1.0 TITLE: GEOMETRICAL OPTICS & LENS DESIGN 1051-736  DATE: 10/25/2006

Credit Hours:  4
Prerequisite(s):  RIT/CIS Graduate School admission prerequisites, Optics&Detectors1051-733, Software: OSLO optical design package.

Corequisite(s) none
Course proposed by: __Robert MacIntyre

2.0 Course information:

<table>
<thead>
<tr>
<th>Contact hours</th>
<th>Maximum students/section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom</td>
<td>4</td>
</tr>
<tr>
<td>Lab DIP</td>
<td>2</td>
</tr>
<tr>
<td>Studio</td>
<td></td>
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<tr>
<td>Other (specify)</td>
<td></td>
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Quarter(s) offered (check)  
___X__ Fall   _____ Winter   __?__ Spring   _____ Summer

Students required to take this course: (by program and year, as appropriate)  
______None____________________________________________________

Students who might elect to take the course:  
___ Graduate students in Imaging Science, Color Science, and Electrical Engineering.

3.0 Goals of the course (including rationale for the course, when appropriate):
This course is directed to the practicing engineer or scientist who Requires effective practical technical information on optical systems and their design. The increase in the utilization of optical devices in Such fields as alignment, metrology, automation, communication, and Space and defense applications has brought about a need for technical people conversant with the optical field.
4.0 **Course description** (as it will appear in the RIT Catalog, including pre- and co-requirements, quarters offered)

This course leads to a thorough understanding of the geometrical properties of optical imaging systems and detailed procedures for designing any major lens system.

5.0 **Possible resources (texts, references, computer packages, etc.)**

5.1 **Required**

Modern Lens Design 2nd Edition by Warren Smith
Optics by Eugene Hecht, 4th edition Chapter 5 & 6 (text for 1051-733)
OSLO User's Guide

6.0 **Topics (outline):**

6.1 Image Evaluation

6.1.1 Introduction
6.1.2 Optical Path Difference: Focus Shift
6.1.3 Optical Path Difference: Spherical Aberration
6.1.4 Aberration Tolerances
6.1.5 Image Energy Distribution (Geometric)
6.1.6 Spread Functions—Point and Line
6.1.7 Geometric Spot Sizes Due to Spherical Aberration
6.1.8 The Modulation Transfer Function
6.1.9 Computation of the Modulation Transfer Function
6.1.10 Special Modulation Transfer Functions:
6.1.11 Radial Energy Distribution
6.1.12 Point Spread Functions for the Primary Aberrations

6.2 Stops, Pupils, Apertures

6.2.1 Introduction
6.2.2 The Aperture Stop and Pupils
6.2.3 The Field Stop
6.2.4 Vignetting
6.2.5 Glare Stops, Cold Stops, and Baffles
6.2.6 The Telecentric Stop
6.2.7 Apertures and Image Illumination—f-Number and Cosine-Fourth
6.2.8 Depth of Focus
6.2.9 Diffraction Effects of Apertures

6.3 Lens Design Data
6.3.1 Lens Prescriptions, Drawings, and Aberration Plots
6.3.2 Estimating the Potential of a Redesign
6.3.3 Scaling a Design, its Aberrations, and its Modulation Transfer Function
6.3.4 Interpretation of Ray Intercept Plot and Various Plots

6.4 Optical Merit Functions
6.4.1 Optimization
6.4.2 Local Minima
6.4.3 Types of Merit Functions
6.4.4 Stagnation
6.4.5 Generalized Simulated Annealing
6.4.6 Spectral Weighting

6.5 Infrared & Ultraviolet Systems
6.5.1 Infrared Optics
6.5.2 IR Objective Lenses
6.5.3 IR Telescopes
6.5.4 Laser Beam Expanders
6.5.5 Ultraviolet Systems
6.5.6 Microlithographic Lenses

6.6 Zoom Lenses
6.6.1 Zoom Lenses General
6.6.2 Zoom Lenses for Point and Shoot Cameras
6.6.3 A 20x Video Zoom Lens
6.6.4 Zoom Lens Design Procedures

6.7 Tolerance Budgeting
6.7.1 The Tolerance Budget
6.7.2 Additive Tolerances

6.8 Lens Types to be Studied
6.8.1 Telescope objectives
6.8.2 Cooke triplet anastigmats
6.8.3 Double-meniscus anastigmats, the Biotar or Double-gauss
6.8.4 Telephoto lenses, Reversed telephoto (retrofocus and fish-eye) lenses
6.8.5 Microscope Objectives
6.8.6 Mirror and Catadioptric systems
6.8.7 Zoom Lenses

7.0 Intended learning outcomes and associated assessment methods of those outcomes

<table>
<thead>
<tr>
<th>Learning Outcome</th>
<th>In class attendance and evaluation</th>
<th>Homework Assignments</th>
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Learning Outcome In class attendance and evaluation Homework Assignments
7.1 Master a thorough understanding of widely utilized principles of optical design

| 7.2 Design a number of Optical Designs (i.e. Triplets, Double Gauss, Telephoto, Miroscope, Zoom, Catadioptic...) | X | X |

8.0 **Program or general education goals supported by this course**

8.1 There are only a modest number of well-understood and widely utilized principles of optical design.
8.2 Our goal is to master these principles.

9.0 **Other relevant information** (such as special classroom, studio, or lab needs, Special scheduling, media requirements, etc.)

9.1 All students need classroom access to IBM-PC Windows XP
9.2 Overhead PC desk top projector
9.3 Internet on line student & professor
9.4 Macromedia Breeze workplace

10.0 **Supplemental information**