MOHAWK VALLEY COMMUNITY COLLEGE

UTICA AND ROME, NEW YORK

COURSE OUTLINE

SCIENCE OF LIGHT 1

PH112

REVIEWED AND FOUND ACCEPTABLE  ***04/24/2017***

I. CATALOG DESCRIPTION:

PH112 SCIENCE OF LIGHT 1 C-3, P-2, Cr-4

This course introduces the concepts of light and optics. Topics include the historical development of optical instruments, electromagnetic spectrum, lenses and image formation, light-sensitive materials and processes, color filters, Kirlean imaging, and holography. Examples are chosen from a variety of fields, including photography, human vision, and nature.

Pre-requisites: An appropriate Mathematics Placement test result, or MA090 Essential Math Skills, or MA091 Introductory Algebra

II. STUDENT LEARNING OUTCOMES:

1. Use scientific notation.

2. Calculate conversions between the English and SI system units.

3. Explain what is meant by the focal length of a lens and be able to determine the focal length of a lens given to them.

4. Explain the inverse square law and be able to quantitatively apply it to real world situations.

5. Describe, and apply in a quantitative manner, how apertures control image brightness.

6. Describe the extent and components of the Electromagnetic Spectrum.

7. Differentiate and be able to convert between the basic units used to express the wavelengths of light.

8. Apply to real world situations, the basic optical laws of reflection and refraction.

9. Explain how converging and diverging lenses work and be able to predict quantitatively and graphically the location of the resulting image once the object's location is known.

10. Explain the meaning of third order lens aberrations and the need for compound lenses to minimize their presence.

11. Determine and use principle planes in connection with compound lenses.

12. Use several techniques for determining the angle of view of an optical system.

13. Use and control perspective in photographs.

14. Explain how the optics of the human visual system works and how common refractive problems of the eye arise and are corrected.

15. Demonstrate the production and viewing of 3-D stereoscopic images.

16. Demonstrate the production and viewing of Holograms.

17. Describe the historical development and current design of a variety of optical instruments.

18. Compute the logarithms of numbers.

19. Explain and compute the transmittance, opacity, and density for a given filter and be able to read the manufacturer's technical data for a given filter.

20. Apply the techniques and applications of additive and subtractive color mixing.

21. Explain the value of polarized light and several ways to obtain polarized light.

III. DETAILED COURSE OUTLINE:

I. Introduction, Light, and Exposure

A. Numbers and Units

1. Introduction

2. Scientific Notation

3. Systems of Units

B. Nature of Light

1. Wave Description

2. EM Spectrum

3. Quantum Description

C. Exposure

1. Aperture

2. Angle of View

3. Depth of Field

4. f-number

5. Change with Distance

6. Shutter Speed and total exposure

II. Geometric Optics

A. Reflection and Refraction

1. Law of Reflection

2. Law of Refraction

3. Total Internal Refraction

B. Lenses and Mirrors

1. Ray Tracing

2. Thin Lens Equation

3. Converging and Diverging Lenses: Ray tracing and calculation

4. Converging and Diverging Mirrors: Ray tracing and calculation

5. Aberrations: Chromatic and Spherical

D. Optical Systems

1. Optical Telescopes: Reflection and Refracting

2. Non-optical Telescopes: Radio, Microwave, X-ray, Gamma Ray

3. Microscopy

4. Non-optical Microscopy: SEM, TEM, AFT, STM

III. Optical Characteristics of Human Vision, Wave Optics, and Filters

A. The Eye

1. Physical Components

2. Abnormalities and Corrections: Nearsightedness and Farsightedness

3. Color Abnormalities

B. Perception

1. Color Constancy

2. Stereopsis

3. Artificial Stereo Viewing

C. Wave Optics

1. Huygen’s Principle

2. Diffraction

3. Double Slit, Single Slit, Diffraction Gratings

4. Double Slit Diffraction Calculations

D. Light Fields

1. Light Field

2. Lasers

3. Holography

E. Filters

1. Polarization, Rayleigh Scattering

2. Polarization filter intensity

3. Neutral Density Filters

4. Transmittance, Optical Density Calculations

5. Color Filters with Transmission Curve

IV: Applications

A. Imaging

1. Film construction

2. Sensitometry

3. Photoelectric Effect

3. CCD and CMOS

B. Other applications

1. Photolithography

2. Solar Energy

3. X-ray Diffraction

4. Selected topics relevant to student interests or current events

IV. LABORATORY TOPICS:

1. Measurements

2. Introduction to Camera Operation

3. Depth of Field

4. Lighting Ratios

4. Exposure Exercises with Camera

5. Reflection

6. Refraction

7. Lenses

8. Mirrors

9. Optical Systems

10. Stereo Viewing

11. Diffraction

12. Polarization

13. Neutral Density Filters

14. Elemental Spectra