OPTI 475/575 Optical Thin Films

Course Description:

The optical properties of single films, design and multilayer optical coatings, calculation and visualization aids, accurate computation methods, introduction to manufacturing methods, non-ideal behavior of thin films. Undergraduate Prerequisite: OPTI 310 or Instructor Consent; Graduate Prerequisite: OPTI 505R or Instructor Consent.

Instructor:

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Textbooks:

No textbook is required for the course. A comprehensive set of notes in the form of a pdf file will be available. Do not be misled. The notes contain an enormous amount of material and very much more than is necessary to pass the course. There is also a list of text books for those who might wish to go further into the subject. Homework and exam will be based on what is covered in class.

Grading Policy:

Total score ≥ 85% A

85% > Score ≥ 75% B

75% > Score ≥ 60% C

60% > Score D

The assessment will be based on homework and a final exam which will be a written open-book exam. The total homework mark will be combined with the exam mark with equal weight and the result will be expressed in %.

The grading policy for both graduate and undergraduate levels is identical, but the homework and exams on which the grades are based will be separately designed for each group, the graduate versions representing a more advanced level.

Course Syllabus

Topics

Optical systems and instruments almost invariably consist of a series of optical surfaces that reflect and refract the light. If these surfaces are untreated then they present properties that are determined purely by the massive materials on either side. The limitations represented by these natural properties are so severe that they would prevent acceptable operation of any but the

simplest of systems. Modification of the properties of the surfaces requires the application of optical coatings. Although optical coatings are primarily used to alter the reflectance and/or transmittance of a surface other properties are also important. Coatings frequently revolutionize technologies. Topics to be discussed include such examples as the surface plasmon resonance detector used for sensing extremely small changes in biological systems, the chirped coatings used in ultrafast pulse applications and the narrowband beam splitters used in wavelength division multiplexing.

This course will cover the structure, design and performance of thin-film optical coatings. The fundamental theory of thin film multilayers and of their design will be included but considerable emphasis will be given to techniques for understanding and prediction that supplement the straightforward calculation of performance that is normally carried out by computer.

Types of coatings will include antireflection and high reflectance coatings, beam splitters, edge and dichroic filters, band-pass filters, polarizers, rugates, retarders, surface plasmon resonance detectors, and coatings for ultrafast applications. Although each may seem quite different from the others in structure and operation nevertheless they are governed by the same principles.

The emphasis throughout the course is on fundamental understanding. There are no strict prerequisites beyond an acquaintance with electromagnetism, complex numbers and 2x2 matrices. OPTI 505R would be useful for Graduate Students and OPTI 310 for Undergraduate Students.

Provisional Outline

1. Fundamentals
2. Metals and dielectrics
3. Matrix method
4. Quarterwave rule and simple coatings
5. Oblique incidence intro
6. Admittance diagram intro
7. Admittance diagram and antireflection coatings
8. Admittance diagram and high reflectance coatings
9. Electric fields.
10 Oblique incidence introduction
11. Vector diagram
12. Inhomogeneous layers - rugates
13. Metal layers and admittance diagram
14. Oblique incidence of metals and further study of dielectrics
15. Symmetrical periods
16. Edge filters
17. Narrowband filters
18. Potential transmittance
19. Beyond the critical angle

20. Surface plasmon resonances
21. Short pulse effects
22. Double-sided systems, Absorbing substrate
23. Half-wave hole and other problems. New antireflection coatings for plastics.
24. Smith chart, circle diagrams etc
25. Color in optical coatings
26. Monitoring of thin film thickness
27. Microstructure and processes
28. Microstructure and processes continued
29. Revision

8 October 2012