SECTION A: Answer ALL Questions in this section.

Question 1 (30 Marks)

a) Define the following terms as used in optics

(i) Dispersion [1 mark]

(ii) Polarization angle [1 mark]

(iii) Diffraction grating [1 mark]

b) A lens has a convex surface of radius 20.00 cm and a concave surface of radius 40.00 cm and is made of glass of refractive index 1.54. Compute the focal length of the lens, and state whether it is a converging or diverging lens. [4 marks]

c) **(i)** State the lens makers equation [2 marks]

(ii) An equiconvex lens is to be made of flint glass of refractive index 1.75. Calculate the radii of curvature if it is to have a power of 3.00 dioptres. [3 marks]

d) Differentiate between Optical aberration and Spherical aberration. [2 marks]

e) Consider a common mirage formed by superheated air just above a roadway. A truck driver whose eyes are 2.00 m above the road, where n = 1.0003, looks forward. He has the illusion of seeing a patch of water ahead on the road, where his line of sight makes an angle of 1.20° below the horizontal. Find the index of refraction of the air just above the road. [3 marks]

f) A double-slit source with slit separation 0.20 mm is located 1.20 m from a screen. The distance between successive bright fringes on the screen is measured to be 3.30 mm. What is the wavelength of the light? [3 marks]

g) Briefly describe how light gets polarized by dichroism [3 marks]

h) **(i)** State the principle of superposition of waves. [2 marks]

(ii) Obtain an expression of the resultant waveform when two waves of the same frequency and travelling along the same direction superimpose with each other. [3 marks]

i) Differentiate between dextrorotory and laevorotory as used in rotation of the plane of polarization. [2 marks]

SECTION B: Answer ONLY TWO questions from this Section.

Question 2 (20 Marks)

a) A pair of narrow, parallel slits separated by 0.25 mm is illuminated by the green component from a mercury vapor lamp (wavelength=546.10 nm). The interference pattern is observed on a screen 1.20 m from the plane of the parallel slits. Calculate the distance

(i) from the central maximum to the first bright region on either side of the central maximum [5 marks]

(ii) between the first and second dark bands in the interference pattern [4 marks]

b) A transparent oil with index of refraction 1.29 spills on the surface of water (index of refraction 1.33), producing a maximum of reflection with normally incident orange light (wavelength 600 nm in air). Assuming the maximum occurs in the first order, determine the thickness of the oil slick. [5 marks]

c) Light of wavelength 600 nm falls on 0.40 nm wide slit and forms a diffraction pattern on a screen 1.5 m away.

(i) Find the position of the first dark band on each side of the central maximum [4 marks]

(ii) Find the width of the central maximum [2 marks]

Question 3 (20 Marks)

a) State the Huygen's principle. [2 marks]

b) Using the Huygen's principle, obtain the Snell's law of refraction [6 marks]

c) State the Fermat's principle of least time. [2 marks]

d) Use the Fermat's principle to prove the laws of reflection [10 marks]

Question 4 (20 Marks)

a) Astronomers often take photographs with the objective lens or mirror of a telescope alone, without an eyepiece.

(i) Show that the image size h' for this telescope is given by $h' = \frac{fh}{f-p}$ where h is the object size, f is the objective focal length and p is the object distance. [6 marks]

(ii) Simplify the expression in part (i) above if the object distance is much greater than the objective focal length. [4 marks]

(iii) The *wingspan* of the International Space Station is 108.60 m, the overall width of its solar panel configuration. When it is orbiting at an altitude of 407 km, find the width of the image formed by the telescope objective of focal length 4.00 m. [4 marks]

b) A converging lens with a diameter of 30.00 cm forms an image of a satellite passing overhead. The satellite has two green lights of wavelength 500 nm spaced 1.00 m apart. If the lights can just be resolved according to the Rayleigh criterion, what is the altitude of the satellite? [6 marks]

Question 5 (20 Marks)

a) A student is looking vertically down into a swimming pool with calm water (n=1.33) and sees his Optics textbook lying on the bottom at 2.00 m. How deep is the pool? [5 marks]

b) The student then decides to plunge into the pool to retrieve the book. While inside the pool, he decides to look vertically upwards at a depth of 1.50 m and sees the surface to be flat. Find the diameter of the circle entering form above. [7 marks]

c) An object sits to the left of a lens at a distance of 74.20 cm. An inverted image is formed on the right of the lens that is 2.88 times the size of the object.

(i) Where is the image formed with respect to the lens (in cm) and is it real or virtual (why)? [4 Marks]

(ii) What is the focal length of the lens (in cm) and is this a diverging or converging lens (why)? (*Show all work!!!*) [4 Marks]

********** END OF SPH 103 EXAMINATIONS **********

MERRY XMAS AND A PROSPEROUS NEW YEAR