TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES
DEPARTMENT OF MATHEMATICS AND PHYSICS

UNIVERSITY EXAMINATIONS 2017/2018
APS 4107: GEOMETRICAL OPTICS

SERIES: SEPTEMBER 2018 TIME: 2 HOURS

Instructions to candidates:

You should have the following for this examination:
Answer booklet, Examination paper, Examination Pass, Mathematical Set and Student ID.

This examination paper contains Five questions.
Answer question **ONE and any TWO** other questions.
Question **ONE** carries **30** marks while the rest of the questions carry **20** marks each.

Given Constants:
Permittivity of free space: $\epsilon_0 = 8.854\ 185 \times 10^{-12}\ Fm^{-1}$,
Permeability of free space: $\mu_0 = 4\pi \times 10^{-7}\ Hm^{-1}$
Velocity of light in free space: $c = 3.0 \times 10^{8}\ ms^{-1}$.

QUESTION ONE (30 MKS)

a). A ray of light travelling in water strikes normally a water-glass interface. Find the percentage of light that is transmitted given that the refractive indices of glass and water are 3/2 and 4/3, respectively.

(3marks)

b). An object is placed 12 cm from a converging lens of focal length 18 cm. Find the position of the image.

(3marks)

c). A ray of light is incident at an air glass interface at an angle 30^o to the normal and is refracted into glass of refractive index 1.5. Find the angle of refraction in glass.

(4marks)

d). Find the angular spread of a fish view disc for a fish in sea water whose refractive index is 1.4.

(3marks)

e). A concave mirror has a radius of curvature of 30 cm. A 5 cm tall object is placed 5 cm from the mirror along its axis. By accurate sale drawing find the location, the size and the nature of the image formed.

(7marks)

f). Differentiate between Photoemissive and Photoelectric photodetectors.

(2marks)

g). A concave mirror has a radius of curvature of 80 cm. In front of it is a 2 cm tall object placed 20 cm away. Characterize the image produced by the mirror.

(4marks)

h). Find the velocity of light in glass of refractive index 3/2. (Use the values of permittivity and permeability of free space given).

(4marks)

QUESTION TWO (20MKS)

a) Show using an appropriate sketch diagram, that the Gaussian lens equation: $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ is equivalent to the Newtonian Lens Formula.

(3marks).

b) By means of a ray diagram show how chromatic aberration occurs in a convex lens

(3marks).

c). A converging lens of focal length 30 cm is 20 cm away from a diverging lens of focal length 5 cm. An object is placed 6 meters distant from the former lens (which is nearer to it) and on the common axis of the system. Determine the position, magnification and nature of the image.

(7marks)

d). A converging beam of light is incident on a diverging lens of focal length 20 cm. If the beam converges to a point 4 cm behind the lens, find the position of the point image.

(5marks)

e). What is (i) A virtual image

(ii) Refractive power,

(2marks)

QUESTION THREE. (20MKS)

a). A lantern is required for the projection of slides 7.5 cm square on to a screen 2.1m square. The distance between the front of the lantern and the screen is to be 20m. What focal length of projection lens would you consider most suitable.

(4marks)

b). Describe a good method of measuring the refractive index of a substance such as glass.

(4marks)

c). Name the defects of the human eye and state how they are corrected.

(4marks)

d). A Galilean telescope has an object-glass of 12 cm focal length and an eye lens of 5 cm focal length. It is focused on a distant object so that the final image seen by the eye appears to be situated at a distance of 30 cm from the eye lens..Determine the angular magnification obtained.

(3marks)

e). An astronomical telescope has an object glass of focal length 50 cm and an eye lens of focal length 5 cm.

(i) What is its magnifying power?

(2marks)

(ii) If it is assumed that the eye is placed very close to the eye lens and that the pupil of the eye has a diameter of 3 mm, what will be the diameter of the object glass if all the light passing through the object glass is to emerge as a beam which fills the pupil of the eye?

(3marks)

QUESTION FOUR (20 MKS)

a). Using luminance explain why white chalk is more visible on a black board than a blue board.

(2marks)

b). A ray of light is incident at an air glass interface at an angle $\beta 1$ to the normal and is refracted into glass of refractive index n at an angle $\beta 2$ to the normal. By applying Fermat's principle, state the relationship between n, $\beta 1$, and $\beta 2$.

(2marks)

c). Find the minimum height of a plane mirror needed for a person of height 1.6 meters to see her entire self in the mirror.

(2maks)

d). A photometric balance is obtained between two lamps A and B when B is 100cm from the photometer. When a block of glass G is placed between A and the photometer, balance is restored by moving B through 5 cm. Where must B be placed in order to maintain the balance when two more blocks, identical with G, are similarly placed between A and the photometer.

(6marks)

e). An area of 2 m^2 is illuminated by a lamp of 100 candela at a distance of 20 m away.
Find (i) the flux F in lumens emitted all around the lamp

(2marks)

(ii) The total flux on an area of two square meters.

(2marks)

f). Explain the term "luminous energy".

(2marks)

g). Arrange the following in ascending order of wavelength:
Longwave, Gamma rays, Microwave, Xrays,

(2marks)

QUESTION FIVE. (20MKS)

a). What do you understand by the angular magnification, m of a magnifying glass? Illustrate your answer with a ray diagram.

(3marks)

b). A man 2m tall, whose eye level is 1.84 m above the ground, looks at his image in a vertical mirror. What is the minimum vertical length of the mirror if the man is to be able to see the whole of himself ?

(3marks)

c). The refractive index of a transparent liquid for red light is 1.634 and the difference between the critical angles for red and blue light at the liquid-air interface is 0.93^{o}. What is the refractive index of the liquid for blue light?

(5marks)

d). Two plane mirrors are stood vertically making a right angle between them. A point object is placed 2 cm from each of the mirrors. By accurate drawing, find the number of images formed

(3marks)

e). A 5 cm tall object is placed 20 cm from a converging mirror of focal length 40 cm. By accurate scale drawing obtain the position, size, magnification and nature of the image.

(6marks).