Sir Arthur Lewis Community College

Division of Technical Education and Management Studies

Department of Engineering

SIR ARTHUR LEWIS COMMUNITY COLLEGE
HUNTER J FRANCOIS
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Morne Fortune Castries, Saint Lucia

Alternate Examination May 2014

PROGRAMME TITLE(S) : Computer System Engineering, Electronic Engineering, Automotive Engineering, Mechanical Technicians

PROGRAMME CODE(S) : 3EE-CMS-AD 3EE-ESC-AD 3ME-MEC-AD 3ME-AUT-AD

COURSE TITLE : **Applied Engineering Science 1**

COURSE CODE : **ESC 103**

DURATION : 3 HOURS

TIME AND DATE :

ROOM :

COURSE TUTOR : Mr. Narpaul Heeralall & Mr. F. Combie

INVIGILATOR(S) :

Students ID Number :

INSTRUCTIONS

*This paper has two sections **A** & **B**

*There are **TWELVE** questions. All questions carry equal marks

*You are to answer **FOUR QUESTIONS ONLY** from **EACH** section

*Ensure your answers and pages are numbered correctly

*Diagrams MUST be neat and clear.

*Do all work in blue or black ink pen.

*Enter the questions you have attempted, in the order they appear in you answer booklet, on the table below.

DO NOT TURN THIS COVER SHEET UNTIL

YOU ARE TOLD TO DO SO

Write the numbers of the questions you attempted in this table

Questions								
Marks								

SECTION A
(ANSWER ANY 4 QUESTIONS)

Question 1 -*12 marks*

Fig 1 shows a scanner in which a laser beam is directed on to a rotating plain mirror. The mirror has a diameter of 25mm and the laser bean is offset from centre by 10mm. As the mirror rotates it intersects the beam which is reflected towards the target area.

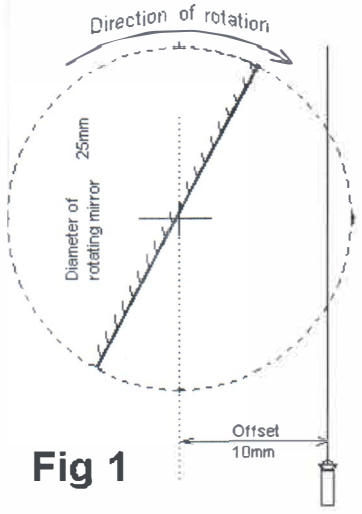


Fig 1

a) Draw a ray diagram showing how the reflected beam will sweep an arc across the target area. [2]

b) Calculate the angle of the arc through which the beam scans. [4]

c) What should be the offset if the reflected ray is to scan an arc of 75°. [4]

d) If the beam must scan the target area at a rate of 2.75 radians per sec, what should be the speed of rotation of the mirror (in rev per min)? [2]

Question 2 -*12 marks*

A spherical mirror of radius of curvature 90mm is used to form an inverted image of an object. If the image is to be five times as tall as the object then

a) Draw the ray diagram to show the type of mirror used, where should the object be placed relative to the mirror, the nature and relative size of the image. [4]

b) Calculate the distance between the object and the mirror [4]

c) Calculate the location of the object if the image was to be upright. [4]

Question 3 -*12 marks*

When viewed with a certain spherical **lens** an object 3.5 mm tall and 8.0 cm away from the **lens** appears to be upright and 10 mm tall.

a) Draw the ray diagram showing how the image is formed. [4]

b) Calculate the focal length of the lens [5]

c) If an object is located 12 cm away from this lens calculate the magnification of the image that will result. [3]

Question 4 -*12 marks*

Two radar transmission towers located 6.4 km apart emit identical signals of wavelength 420 meters. A ship located at a point 30 km equidistant from the towers, experiences a strong signal from the towers. However, as it sails parallel to the line of the towers it experiences an alternating diminishing and re-strengthen of the signal strength.

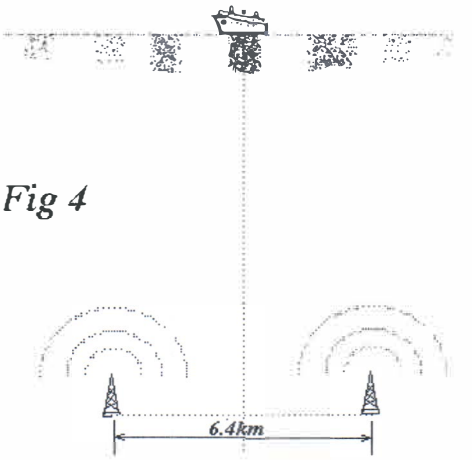


Fig 4

a) Calculate the distance between the points of minimum signal strength. [6]

b) What would be the effect on the distance between strong signals if:

i. The distance between the towers was decreased

ii. The ship was a greater distance away from the towers

iii. The signals had a longer wavelength [3]

c) Given that the wavelength of the signal emitted by the towers is 450m, then:

i. What is its frequency? [2]

ii. Name the frequency band this signal would classified as. [1]

Question 5 -*12 marks*

a) In a simple pipe (fig 5), a ray of light must be transmitted, with minimum loss, along a core. List **three** major conditions, for this to be possible. [3]

