)

Course Materials (daily lecture notes, handouts, and homeworks)

These materials will be available for downloading from the web. (For daily lecture notes, allow 24 hours after each class for posting.) The web site for EE 401 materials is reachable from the main DEN page:

http://mapp.usc.edu/distanceeducation/

You will need a DEN account, which is automatically set up for you if you are registered for this class. You will need Adobe Acrobat Reader to view the files.

Course Contact Information

Instructor: Prof. B. K. Jenkins
Office: EEB 404A
Phone: 213-740-4149
Fax: 213-740-6618
Email: jenkins@sipi.usc.edu [Please include "EE 566" in the subject line]
Office hours: TBD

T. A, grader.: TBA
Office:
Phone:
Fax:
Email:
Office hours:

Distance Education Network (DEN) Program Contact Information

Main web page: http://mapp.usc.edu/distanceeducation/

Complete contact information is available from this web page. A few contacts are listed below for your convenience:

General technical problems (online services, webcasts, software)	webclass@usc.edu	213-821-1321
General administrative problems	denadmin@usc.edu	213-740-4488
Master Control (Class broadcasting, classroom telephones)	networkcontrol@den.usc.edu	213-740-0130
Exams and proctoring:	denexam@usc.edu	213-821-3136
Homework submissions, records, and delivery (remote students):		213-740-9356
denhw@usc.edu	Fax submission:	213-740-9121

Grading

Homework	[approximately 1 per week, mostly to be solved with pen and paper; some optional problems may use applets (to be provided) or Matlab)]	25%
Midterm	(TBA; most likely Mon. 3/8/2010 or Wed. 3/10/2010 , 12:30 – 1:50 PM PDT)	35%
Final exam	(Friday, May 7, 2010, 11:00 AM – 1:00 PM PDT)	40%

Policy on Academic Integrity

All students are expected to abide by the USC student conduct code, as well as apply common sense as to what behavior is reasonable and fair to other students. Violations will be dealt with in accordance with university guidelines.

In this class, collaboration on techniques for solving homework assignment problems is allowed, and can be helpful; however, each student is expected to work out, code, and write up his or her own solution. Use of solutions from anyone else or any other source, before the assigned homework is turned in, is not permitted. Of course, collaboration on exams is not permitted.

More information on academic integrity can be found in the Scampus, including these links:
http://web-app.usc.edu/scampus/university-student-conduct-code/
http://web-app.usc.edu/scampus/1100-behavior-violating-university-standards-and-appropriate-sanctions/

EE 566 **Optical Information Processing** **Spring 2010**
Course Outline

1. Course introduction [1.5]
   - Course logistics and requirements
   - Overview of course material and applications
2. Background material and review [2.5]
   - Delta functions
   - Linear systems
   - Fourier transforms (2-D)
   - Space-bandwidth product and local spatial frequency
3. Scalar diffraction theory and wavefront propagation [4]
   - Preliminaries (representation, scalar diffraction theory assumptions)
   - Wave and Helmholtz equations
   - Formulation of optical waves
   - Diffraction formulas (Monochromatic and nonmonochromatic cases; time and frequency domains)
   - Angular spectrum of plane waves interpretation (Spatial-frequency domain)
   - *Evanescent waves and negative index materials (metamaterials)
4. Approximations to diffraction formulas [4]
   - Rayleigh-Sommerfeld formula; initial approximations
   - Fresnel
   - Fraunhofer (far-field, paraxial)
   - *Far-field, large angle
   - Regions of validity
   - Limited spatial frequency
   - Examples 1: absorption and phase gratings; diffraction efficiency
   - *Examples 2: diffractive optical elements – computer designed to synthesize arbitrary diffraction patterns
5. Optical Fourier transforming and imaging using thin-lens systems [4.5]
   - => Assume monochromatic illumination
   - Thin lenses
   - Fourier transforming
   - Imaging
   - *Research frontier example: superlenses to exceed the diffraction limit
   - General optical system analysis

6. Coherence [1.5]
   - Spatial and temporal coherence
   - Coherent and incoherent illumination
   - *Biomedical application example: Optical coherence tomography for 3-D imaging
7. Analysis of optical imaging systems [3]
   - Frequency-domain analysis of generalized imaging systems
   - Coherent illumination
   - Incoherent illumination
   - *Application example: diffraction effects in the eye
8. Information processing: optical/photonic devices and systems [2.5]
   - *Wavefront modulation (fixed materials, real-time devices, diffractive optical elements)
   - *Early information processing work
   - *Incoherent processing systems
   - *Incoherent processing application: compressive sensing of images
   - Coherent processing systems (including frequency domain processing)
   - *Application examples: Optics in computing systems - memory and interconnections
9. Introduction to holography [1.5]
   - Wavefront recording and reconstruction
   - Planar holography
   - *Application example: noninvasive evaluation of surface topography
   - *Computer-generated holography
   - *Volume holography
   - *Application example: diffractive optical concentrators for solar cells
10. *Other topics and applications of interest [1]

Notes:

*Degree of inclusion and emphasis of indicated topics will depend on class interest and available time.

Numbers in brackets [•] represent approximate number of lectures on that topic.