1. **Number and title of course:** EE 119, Introduction to Optical Engineering

2. **Catalog description:** (3 units) Three hours of lecture and one hour of discussion per week. Fundamental principles of optical systems. Geometrical optics and aberration theory. Stops and apertures, prisms, and mirrors. Diffraction and interference. Optical materials and coatings. Radiometry and photometry. Basic optical devices and the human eye. The design of optical systems. Lasers, fiber optics, and holography.

3. **Prerequisites:** Physics 7C.

4. **Textbooks and/or other required material:**

5. **Course objectives:** This course introduces fundamental physical principles of both classical and modern optics as well as principles of optical design used in the engineering of optical systems. It also provides exposure to practical aspects of optical materials and devices. Its intention is to provide a foundation of basic principles, design methodology, and practical considerations needed to design or use optical instruments in engineering practice.

6. **Topics covered:**
   a. Introduction to the propagation of light: Snell’s law and Huygen’s principle; Refraction and reflection; Plane waves, spherical waves and image formation; Total internal reflection; Polarization, polarizers, and wave-plates.
   b. Lenses and aberrations: Formation of images; Resolution and primary aberrations; Prism devices; Various optical material types and their application to optical components.
   c. Some simple optical instruments: Cameras, telescopes, microscopes, and projection systems.
   d. Basic diffraction: Fresnel and Fraunhauer; Spatial and temporal coherence.
   e. Gaussian beam propagation, the ABCD matrices, and paraxial concepts from the point of view of diffraction.
   f. Coherent sources: Optical gain; Quantum mechanics sufficient to discuss spontaneous and stimulated emission; Light emitting diodes; Population inversion; Optical feedback and resonant cavities; Laser modes; Spectral bandwidth and coherence length; Parametric sources.
   g. Detectors: Semiconductor detectors, including p-n junction diodes, PIN diodes, and avalanche diodes; Photomultipliers; CCD microchannel plate image intensifiers.
   h. Polarization and light modulators: Liquid crystal light valves and flat panel displays; Deformable mirror array devices; Basis of electro-optic modulation.
   i. Fiber optics: Waveguides and models; Fiber coupling; Single- and multi-mode fiber; Fiber communication systems, including couplers and switches, time division, and wavelength division multiplexing; Fiber dispersion; Fiber amplifiers and array detectors.
   j. Partial coherence: Illuminators and condensers; Brightness theorem; Field uniformity and light collection efficiency; Incoherent or partially coherent light sources, including solar, arc lamp, tungsten filament lamp, and mercury
discharge lamp; Solar energy collectors, including photovoltaics and thermal concentrators.

k. Interference: Young’s 2-slit experiment and fringe visibility; Michelson Interferometer; Multiple beam interference and thin film coatings.

l. Holography: In-line holography and off-axis holography; Various holographic schemes, including reflection holograms, rainbow holograms; Holographic data storage.

m. Optics and nanostructures–Recent approaches to confined optical interactions and guiding: Surface wave couplers and devices, near field effects, and sub-wavelength optical components.

7. **Class/laboratory schedule:** Two 90-minute lectures and a one hour discussion section per week. Seven half-hour lab demonstration sessions per semester.

8. **Contribution of course meeting the professional component:** This course covers engineering topics. It provides introductory laboratory experience. It is approximately 75% science and 25% design.

9. **Relationship of course to program outcomes:** EECS 119 requires students to apply a fundamental knowledge of optical physics and optical design principles to solve optical engineering problems. Students gain an understanding of conceptual foundations and emerging applications of optical and electro-optical systems.

10. **Expected outcomes:**
    a. Basic knowledge of the laws governing optical propagation and the influence of boundaries and finite transverse extent on optical beams.
    b. To have acquired basic knowledge of optical components and instruments.
    c. Have knowledge and understand the measurement of first order spatial and temporal coherence.
    d. To have a conception of sources of coherent and incoherent optical beams.
    e. To have acquired the basic concepts of spontaneous and stimulated emission and their role in optical gain and noise.
    f. Understand the principles of optical feedback, resonant cavities.
    g. To have acquired a comprehension of detection principles and the various types of detectors.
    h. To have an understanding of the modulation of light beams and to be able to discuss various techniques for accomplishing this.
    i. To have acquired a basic comprehension of fiber optical systems, the important parameters, and various standards and economic issues.
    j. To have acquired some knowledge of optical signal processing techniques, including: holography, Fourier transforms, and phase contrast.
    k. To have some knowledge of recent developments in linear, nonlinear, and surface wave optics.
    l. To have exposure to experimental technique, either through demonstration experiments, mini-labs, or a class project.

11. **Prepared by:** Professor T. K. Gustafson (1/2008)