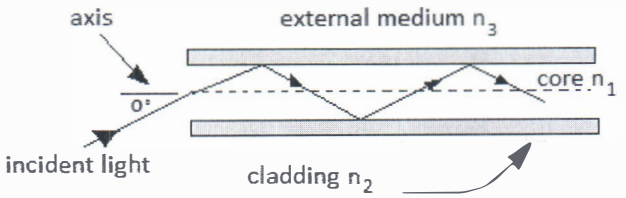
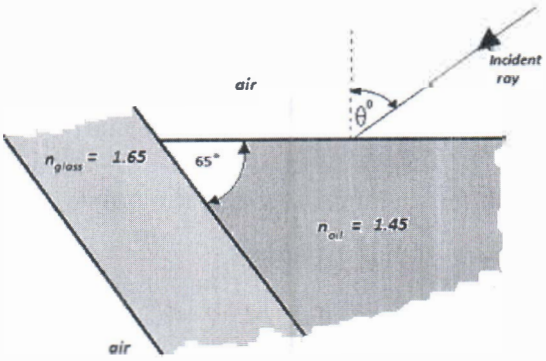


fig 5

b) The diagram shows a ray light, entering the surface of oil at an unknown angle of incidence θ^o. The light passes through the oil, strikes and enters the glass and is just totally internally reflected at the glass/air boundary.

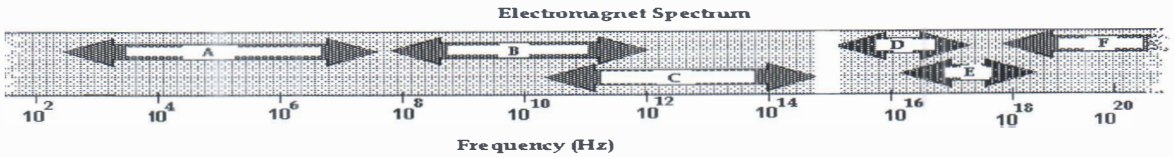


i. Calculate the critical angle at the glass/air boundary. [2]

ii. Hence determine the path the light takes, as it passes through the different media. Calculate the angles of incident and refraction at each surface. [7]

Question 6 *-12 marks*

a) State briefly Maxwell's equations (in worded form). [3]



b) i. Identify the frequency bands A,B,C,D,E and F in the Electromagnetic spectrum above and state one specific application of each. [6]

ii. Refer to the electromagnetic spectrum above. Explain why it is usually possible for us to see through the glass door of the domestic microwave oven, yet the microwave radiation cannot escape through the door and cause harm. [3]

SECTION B
(ANSWER ANY 4 QUESTIONS)

Question 7 *-12 marks*

a) Define a simple harmonic oscillator. [2]

b) A vertical spring, fixed at the upper end, has a mass of $620g$ attached to its lower end. When the spring is given a small extension, it was observed to oscillate at a rate of 45 cycles per minute. When an additional mass m is attached to the spring it oscillates at a rate of 30 cycles per minute.

i. Calculate the spring constant. [2]
ii. Calculate the extension produced by the 620 g mass. [1]
iii. What is the value of m. [2]
iv. What is the total extension on the system? [1]
v. If the spring is given an additional deflection of 12 cm, calculate the potential energy stored in the system. [2]
vi. What is the velocity of the mass as it passes through the equilibrium point? [2]

Question 8 *-12 marks*

a) A string under tension is set in vibration to produce its third harmonic, how many antinodes will exists on the string. [1]

b) A cord of mass 200 grams and length 2.5 m is stretched between two supports 2.2 meters apart. If the tension in the cord is 968N, how long will it take for a pulse to travel from one support to the other? [4]

c) What are the first three resonant frequency will the string produce if struck? [3]

d) By what percentage should the tension on a stretched string of unknown length and mass be adjusted for the fundamental frequency to change by 10% [4]

Question 9 - *12 marks*

a) Explain the apparent change of frequency of a sound as the source and observer move relative to each other. [3]

b) The predominant frequency of a certain police car's siren is 1800 Hz when at rest. What frequency would you detect, if the police car moves with a speed of 30.0 m/s away from you. [4]

c) A technician in the pits at the NASCAR tracks, observes the sound from an approaching racecar to be of frequency 12560 Hz. After the racecar passes his location, the frequency was measured to be 11860Hz. Calculate how fast was the racecar moving? [5]

Question 10 – *12 marks*

a) An organ pipe can resonate at frequencies of 234Hz, 390Hz and 546Hz but not at any other frequencies between 234Hz and 546Hz. Show whether this is this an open pipe or a closed pipe and calculate the fundamental frequency. [4]

b) Two dog whistles, when blown individually produce no audible sound. However, when blown together produces an audible note of 5000Hz. Explain why is it possible to hear a note when blown together, but not when blown individually. [4]

c) If when one of the whistles is replaced with a third whistle labeled 20000Hz and blown together with the first, a note of 7000Hz is heard, what are the frequencies of the whistles? [4]

Question 11 - *12 marks*

a) Light – wave or particle
   i. List **five** pieces of evidence to support the dual nature of light.
   ii. List **one** that does not support this theory. [3]

b) Explain two that support and one that refutes this theory. [9]

Question 12 - *12 marks*

Explain briefly the following terms:

a) Transverse wave [1]
b) Standing wave [1]
c) Resonance [1]
d) Echo location [1]
e) Wave front [1]
f) Harmonics [1]
g) Decibel [1]
h) Fundamental note [1]
i) Human audio range [1]
j) Beats [2]
k) Inverse square law [1]